

**ELECTRICAL ONE-LINE DIAGRAM**

NO SCALE

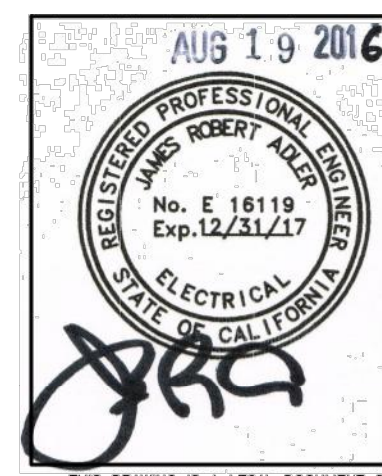
**KEY NOTES :**

- ① (3) 400 MCM CU THWN-2, (1) #1/0 CU THWN-2 NEUTRAL, (1) #4 CU GRD, 3" CONDUIT.
- ② (3) #8 CU THWN-2, (1) #8 CU GRD, 1" CONDUIT.
- ③ (3) #3 CU THWN, (1) #6 CU GRD, 1 1/4" CONDUIT.
- ④ (3) 600 MCM CU THWN, (1) #4/0 CU THWN NEUTRAL, (1) #1/0 CU GRD.
- ⑤ INCLUDE MANUFACTURER OPTIONS MOTOR ELAPSED TIME METER, H-O-A SELECTOR SWITCH, RUN PILOT LIGHT, & NAMEPLATE.
- ⑥ INSTALL NEW BRANCH CIRCUIT BREAKERS TO MATCH EXISTING (20A/1P LIGHTING, 20A/1P BOOSTER CONTROL, 20A/1P BOOSTER WELL CONTROL, 20A/1P GENSET BATTERY CHARGER, 20A/1P OUTDOOR RECEPTACLES, 60A/2P WELDER/EQUIPMENT RECEPTACLE, 20A/1P SPARE). RECONNECT EXISTING BRANCH CIRCUITS & LABEL PER SPECIFICATIONS.
- ⑦ RELOCATE EXISTING FEEDER FROM EXISTING EQUIPMENT TO NEW EQUIPMENT.
- ⑧ RELOCATE & CONNECT EXISTING FEEDER TO NEW MOTOR SMARTER.
- ⑨ NEW AUTO DIALER PER OWNER NEEDS & REQUIREMENTS. AUTODIALER TO MONITOR ALARM CONDITIONS INCLUDING HIGH & LOW WATER LEVEL CONDITIONS, PUMP FAILURES, & ATS/GENSET ALARM CONDITIONS. MINIMUM 8 MONITOR INPUTS, PLC INTERFACE, SOLID STATE MESSAGE RECORDING, 120V W/ BATTERY BACKUP. PROVIDE PHONE LINES IN CONDUIT AND CONNECT TO NEAREST AVAILABLE TELEPHONE LINES OR PROVIDE ALTERNATE CELLULAR OPTION. (RACQ VERBATIM OR EQUAL.)
- ⑩ PLC & OPERATOR INTERFACE, A-B ROCKWELL MICROLOGIX WITH PANEL VIEW PLUS 700, TOUCH PAD INPUT, 10" COLOR DISPLAY, 120V INPUT, MULTI-APPLICATION 256MB RAM. COORDINATE WITH CIVIL ENGINEER TO PROGRAM WELLS & BOOSTER PUMP CONTROLS INTERFACE. SEE CIVIL SHEETS C2 & C3 FOR CONTROL PARAMETERS. DESIGN, ASSEMBLE, & INSTALL NEW PUMP PLC CONTROLS COMPATIBLE TO NEW & EXISTING MOTOR CONTROLS & PUMPS & NEW MCC. VERIFY EXISTING PUMP CONTROLS INCLUDING TANK LEVEL CONTROLLED START/STOP, TANK SELECTOR SWITCH TO SELECT BETWEEN NORTH TANK & SOUTH TANK LEVEL CONTROLS, BOOSTER PUMP CONTROL, & MOTOR PROTECTION CIRCUITS. VERIFY NEW PARAMETERS IN THE CIVIL PLANS. INPUTS AT THE NEW PLC WILL INCLUDE THE EXISTING WELL PUMP START CIRCUIT, THE BOOSTER PUMPS START & SHUTOFF CIRCUITS, PRESSURE SWITCHES, THE A.T.S. EMERGENCY POWER SIGNAL TO LOCK OUT DESIGNATED PUMPS UPON TRANSFER TO EMERGENCY POWER (NOTE 10), & MOTOR PROTECTION CIRCUITS. COORDINATE FINAL ADJUSTMENT OF PLC & VFD'S WITH THE CIVIL ENGINEER.
- ⑪ RELOCATE EXISTING TANK SELECTOR SWITCH & PUMP ELAPSED TIME METERS FROM MCC TO BE REMOVED TO NEW MCC. PROVIDE & INSTALL ALL WIRING & CONDUIT TO MATCH EXISTING AS REQUIRED TO RELOCATE THE EQUIPMENT.
- ⑫ COORDINATE W/I.L.D. TO UPGRADE EXISTING POLE MOUNT XFMR'S & UG SERVICE FROM 300A TO 400A. TRENCH, BACKFILL, & CONDUIT PER I.L.D. DRAWINGS & SPECS.
- ⑬ EXISTING FEEDER.

**NOTES (ONE-LINE DIAGRAM):**

1. PROVIDE RATED EQUIPMENT & DEVICES BY MANUFACTURER CAPABLE OF SAFELY INTERRUPTING THE AVAILABLE FAULT CURRENT.
2. PROVIDE WARNING LABELS & MARKING BY MANUFACTURER AT ALL SWITCHBOARDS, PANELBOARDS, & INDUSTRIAL CONTROL PANELS/MCC'S LIKELY TO CREATE ARC FLASH CONDITIONS AS REQUIRED BY NEC ART. 110.16.
3. LABEL & MARK MAIN SERVICE DISCONNECT(S) PER NEC. MAXIMUM OF 6 DISCONNECTS PERMITTED PER NEC.
4. MCC, PLC, & VFD'S SHALL BE DESIGNED & MANUFACTURED FOR OPERATION IN AN OUTDOOR ENVIRONMENT WITH A MINIMUM AMBIENT OF 50°C. (122°F.). PROVIDE AMBIENT COMPENSATED CB'S, OVERLOAD RELAYS, WIRING, CT'S, & ACCESSORIES AS REQUIRED BY MANUFACTURER.
5. SES, MCC, & ANCHORS SHALL BE DESIGNED & MANUFACTURED AS REQUIRED FOR WIND VELOCITIES UP TO 90 MPH & SEISMIC ZONE 4/DESIGN CATEGORY D.
6. PROVIDE SERVICES OF MANUFACTURER'S TECHNICAL REPRESENTATIVE AS REQUIRED TO SET UP, CONNECT, TEST, DEMONSTRATE, & TRAIN FOR PROPER INSTALLATION & OPERATION OF VFD'S, PLC, & AUTODIALER.
7. MCC MOUNT HUMAN INTERFACE MODULE (HIM) SHALL BE BY MCC/VFD MANUFACTURER. HIM SHALL BE LCD DISPLAY WITH FULL NUMERIC KEYPAD. (ALLEN-BRADLEY 20-HIM-A3 OR EQUAL.)
8. THE EXISTING SES, MCC, MOTOR CONTROLLERS, & CONTROLS ARE UNDERSIZED FOR THE NEW WORK AND OBSOLETE AND WILL BE REPLACED UNDER THIS PROJECT. THE EXISTING GENERATOR IS NEW AND WILL REMAIN. THE EXISTING ATS IS NEW AND WILL BE RELOCATED TO A NEW ENCLOSURE UNDER THIS PROJECT. THE CONTRACTOR SHALL MAINTAIN THE WATER TREATMENT PLANT IN OPERATION AT ALL TIMES BY PHASING THE WORK AS FOLLOWS OR BY AN ALTERNATE SCHEDULE/PHASING PLAN TO BE PROPOSED & SUBMITTED BY THE CONTRACTOR & APPROVED BY THE OWNER.
  - A. INSTALL NEW SES W/DISTRIBUTION SWITCHBOARD & ATS ENCLOSURE. INSTALL TEMPORARY ATS BYPASS FEEDER BETWEEN SES, MCB & SWITCHBOARD. INSPECT & TEST SES. COORDINATE WITH I.L.D. & ENERGIZE SES. RELOCATE ALL EXISTING FEEDERS TO NEW DISTRIBUTION SECTION. RELOCATE OR PROVIDE & INSTALL TEMPORARY FEEDER FROM NEW SES TO TEMPORARILY RECONNECT EXISTING MCC & PUMP CONTROLLERS TO NEW SES.
  - B. COORDINATE WITH I.L.D. & SHUT DOWN/DE-ENERGIZE EXISTING SES. RELOCATE (E) ATS & (E) GENERATOR FEEDER TO NEW ENCLOSURE AT NEW SES. REMOVE TEMPORARY BYPASS & CONNECT LOAD, NORMAL, & EMERGENCY FEEDERS AS SHOWN. INSPECT & RETEST ATS.
  - C. REMOVE & DISPOSE (E) SES & (E) ATS ENCLOSURE. REMOVE OR TEMPORARILY RELOCATE (E) MCC AS REQUIRED TO PROVIDE TEMPORARY POWER AND CONTROLS TO ACTIVE EQUIPMENT.
  - D. INSTALL NEW MCC WITH PANEL 'A'. RELOCATE FINAL REMAINING ACTIVE CIRCUITS TO NEW MCC & PANEL 'A'. REMOVE & DISPOSE (E) MCC.
9. COORDINATE OUTAGES WITH OWNER & MINIMIZE DISRUPTION TO NORMAL OPERATIONS. OUTAGES SHALL BE SCHEDULED FOR MAXIMUM 30 MINUTES DURATION AS SCHEDULED IN ADVANCE WITH THE OWNER. PROVIDE TEMPORARY PORTABLE GENERATOR UNIT AS REQUIRED TO POWER WATER TREATMENT PLANT DURING OUTAGES LONGER THAN 30 MINUTES IN DURATION.
10. EXISTING CATERPILLAR D80-6 80KW GENERATOR SET IS ABLE TO PROVIDE 240.6A EMERGENCY POWER WHICH IS INADEQUATE TO POWER THE ENTIRE PLANT AT 100% OPERATIONAL CAPACITY. THE GENERATOR IS SUFFICIENTLY SIZED TO POWER (1) 15HP WELL PUMP, (1) 10HP VFD BOOSTER PUMP, & (3) 20HP SOFT START BOOSTER PUMPS AT FULL LOAD ALONG WITH MINIMAL ACCESSORY LOADS. ADDITIONAL PUMPS AT FULL LOAD WOULD PUT THE GENERATOR SET INTO AN OVERLOAD CONDITION. PLC PUMP CONTROLS SHALL INCLUDE CIRCUITRY FROM THE A.T.S. TO SIGNAL THE PLC TO LOCK OUT A 2ND WELL PUMP & A 4TH BOOSTER PUMP WHILE RUNNING ON EMERGENCY POWER.
11. DESIGNATE, INSTALL, MARK & LABEL 'B' PHASE AS THE HIGH-LEG OF THE 240V 3-PHASE DELTA SYSTEM ON ALL LOAD SIDE EQUIPMENT PER NEC. ('C' PHASE SHALL BE PERMITTED TO BE THE HIGH-LEG ON UTILITY COMPANY EQUIPMENT ONLY.)

LOAD SUMMARY (NEW 400A SES) (AMPS @ 120/240V/3PH)					
EQUIPMENT	HP	QTY	LOAD	TOTAL LOAD	TOTAL AMPS
<b>NEW SES &amp; SWITCHBOARD</b>					
<b>NEW MCC</b>					
PLC, AUTODIALER, CONTROLS	-	-	1,500 VA		
EXISTING LIGHTING (ESTIMATED)	-	-	1,500 VA		
EXISTING GENSET BATTERY CHARGER	-	-	1,500 VA		
EXISTING OUTDOOR RECEPTACLES (ESTIMATED)	-	-	540 VA		
EXISTING MISCELLANEOUS (ESTIMATED)	-	-	2,500 VA		
BOOSTER PUMPS	10	2	23,278 VA		
BOOSTER PUMPS	20	3	67,341 VA		
25% LARGEST MOTOR	20	0.25	5,612 VA	103,771 VA	249.6 AMPS
<b>WELL PUMPS</b>					
VENTILATION SYSTEM BLOWER	15	2	34,918 VA		
BUILDING PANELS (ESTIMATED LOAD)	-	-	1,500 VA	48,418 VA	116.5 AMPS
<b>TOTAL</b>				<b>152,189 VA</b>	<b>366.1 AMPS</b>



**JOLENTERPRISES, INC.**  
720 E. 50th Street, Suite 5  
Yuma, Arizona, 85305

office: (928) 783-0922  
fax: (928) 783-3954  
www.jolenterprises.com

JOB. No.: 16-036

**WINTERHAVEN WATER/SEWER IMPROVEMENT**

**W.T.P. ELECTRICAL ONE-LINE DIAGRAM**



**Nicklaus Engineering Inc.**  
1851 West 24th Street, P.O. Box 6029  
YUMA, ARIZONA 85364 (928)344-8374  
Email: nel@nelaw.com

SCALE: NONE  
DATE: JUNE, 2016  
DES. BY: JRA  
DRAWN BY: VED  
SURVEYED BY: RS  
JOB. No.: 016-0039  
SHEET 12 OF 17

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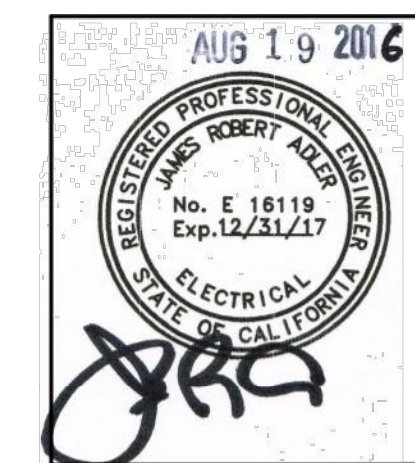
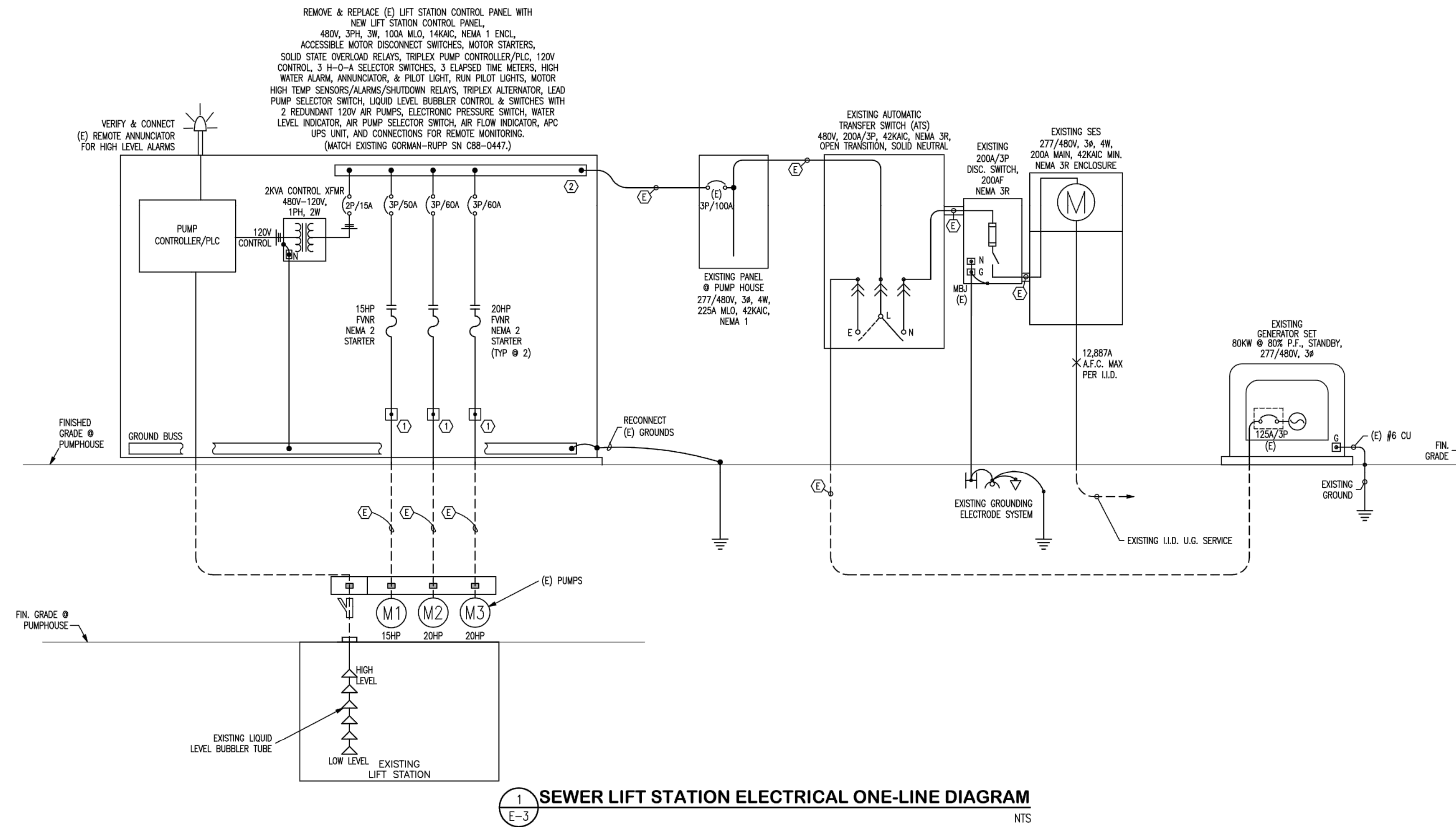


**NOTES (ONE-LINE DIAGRAM):**

1. PROVIDE RATED EQUIPMENT & DEVICES BY MANUFACTURER CAPABLE OF SAFELY INTERRUPTING THE AVAILABLE FAULT CURRENT.
2. PROVIDE WARNING LABELS & MARKING BY MANUFACTURER AT ALL SWITCHBOARDS, PANELBOARDS, & INDUSTRIAL CONTROL PANELS/MCC'S LIKELY TO CREATE ARC FLASH CONDITIONS AS REQUIRED BY NEC ART. 110.16.
3. LABEL & MARK MAIN SERVICE DISCONNECT(S) PER NEC. MAXIMUM OF 6 DISCONNECTS PERMITTED PER NEC.
4. CONTROL PANEL SHALL BE DESIGNED & MANUFACTURED FOR OPERATION IN AN OUTDOOR ENVIRONMENT WITH A MAXIMUM AMBIENT OF 50°C. (122°F). PROVIDE ADDITIONAL VENTILATION AND AMBIENT COMPENSATED CB'S, OVERLOAD RELAYS, WIRING, CT'S, & ACCESSORIES AS REQUIRED BY MANUFACTURER.
5. CONTROL PANEL & SUPPORTS SHALL BE DESIGNED & MANUFACTURED AS REQUIRED FOR SEISMIC ZONE 4 DESIGN CATEGORY D.
6. PROVIDE SERVICES OF MANUFACTURER'S TECHNICAL REPRESENTATIVE AS REQUIRED TO SET UP, CONNECT, TEST, DEMONSTRATE, & TRAIN FOR PROPER INSTALLATION & OPERATION OF CONTROL PANEL.
7. THE CONTRACTOR SHALL MAINTAIN THE PUMP STATION IN OPERATION AT ALL TIMES BY PHASING THE WORK AS FOLLOWS OR BY AN ALTERNATE SCHEDULE/PHASING PLAN TO BE PROPOSED & SUBMITTED BY THE CONTRACTOR & APPROVED BY THE OWNER. NEW CONTROL PANEL SHALL BE ASSEMBLED & PREPARED FOR INSTALLATION PRIOR TO ANY WORK AT THE PUMP STATION. TEMPORARILY RELOCATE THE EXISTING CONTROL PANEL TO THE SOUTH WALL ADJACENT THE PERMANENT CONTROL PANEL LOCATION. MAINTAIN CONTROL PANEL IN SERVICE UNTIL THE NEW CONTROL PANEL IS INSTALLED, OPERATIONAL, & PUT INTO SERVICE. BOTH NEW & EXISTING CONTROL PANELS MAY BE TAPPED FROM THE 3P/100A CIRCUIT BREAKER UNTIL THE NEW CONTROL PANEL IS IN SERVICE. RELOCATE PUMP CIRCUITS TO NEW PANEL & REMOVE EXISTING CONTROL PANEL ONCE THE NEW CONTROL PANEL IS IN SERVICE.
8. COORDINATE OUTAGES WITH OWNER & MINIMIZE DISRUPTION TO NORMAL OPERATIONS. OUTAGES SHALL BE SCHEDULED FOR MAXIMUM 30 MINUTES DURATION AS SCHEDULED IN ADVANCE WITH THE OWNER.
9. SEE CIVIL PLANS, SHEETS C-7 & C-8, FOR SITE & PLAN DRAWINGS.

**KEY NOTES :**

- ① RECONNECT EXISTING PUMP CIRCUIT TO NEW CONTROL PANEL.
- ② RECONNECT EXISTING PUMP CONTROL PANEL FEEDER TO NEW PUMP CONTROL PANEL.
- ③ NEW AUTO DIALER PER OWNER NEEDS & REQUIREMENTS. AUTO DIALER TO MONITOR ALARM CONDITIONS INCLUDING HIGH & LOW WATER LEVEL CONDITIONS, PUMP FAILURES, & ATS/GENSET ALARM CONDITIONS. MINIMUM 8 MONITOR INPUTS, PLC INTERFACE, SOLID STATE MESSAGE RECORDING, 120V W/ BATTERY BACKUP. PROVIDE PHONE LINES IN CONDUIT AND CONNECT TO NEAREST AVAILABLE TELEPHONE LINES OR PROVIDE ALTERNATE CELLULAR OPTION. (RACO VERBATIM OR EQUAL.)
- (E) EXISTING FEEDER OR PUMP CIRCUIT.



**JOLENTERPRISES, INC.**  
720 E. 50th Place, Suite 5  
Yuma, Arizona, 85305

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fax: (928) 783-3954  
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JOB. No.: 16-036

**WINTERHAVEN WATER/SEWER IMPROVEMENT**

**LIFT STATION ELECTRICAL ONE-LINE DIAGRAM**

SCALE: NONE  
DATE: JUNE, 2016  
DES. BY: JRA  
DRAWN BY: VED  
SURVEYED BY: RS  
JOB. No.: 016-0039  
SHEET 13 OF 17

**Nicklaus Engineering Inc.**  
1851 West 24th Street, P.O. Box 6029  
YUMA, ARIZONA 85364 (928)344-8374  
Email: nel@nelaw.com

**E-3**

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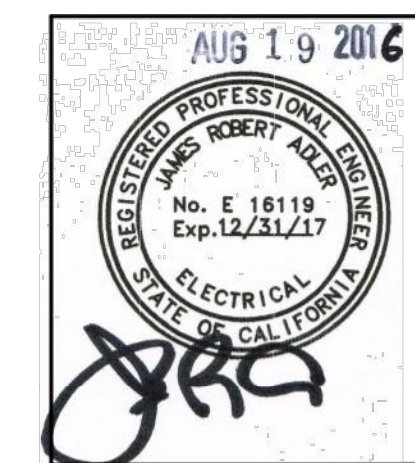
GENERAL PROVISIONS FOR ELECTRICAL WORK

1. PART ONE --- GENERAL
- 1.1. WORK SPECIFIED HEREIN
- A. Provide all labor, materials, equipment, services and transportation necessary to receive, install, adjust and put into operation complete electrical systems as indicated or specified. Provide products not mentioned but obviously necessary and incidental to the completion of this work.
- 1.2. EQUIPMENT FURNISHED BY OTHERS & INSTALLED BY ELECTRICIAN
- A. Mount and install unmounted motor starters and equipment not in motor control centers, related to:
- HVAC System.
- B. Provide power, control, and interlock electrical wiring for mechanical equipment and systems.
- 1.3. POWERED EQUIPMENT ELECTRICAL EQUIPMENT CONNECTIONS
- A. Make final connections to electrical equipment, furnished and set in place under other sections as shown or specified. Provide disconnect switches, conduits, wire, outlet boxes, and other required appurtenances.
- B. Rough-in and connections work shall be done in strict accordance with shop drawing and details furnished by the equipment supplier. Connections shall be made as directed, and shall be checked and approved by the party furnishing the equipment. Suppliers shall furnish shop drawings indicating exact locations, power requirements, and details, which shall govern in the installation of rough-in requirements. Verify requirements before installing work. Coordinate completely with affected trades.
- C. Include descriptive data showing complete arrangements, construction, electrical, optical, physical, and quality characteristics for materials and equipment. Submit shop drawings of electrical closets, shafts, major conductor routing, and mechanical/electrical rooms.
- 1.4. CODES, LAWS, AND ORDINANCES
- A. Work shall be performed in accordance with the current rules and regulations of:
- National Electrical Code (NEC).
  - Underwriter's Laboratories, Inc. (UL).
  - Insulated Power Cable Engineers Association (IPCEA).
  - National Electrical Manufacturers Association (NEMA).
  - National Fire Protection Association (NFPA).
  - Occupational Safety and Health Administration (OSHA).
  - National Electrical Safety Code.
  - Applicable Local Codes, Laws and Ordinances.
2. PART TWO --- BASIC MATERIALS AND IDENTIFICATION
- 2.1. MATERIALS
- A. Materials and products included in this work shall be listed, labeled or certified by Underwriters Laboratories, Inc.
- 2.2. HANGERS AND SUPPORTS
- A. Suspend and support horizontal and vertical conduit from approved hangers and structural steel supports, spaced as scheduled. Provide necessary accessories, nuts, lock nuts, bolts, rods and devices to allow installation to freely expand and contract. Hangers shall be formed steel with adjustable attachment to hanger rod.
- 2.3. EQUIPMENT FOUNDATIONS
- A. Floor mounted electrical equipment shall be mounted on concrete housekeeping pads at least 4" higher than final grade, poured integral with the floor slab wherever practicable.
- B. Where required, pads shall extend a minimum of 36" in front of equipment where necessary to afford operating surface no more than 78" beneath the center of the highest operating handle in it's highest position. Slope to drain away from equipment.
- C. Coordinate pad sizes and locations for pad mounted transformer with serving utility company.
- 2.4. IDENTIFICATION
- A. Products shall be identified as specified in "General Requirements for Electrical Work" and equipped with identification as follows:
- Manufacturer's attached circuit number identification at each panelboard and branch circuit overcurrent device.
  - A typed circuit directory identifying use of each panelboard branch circuit overcurrent device.
- B. Provide permanently attached engraved laminated plastic nameplate to indicate:
- Identity of each transformer, switchboard, switchgear assembly, motor control center, distribution panel, panelboard, and individually enclosed overcurrent device, using the identification shown on the contract drawings.
  - Circuit number and equipment supplied, at each switchboard, switchgear, motor control center, and distribution panel overcurrent device.
  - Use of equipment disconnecting devices by identifying the equipment disconnected.
  - The identity of signal, alarm, and communications cabinet, racks, and other enclosures using the identification shown on the drawings.
- C. Identify underground conduits using one detectable underground warning tape per trench at 3 inches below grade. Tape shall be 4 inch wide plastic tape with suitable color and warning legend describing buried electrical/communications lines.
3. PART THREE --- SERVICE, GENERAL WIRING AND GROUNDING
- 3.1. UTILITY COORDINATION AND CHARGES
- A. Coordinate, verify, and include all construction and support work required by utilities in the bid. Immediately upon award of contract, coordinate with utilities to finalize the utility company construction requirements. Coordinate between utilities and owner to quantify and finalize total utility company service charges and the owner's direct payment of service charges to the utilities for serving electrical, telephone, and/or cable television utilities. Include in bid and provide all construction work, materials, etc., required by the utilities such as trenching, backfill, conduit, transformer pads, grounding, etc. required to provide complete electrical and telephone service to this project.
- 3.2. ELECTRICAL SERVICE
- A. Contact local power company and obtain written verification of service capacity and fault current available at secondary bushings of service transformer. A copy of each report shall be forwarded to the Architect prior to submission of switchgear for approval.
- B. Power company serving project: Imperial Irrigation District (I.I.D.)
- C. WORK EXCLUDED:
- Primary service cables and service connections to the extent supplied by utility.
  - Service transformer.
  - Service metering equipment to the extent supplied by utility.
- D. WORK INCLUDED:
- Cooperate with serving utility, make all connections, metering arrangements, and layout compatible with the equipment provided by the utility.
  - Electrical contractor will provide service transformer concrete pads, trenching, and conduit in accordance with utility company requirements; coordinate.
  - Provide service transformer grounding in accordance with utility company requirements.
- 3.3. GENERAL WIRING REQUIREMENTS
- A. Enclose interior wiring in metal raceways, boxes, outlets, cabinets, wireways, gutters, or other metal enclosures. Use non-metallic products to enclose wiring only where so specified. Use open wiring only where so specified.
- 3.4. GROUNDING
- A. Provide wiring, connections and devices necessary to comply with the grounding requirements of the local authorities and the National Electrical Code. Exposed non-current carrying metallic parts of the electrical equipment, raceway systems, grounding conductors and neutral conductor of the wiring system shall be grounded.

- 3.5. CALIBRATION AND TESTING OF EQUIPMENT AND WIRING SYSTEMS
- A. Equipment: Shall be tested and adjusted to insure correct functional performance. Inspect, lubricate, test and adjust equipment and correct defects or damages before connecting the equipment and correct defects or damages before connecting the equipment to the system.
- 3.6. WIRING
- A. Test power, lighting and control wiring for continuity, short circuits and improper grounding.
- B. Test feeder and power circuits No. 8 AWG or larger with a "megger" from each conductor to ground and between conductors. Record each reading. At the completion of work, deliver a copy of these "megger" readings to the Architect/owner.
- 3.7. SITE WORK
- A. Contractor shall employ independent locating service to locate and verify all existing services, whether specifically shown on the drawing or not. Location of services shall be recorded on record documents. No trenching or excavation shall commence until locations are verified. The Owner shall be notified in writing prior to any trenching requiring a utility shutdown. Any services interrupted by trenching or excavating shall be repaired by the contractor with no additional cost to the Owner. Existing services not specifically indicated on the drawings to be relocated, which interfere with building components, shall be brought to the Engineer's immediate attention. Prepare drawings showing proposed re-routing, area(s) affected, and length of interruption(s).
- 3.8. ELECTRIC WIRING FOR MECHANICAL EQUIPMENT
- A. Provide wiring in connection with motor driven mechanical equipment required for "hand" operation of each motor or appliance, with cover mounted "hand-off-auto" selector switch on motor starter in "hand" position.
4. PART FOUR --- WIRE, CONDUIT, DEVICES, LIGHTING
- 4.1. EQUIPMENT WITHSTAND RATINGS
- A. Electrical equipment, circuit protective devices, bussing, and switches shall be rated to interrupt or withstand short circuit faults greater than the available fault current.
- 4.2. WIRE AND CABLE
- A. Wire and cable for feeder and branch circuits shall conform to the requirements of the current edition of the National Electric Code, and shall meet applicable ASTM specifications. Conductors shall be soft drawn, annealed 58K conductivity copper. Wire and cable shall be new, shall have size, type of insulation, voltage rating and manufacturer's name permanently marked on the outer covering at regular intervals. Conductors No. 6 AWG and smaller shall be color coded. Colors for each phase and neutral shall be consistent throughout the system.
- B. Provide conductors with insulation rated for 600 volts unless specified or indicated otherwise.
- NEC type TEW, THW, XHWN, THWN, or THHN solid or stranded for number 10 AWG or smaller, except TW not allowed for motor.
  - NEC type THW, XHWN, THWN or THHN stranded for number 8 and larger.
  - NEC type TEW, THW, NMW, AWA or AVL for branch circuit wiring through light fixtures not approved for TW wiring.
- 4.3. CONDUIT AND RACEWAYS
- A. Provide electrical metallic tubing (EMT) within structure, or except as specified otherwise or for the following:
- Outside structure or on roof.
  - At or below grade (concealed).
  - In or beneath slabs of grade.
  - Where exposed to physical damage (interior grade to 5'-0").
  - Where subject to excess moisture and deterioration.
- B. Rigid steel conduit (RSC) shall be used in the following locations:
- In locations where electrical metallic tubing is not permitted and other raceway is not required.
  - At drop connections to motors.
  - Intermediate metal conduit (IMC) may be substituted for RSC if approved by code authority.
  - Rigid aluminum conduit (ARC) may be used in sizes 2-1/2" and larger in lieu of rigid steel conduit except in contact with concrete or embedded in concrete.
  - Provide flexible conduit for transformer connections and at equipment requiring adjustments or removal for service not subject to moisture.
  - Provide liquid-tight flexible conduit for each motor and rotating device for power and control, and for other equipment requiring adjustments or removal for service in mechanical rooms or where subject to moisture or weather.
  - Provide non-metallic conduit (and grounding conductor) with rigid steel riser stub-ups for burial in the earth.
  - Non-metallic conduit (and ground conductor) with rigid steel riser stub-ups used for slabs on grade.
  - Acceptable manufacturers. All manufacturers providing NEMA and UL listed materials.
  - PVC conduit shall be NEMA TC2 Schedule 40 or 80 PVC. Use PVC conduit at exterior underground locations and under slab, per NEC.
- 4.4. WIREWAYS, PULL AND JUNCTION BOXES
- A. Provide wireways, junction and pull boxes indicated and at locations required to facilitate the pulling of wire fabricated in accordance with NEMA and National Electrical Code requirements with respect to material, gauges, dimensions and methods of fastening. Wireways, junction and pull boxes shall bear UL label. Units shall be finished in standard gray enamel, sides and backs spot welded in position, and removable screw cover.
- 4.5. OUTLET BOXES
- A. Interior Boxes: Standard minimum 4" square box with single or multiple gang stamped extension of plaster ring, of the proper depth to accommodate the device and function for which intended. Boxes for mounting of surface lighting fixtures shall be 4" octagon boxes, with 3/8" no-bolt fixture studs. Provide proper covers or device plates.
- B. Exterior Boxes: Hot-dipped galvanized complete with weatherproof covers and rubber or neoprene gaskets.
- C. Concrete Boxes: Outlet boxes in concrete slabs shall be two-piece concrete boxes not less than 4" nominal size with a minimum depth of 2-1/2". If used for lighting fixtures, outlet boxes shall be equipped with fixture stud.
- D. Waterproof Boxes: With threaded hubs and gasketed.
- E. Flush Type Floor Boxes: Fully adjustable (before and after concrete pour), cast iron for slabs on grade, stamped steel for slabs above grades, with surface ring finish to match wiring devices, and covers/plates specified, with waterproof threaded outlets, sized and arranged to receive devices scheduled. Flush boxes shall be Hubbell.
- 4.6. TERMINAL CABINETS
- A. Cabinet Bodies shall be constructed in accordance with the NEMA PBI specification for panelboard cabinets. Provide steel doors with key locks and keys as specified for panelboards.
- 4.7. CONTACTORS AND RELAYS
- A. Contactors and relays shall be UL listed under UL 508, fully rated and marked for use with tungsten lamp and ballast (fluorescent) lamp loads with electrical characteristics as required. Contactors shall be of the single coil, electrically operated, mechanically held type, in NEMA 1 enclosures, or cabinets, or pull boxes with hinged covers, or integrally mounted in panelboards, or as otherwise scheduled. Control voltage shall be 120 volts and where line voltage to unit is greater than 120 volts, phase to neutral shall contain a control power transformer with fused primary.

- 4.8. EQUIPMENT CONNECTIONS
- A. Provide wiring for the connection of motors and control equipment and control wiring as indicated on the electrical drawings.
- B. Equipment installed under other sections of the specifications: Wiring shall be extended to the equipment, and proper connections made thereto.
- C. Flexible connections of short lengths: Shall be provided for equipment subject to vibration or movement for motors. Liquid-tight conduit shall be used in wet locations. A separate ground conductor shall be provided across flexible connections.
- 4.9. CONDUIT INSTALLATION
- A. Coordinate installation of raceways with building structure and other mechanical trades complete with bends, fittings, junction and pull boxes to meet codes and make complete operating systems. Raceways 1" and larger shall not be run in concrete slabs without approval of the Architect.
- B. In general, conduits shall be concealed in finished areas, and may be exposed in unfinished areas, run square to the building construction, and continuous from outlet to outlet, connected mechanically and electrically to assure grounding. Conduits shall be cut square, reamed to full size, shouldered without butting into couplings or fittings. The threads shall be of standard length and diameter required for the size of the conduit used, and graphite bearing thread lubricant shall be used in making up the threads. Running threads will not be acceptable. Conduit shall have a smooth interior surface free of obstructions, shall be capped with conduit seals during the construction period, shall be thoroughly cleaned and dry before pulling and wire. Conduit installation shall clear hot pipes not less than 6".
- 4.10. FASTENINGS
- A. Fastenings for raceways and boxes shall be made by means of toggle or expansion bolts no smaller than 3/16" diameter, or wood screws no smaller than number 9x1 inch long.
- B. Fastenings to masonry or concrete shall be made by means of machine screws no smaller than number 10-32x1-1/4" long, screwed into lead expansion shields no smaller than 3/8" diameter x 5/8" long.
- 4.11. CONDUCTOR INSTALLATION
- A. Wire and cable No. 6 and smaller shall be factory color coded. Where factory color is not available, or where on short runs factory color coding is not practical, mark conductors on each end and in all junction or pull boxes with 1" band of colored pressure sensitive plastic tape. Colors for each phase and the neutral shall be consistent throughout the system.
- B. Color coding shall be:
- |              |                   |         |
|--------------|-------------------|---------|
| 277/480 volt | 120/240 volt      | Use     |
| Brown        | Black             | Phase A |
| Orange       | Orange (High Leg) | Phase B |
| Yellow       | Blue              | Phase C |
| Gray         | White             | Neutral |
| Green        | Green             | Ground  |
- C. Minimum wire size for branch circuits shall be No. 12 except that home runs longer than 100' on 120/240 system and 200' on 277/480 volt systems in actual wire length from panel to the electrical load center of the circuit, shall be no smaller than No. 10 AWG.
- D. Cable terminals, taps and splices No. 6 and larger shall be made secure with UL approved solder less indenter compression barrel type connectors wherever practicable. UL approved set screw lugs may be used on circuit breakers, motor starters, and switches not available with indenter connectors. Joints in conductors No. 8 and smaller shall be made by applying a UL approved insulated, cadmium plated, live steel spring type connector in sizes up to the catalog capacity of the connector.
- PART FIVE --- POWER DISTRIBUTION
- 5.1. CIRCUIT SWITCHING AND PROTECTIVE DEVICES
- A. Shall be complete from incoming line terminals to outgoing load terminals, number of poles and rated for current characteristics indicated, with interrupting ratings at least equal to the available short-circuit current available at the line terminals.
- B. Molded case circuit breakers:
- Shall conform to NEMA standard AB-1, UL 489, and FS-W-C-375B.
  - Shall have an integral rugged housing of molded polyester glass insulating compound, with silver alloy contacts, arc quenchers, and phase barriers for each pole, and stored energy operating mechanism. Shall be electrically and mechanically trip free, with a trip element for each pole, and a common trip bar connected to a single handle of insulating material (handle ties are unacceptable), indicating "on," "tripped," and "off" positions. Provide inverse time element thermal trip for overload protection and magnetic instantaneous trip for short circuit protection unless otherwise indicated.
  - Standard convention breakers (breaker drawing symbol without modification) shall be quick-make, quick-break, wiping contact, thermal, magnetic, common trip, trip indicating, ambient compensated, with arc chutes, single trip-free handle mechanisms, and thermal long time trip and magnetic instantaneous trip.
  - Ground fault interrupting --- provide UL class A (5 milliampere sensitivity) single-phase ground fault circuit protection.
- C. Manual Switch (smaller than 800):
- Shall conform to NEMA Standard KSI, UL 98, and FS-W-865C.
  - Shall not be used in excess of 600 amps rating.
  - Shall be dead front, load break, heavy duty, horsepower rated, quick-make, quick-break, switches with arc quenchers, padlock provisions, and defeatable front accessible door interlock to prevent opening door with switch "on" or switching on with door open.
- 5.2. ENCLOSURES
- A. Circuit switching/protective devices shall be housed in an enclosure suitable for the environment in which they are located.
- B. Normal indoor location --- NEMA general purpose.
- C. Normal outdoor location --- NEMA 3R rain-tight.
- 5.3. TRANSFORMERS, DRY TYPE
- A. Two winding of the size and electrical characteristics as scheduled, in conformance with ANSI-C89.2 and NEMA ST20 standards and Underwriters Laboratories listing UL 506.
- B. Guaranteed sound ratings shall not exceed ANSI standard decibel levels. Transformers shall be rated at full load in a 40 degree C ambient with 30 degree C ultimate hot spot temperature rise allowance, with Class F insulation having a UL 185 degree C rating limiting system temperature to 115 degrees C on 25 KVA and smaller units and Class H insulation. Having UL 220 degree C rating limiting system temperature to 150 degrees on 30 KVA and larger units.
- C. The maximum temperature rise of the top of the enclosure shall not exceed 35 degrees C rise over a 40 degree C ambient.
- D. Transformers 30 KVA and above shall have core and coil assembly completely isolated from enclosure with neoprene rubber pads, and six primary voltage taps rated (4) 2-1/2% below normal and (2) 2-1/2% above normal. Transformers 25 KVA and under shall have four primary voltage taps rated (2) 2-1/2% below normal and (2) 2-1/2% taps above normal.
- 5.4. SWITCHBOARDS AND PANELBOARDS
- A. Provide arrangement and electrical characteristics as indicated or scheduled.
- B. Classification and rating: Complete unit shall be given a single integrated equipment rating certifying that all components are capable of withstanding the stresses of a fault of the magnitude indicated by the RMS symmetrical current available and that no device will be applied beyond its interrupting or switchboard shall carry a certification label indicating suitability for service entrance.

- C. Switchboard Structure: Dead front, floor mounted, comprised of vertical sections bolted together to form one rigid assembly, completely metal-enclosed, self-supporting of the universal frame type, ventilated and constructed UL-891 enclosure standards using standardized components of steel. The sides, top and rear shall be covered with removable screw-on plates. Front plates shall be sectionized and removable. Height shall be nominal 90" with depth as necessary but in no case less than 20". All steel shall be phosphatized, primed, and finished in gray enamel.
- D. Bussing: Copper bus bars shall be uniformly arranged to provide A-B-C sequence, left to right, front to rear, or top to bottom from front of board. Provide copper ground lugs and a full length copper ground bus bolted to each vertical section. All hardware used on bussing shall be zinc or cadmium plated. Each bolt shall have a Belleville washer to maintain clamping force under thermal cycling.
- E. Switching and Protective Devices: Fused switches, equipped with ARC quenchers, and quick-make, quick-break operating mechanism, shall each be mounted in an individual sheet steel enclosure with an external operating handle which may be padlocked in either the ON or OFF position. Doors shall be interlocked to prevent opening when switch is in ON position, with provisions to void cover interlock to allow authorized inspection. Switches 600 amp and smaller shall be 5" minimum height with high pressure spring load rejection type fuse holders.
- 5.5. INDIVIDUALLY MOUNTED SAFETY SWITCHES
- A. Safety switches shall be heavy-duty UL listed, horsepower rated manual disconnect switches in conformance with NEMA specifications KSI-1969. Unit shall be fused with fuse clips having rejection feature, or unfused as indicated with ampere ratings as required. Enclosures shall be NEMA 1, unless otherwise noted. Each switch shall have insulated neutral and ground terminal or proper size where required, for grounded conductors. Lugs shall be UL listed for copper cables.
- B. Motors 1/2 horsepower and less, toggle type, quick-make, quick-break, two (2) horsepower rated manual motor starters, with the number of poles required, with flush mounting wall plate or surface mounted NEMA enclosure, as indicated. Provide overload heaters as required.
- C. Motors 3/4 horsepower and larger, type HD, fused or unfused, 3-pole 480 volt AC in NEMA general purpose or weatherproof enclosure.
- D. Safety switches shall be of same manufacturer as switchboard and panels.
- 5.6. FUSES
- A. Furnish time-current characteristic and coordination curves for each fuse in service entrance equipment and coordinate with utility to assure service entrance fuse opening prior to actuation of the utility circuit protective devices in the event of a fault.
- B. Fuses 600 amperes and less serving non-inductive loads (circuit breakers, circuit breaker panelboards), shall be in accordance with UL standard 198.2, Class J, current limiting, quick acting, with 200,000 RMS symmetrical amperes interrupting capacity.
- C. Fuses 600 amperes and less serving inductive loads (transformer or motor), shall be in accordance with UL standard 198.4, Class RK1, dual element, with minimum time delay of 10 seconds at 500K rating, current limiting, with interrupting capacity of 200,000 amperes RMS symmetrical.
6. PART SIX --- EXECUTION
- 6.1. Contractor is required to install equipment in strict accordance with manufacturer's recommendations and requirements of other sections.



**JOLE ENTERPRISES, INC.**  
 720 S. 59th Place, Suite 105  
 Yuma, Arizona, 85365

office: (928) 783-0922  
 fax: (928) 783-3954  
 www.joleenterprises.com

JOB. No.: 16-036

**WINTERHAVEN WATER/SEWER IMPROVEMENT**

**ELECTRICAL SPECIFICATIONS**

**Nicklaus Engineering Inc.**  
 1851 West 24th Street P.O. Box 6029  
 YUMA, ARIZONA 85364 (928)344-8374  
 Email: nel@nelaw.com

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