



Permitting of Pump Stations and Force Mains

City of Winston-Salem, North Carolina
Utilities Division

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GENERAL REQUIREMENTS

All wastewater pumping stations must comply with the North Carolina Department of Environment and Natural Resources Minimum Design Criteria for the Fast-Track Permitting of Pump Station and Force Mains, as amended to date and available at <http://portal.ncdenr.org/web/wq/swp/ps/cs/regdesign>. In addition, all pumping stations and force main design must comply with the City of Winston-Salem's Technical Specifications and Detail Drawings available at <http://www.cityofws.org/Home/Departments/Engineering/Articles/Publications>.

All new pump station design or station upgrades shall be submitted to the City of Winston-Salem for review and approval. There will be a pre-design meeting for all new stations or station upgrades. Submittals will be reviewed by the Lift Station and Utilities Department with final approval being signed by the Director of Utilities. The Lift Station Information Sheet (see Section III) is to be completed prior to station start up. Adequate operation and maintenance information shall be supplied for all equipment requiring maintenance or other attention. Four hard copies and two electronic copies on CD-ROM of each operation and maintenance manual shall be prepared and delivered to the Owner. Hard copies shall be prepared in three-ring-post binders.

Contractor shall complete full installation and verify pump rotation direction prior to scheduling start-up. Start-up shall be scheduled with the Owner and Engineer at least 10 working days in advance. Representatives from the electrical contractor, pump manufacturer, and emergency generator manufacturer shall be on-site for station start-up and training. Station start-up and training shall take place on the same day.

Contractor shall start and operate pumps and accessories through complete cycles. Operational tests shall be run on each pump after installation. Tests shall include observation and recording of head, actual flow, and motor input (volts and amps). Test results shall be documented and given to the City of Winston-Salem.

After the initial test, each pump shall be raised from the wet-well by the Contractor to test the rail system. Pumps will be visually inspected by the Owner and Engineer.

Contractor shall lower pumps back into place and perform an additional draw-down test on each pump to verify pump discharge properly resets.

The pumps will be operated through at least one cycle on the emergency generator. All pumps shall be operated simultaneously.

At the end of seven days of level controlled operation by the owner, the pump station will be accepted if, in the opinion of the Engineer and the City of Winston-Salem, the pump station has operated satisfactorily without excessive motor overheating, power input, wear, lubrication, or undue attention required for this operation, and if all rotating parts operate without excessive vibration or noise at any operating head, including shut-off. A Lift Station Acceptance Form will be completed by the Lift Station Supervisor and signed by the Engineer, Contractor/s, and Utilities Director after the pump station has had seven consecutive days of satisfactory operations.

PURPOSE OF THIS DOCUMENT

This document is a supplement to the North Carolina Department of Environment and Natural Resources Minimum Design Criteria for the Fast Track Permitting of Pump Stations and Force Mains. This document is intended to be used in addition to the State's minimum design criteria for permitting pump station and force main systems that will be owned and maintained by the City of Winston-Salem/Forsyth County Utilities.

SUPPLEMENTAL CONDITIONS TO THE NCDENR MINIMUM DESIGN CRITERIA FOR THE PERMITTING OF PUMP STATIONS AND FORCE MAINS

2.0 Pump Design

2.1 General Requirements

- A. Only submersible pumps designed and manufactured for use in conveying raw, unscreened wastewater shall be acceptable. Every effort should be made to avoid using grinder pumps. Grinder pumps will only be allowed with prior approval.

2.2 Selection Methodology

- A. 1. The City of Winston-Salem's approved pumps are as follows. Substitutions must be approved by the City of Winston-Salem.
 - a. KSB
 - b. Fairbanks-Morris
 - c. Hydromatic
 - d. Myers
 - e. ABS/Sulzer
 - f. Tsurumi

3.0 Pump Station Design

3.1 General Requirements

- A. Stations shall be designed so that the wet well provides a minimum two hours of storage above the wet well high level float at design daily flow to allow for adequate response time due to a pump failure. Final wet well size shall be determined by the Director of Utilities or his designee.
- B. All stations shall have by pass pumping capabilities.
- C. The following spare parts are required and should be provided by station start-up.
 - 1. Mechanical seal
 - 2. Impellor
 - 3. Set of wear rings (replacement volute if pump does not have replaceable wear rings)
 - 4. Any gaskets or O-rings needed to install the above parts
- D. A permanently mounted electric hoist capable of pulling all pumps and check valves (minimum 500 lbs. rating) shall be installed.
- E. All control/electrical panels are to be mounted with stainless steel "unistrut" affixed to 5"x5" concrete post or 3.5" or larger diameter galvanized post with top caps. All fasteners are to be stainless steel. All threaded areas to be coated with anti-seize.
- F. The station's electrical and control panels must be covered with an approved free standing rain cover (where applicable) with the following dimensions. There shall be two feet minimum over hang on each end of control panel rack. There shall be two feet minimum over hang on rear of rack providing there are no panel doors that can be opened. Otherwise the cover shall have a minimum of three feet over hang from the point of the

largest panel door open at 90 degrees. The cover shall have a minimum height of seven feet from lowest point.

1. Type: Free Standing
2. Deck: 0.025 24" V-Span
3. Post: 3" square 18 ga. Steel in ground 18-24" concrete
4. Fascia: 7" roll formed 0.050 gutter with scuppers
5. Finish: Powder Coated
6. Erection: Straight, level and clean condition.

All materials shall be first quality and fabrication shall be executed with weather tight sealed joints. Connections must meet North Carolina Building Codes.

- G. Pump power supply cables must have individual penetrations through wet well wall with a minimum opening of 3" ID. Openings must be sleeved with PVC pipe.
- H. Individual amp meter local read out for each pump.
- I. Standard 110 volt LED street light mounted on four inch diameter, 12 feet tall aluminum pole. Pole to be located next to wet well but not in such a manner to impede the removal of the pumps or the construction of the control panel rain cover.
- J. All stations will be required to have a backup generator. See generator specifications.
- K. A spare pump shall be required.

3.2 *Site Selection*

A. Location and Access

1. Pump stations shall be located and designed to minimize the development of nuisance conditions (i.e., noise, odor, etc.) in the surrounding area. Lot sizes must be adequate for maintenance of stations.
2.
 - a. At a minimum, the roadway shall be constructed from a six-inch layer of compacted aggregate base course (ABC) stone. In no case shall uncompact gravel or stone material be allowed for roadway construction. Roadways shall be designed in a straight line to the extent possible and guard rail shall be installed on bridges and culverts at creek crossings.
 - b. Final site grades shall minimize infiltration/inflow and environmental impacts including but not limited to streams and ponds.

B. Security

1. Access to the pump station structures as well as all associated equipment and appurtenances shall be restricted in accordance with 15A NCAC 2T .0305(h)(4).
 - a. All ports of entry into pump station structures shall be locked. Exterior access doors into the building shall have

- deadbolt locks that are keyed to accept the Utilities Division's standard access key.
- b. All stations shall provide security/privacy fencing that conforms to the characteristics of the neighborhood. Fencing provided around pump station structures shall be of sufficient height and material to deter entry. Locked gates, a minimum of 12-feet wide, shall be provided in the fence to allow vehicular access by operation and maintenance staff. Consideration shall be given to complying with the requirements in. as well.
 - c. All access hatches to the wet well, dry well, and other pump station structures shall be padlocked. In addition, padlocked and dead-front type control and electrical panels shall be provided. Guardrail(s) may be required around control panels, valve vaults and wet wells located in a right-of-way where security fencing cannot be provided.

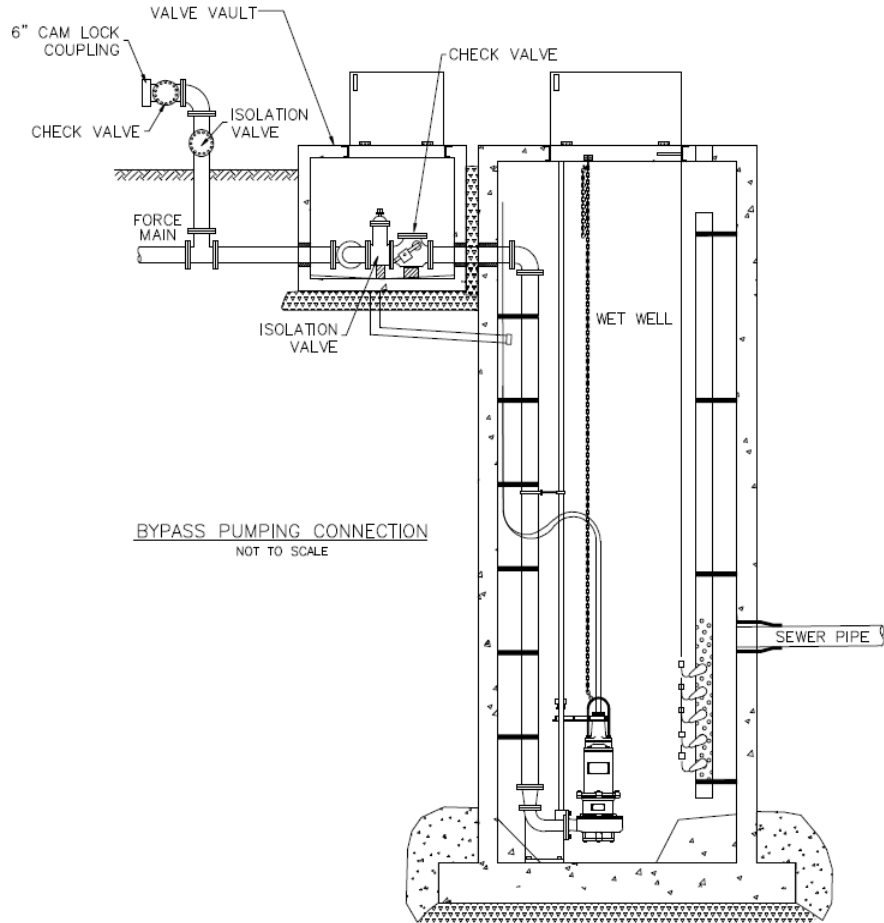
3.3 *Piping and Valves*

A. Suction and Discharge Piping Configurations

- 1. The suction and discharge piping systems shall be provided with sufficient valves to effect proper operation and maintenance of the pump station during both normal and emergency conditions.
 - a. Selected valves shall be suitable for use with raw, unscreened wastewater and shall be of a design suitable for its function, its installation location, as well as the normal and maximum operating pressures expected at the pump station. Selected valves shall not be installed in the wet well(s)
 - i. A full closing shut-off valve shall be provided on the discharge piping of each pump and shall be installed in a valve vault located outside of the wet well structure adjacent to the point where the force main penetrates the wet well wall. A separate check valve shall be provided for each pump discharge and the check valves shall be located in the same external valve vault at a point between the isolation valve and the pump.
 - ii. All isolation and check valves shall be located before the confluence of the separate pump discharge lines if more than one force main.

Check valves shall be placed in the horizontal position and shall be of weighted swing arm type.

- b. All valves shall be located such that they are readily accessible. All valves are to be placed in a separate valve vault located outside of the wet well(s). Valves shall be equipped with standard square operating nut to allow operation with "T" handle valve wrench when access hatch door is open. Wrench to be 36 inches above hatch opening. Wrench to be provided by contractor. Vault shall have a drain line of not less than four inches to allow any captured water to drain back to wet well. Line shall be free flowing in both directions.
- c. A stainless steel, glycerin-filled, 0-200 psi back fed pressure gauge with a minimum 2" diameter face shall be installed on all check valve covers. Gauges shall be installed with an isolation ball valve. All fittings, ball valves, and gauges shall be 316 stainless steel with piping of at least ¼ inches diameter ID. Gauge shall be installed in a conspicuous location.
- d. Force mains on pump stations shall include piping to allow portable pumps to be connected to the force main for emergency use. The piping shall consist of a tee equipped with a flanged isolation valve located on the force main at a point after the pump discharge lines have joined into a single pipe, a check valve installed before the isolation valve and a six inch male cam-lock fitting to accept the portable pump's discharge line. See following detail.



- e. Influent line shall not be higher than top of pump. If drop is required, it shall be outside wet well and have provisions to allow for cleaning.

B. Water Service

- 1. A 1" potable water connection with approved frost free hydrant shall be required. Connections to be installed in accordance with the City of Winston-Salem Utilities Backflow Prevention.

3.4 Appurtenances

A. Pump Removal Methods/Equipment

- 1. Provisions shall be so that the largest piece of equipment installed at the pump station may be removed. All electrical services shall be underground and no overhead power lines in areas where hoisting equipment may have to operate shall be allowed.

2. Pump stations utilizing submersible pumps installed in wet wells shall be provided with a system that allows for the removal and installation of the pumps without requiring entry into the wet well.
 - a. Each submersible pump shall be provided with a guide rail and a lift-out chain. The chain shall be load rated and tagged as per OSHA standards for lifting. All components of the rail, lift-out chain, nuts, bolts and attachments shall be of 316 stainless steel.
- B. Access Equipment
 1. Wet well hatch openings shall be a minimum of 48 inches by 48 inches and be of Bilco type doors or equal.

5.0 Electrical and Instrumentation/Control Systems Design

5.1 General Requirements

- A. Electrical systems for pump stations shall be designed and installed in strict conformance with NFPA 70 "National Electric Code," ANSI, as well as all applicable federal, state, and local codes.
 1. Wire color codes shall be as follows:
 - 120/208- Black, Red, Blue colors per phase
 - 480/277- Brown, Orange, Yellow colors per phase
 - Ground- Green; Neutral- White; Power- Black
 2. All power to stations shall be 3 phase power.
- B. Supply power will be such that all pumps can be in operation at the same time.

5.2 Enclosures

- A. Enclosures shall have a minimum NEMA 4X rating, stainless steel.
- B. Enclosure shall include quarter-turn latches.
- C. Enclosure shall include a padlock hasp kit installed.
- D. Enclosure shall be "dead-front" with swing-out inner panel. All pilot devices, gauges, displays, etc. shall be mounted to swing-out panel.

5.3 Instrumentation and Controls

- A. Wastewater Level Sensing Equipment
 1. Station wet well level control shall be either discrete or analog. The Engineer and Owner will determine the method of control.
 2. For discrete level control the contractor shall provide a MultiTrode level sensing system for the purposes of controlling lift station wet well level.
 - a. Controller shall be the MTIC3 model, 120VAC.
 - b. Probe shall be the 3.0/10-30 model, 115 inch long, 12 inch sensor separation, 10 sensors with 100 ft. of cable.
 - c. Cable excess shall be coiled and left intact to allow for probe removal.
 - d. Installations where the 100 ft. cable is not long enough a junction box shall be provided with terminals. Wiring shall be labeled on both sides of the terminal strip. Junction box shall be NEMA-4X stainless steel.

- e. Contractor shall install flexible probe cleaner and stainless steel hook bracket provided with probe.
 - f. Engineer will establish installed probe elevation and location within the wet well based on wet well hydraulics and lift station requirements.
3. For analog level control the contractor shall provide the specified level sensing device (bubbler system, ultrasonic, hydrostatic pressure, etc.). The level control device shall be a Precision Digital PD6000 ProVue series with the 6R7 expansion module to accommodate relay outputs as well as a 4-20mA output.
 4. Contractor shall provide floats for the purpose of a HIGH ALARM and LOW ALARM. The floats shall be a non-mercury mechanical float switches, such as Anchor Scientific, Eco-Float, or equal. No mercury containing float switch will be allowed. In addition to alarming the floats will operate as backup in the event of primary level control system failure.
 5. Wastewater level sensing equipment shall be used to indicate the following levels and operate the pump station accordingly: ALL PUMPS OFF, LEAD PUMP ON, LAG PUMP ON, LAG-LAG PUMP ON (if applicable), HIGH WET WELL, LOW WET WELL, and WET WELL OVERFLOW.
 6. Wet well installed floats shall exhibit the following color code:
 - a. Low level alarm cable must be color coded brown at mounting hook.
 - b. High level alarm cable must be color coded yellow at mounting hook.
 - c. The above color coding can be accomplished by using colored tape on float cables.
 - d. Float bracket must have minimum 12 inches between hooks. Options must be approved by the City of Winston-Salem.
 7. Pump control system must provide “dry contact” outputs for telemetry system PUMP 1 RUN, PUMP 1 FAIL, PUMP 1 FLOW FAIL, PUMP 2 RUN, PUMP 2 FAIL, PUMP 2 FLOW FAIL, HIGH WET WELL LEVEL, LOW WET WELL LEVEL, MTIC OK, Control Power. If the station is a triplex include PUMP 3 RUN, PUMP 3 FAIL, and PUMP 3 FLOW FAIL.
 8. Generator run, generator fail, bar screen run, and bar screen fail (if applicable) shall be provided by associated suppliers control panel(s).

B. Components

1. At a minimum, the following operator control devices shall be provided for the pump station:
 - a. Pump Station Function
 - i. Selector switches shall be provided for Pump 1 Hand-Off-Auto, Pump 2 Hand-Off-Auto, Pump 3 Hand-Off-Auto (if Applicable).
 - ii. Lead Select selector switch (Pump 1-Auto-

- Pump 2). Pump 3 select shall be included if applicable.
 - iii. Pilot lights shall be provided for each Pump Run, Overload, Overtemp, and Seal Fail. In addition, pilot lights shall be provided for High Wet Well Level and Low Wet Well Level.
 - iv. Pump 1 Elapsed Run Time meter, Pump 2 Elapsed Run Time meter. Pump 3 Elapsed Run Time Meter (if applicable).
 - v. Pump 1 motor current, Pump 2 motor current.
 - vi. Alarm Horn Silence pushbutton.
 - vii. Alarm Reset pushbutton.
 - viii. All pilot devices (selector switches, pilot lights, pushbuttons, etc. shall be NEMA-4X corrosion resistant.
 - ix. All selector switches shall be gloved-hand knob type.
 - x. All pilot lights shall be full voltage LED Push-to-test type.
 - xi. Pilot light color coding shall be Red=RUN, Amber=FAIL, White=Control Power
- b. Weather-proof audible and visual alarms that are external to any structure or enclosure shall be provided at the pump station in accordance with 15A NCAC 2T .0305(h)(1)(F). At a minimum, the following conditions shall be monitored by the system, and each shall initiate a signal to the SCADA system:
 - i. General pump failure (visual alarm only)
 - ii. Low wet well level (visual alarm only).
 - iii. High-water in the wet well (audible and visual alarms).
 - iv. Loss of utility power supply (visual alarm only).
 - v. Automatically-activated stand-by power generation source failure (if applicable) (visual alarm only).
 - vi. Bar screen failure (if applicable) (visual alarm only).
 - vii. Intruder alarm (if applicable) (visual alarm only).
 - viii. Flow fail from check valve limit switch shall be alarm only (visual alarm only).
- c. A telemetry system shall be required for all pump stations. An approved telemetry system as determined by CCUC shall be installed at all pump stations. Telemetry panel shall conform to the City of Winston-Salem's standard detail and specifications on panels/controls.
 - i. The telemetry system shall contact personnel capable of initiating a response to a pump station alarm condition 24 hours per day, 365 days per

year. The telemetry system shall contact Utilities Lift Station Department telephone numbers as provided.

- ii. The contractor shall include an allowance for the construction of approved telemetry panel.

6.0 Quality Assurance and Quality Control

6.1 Operations and Maintenance (O&M) Manuals

- A. At a minimum, final documentation shall contain the following information.
 1. Transfer of spare parts to the City of Winston-Salem's Lift Station Department must be documented by some form or sign off sheet. This shall include all name plate data from pumps. All spare parts are to be in factory containers and labeled with all part names and numbers including supplier's information (name, address, etc.) and cost.
 2. All pertinent torque values to be witnessed, documented, and turned into the City of Winston-Salem. Pump O&M including pump control panel
 3. Completed Lift Station Information Sheet (attached). GPS coordinate data shall be in NAD83 format.
 4. Electrical systems O&M
 5. Remote Telemetry Unit (RTU) O&M (including configuration data, PLC program, etc.)
 6. Instrumentation calibration data sheet(s)

LIFT STATION INFORMATION

STATION NAME: _____

ADDRESS: _____

PHONE: _____

LONGITUDE: _____ LATITUDE: _____

WET WELL DIMENSIONS: _____

LENGTH, TYPE AND SIZE OF FORCE MAIN:

LOCATION OF END OF FORCE MAIN: _____

AVERAGE FLOW (gpd): _____

OVERFLOW POINT (Creek Name if applicable):

OVERFLOW POINT (GPS) FORCE LONGITUDE: _____

MAIN PRESSURE

(1 PUMP RUNNING): _____

(2 PUMPS RUNNING): _____

PUMP INFORMATION #1

NAME: _____ TYPE (Model): _____

SERIAL NUMBER: _____ HORSEPOWER: _____

NORMAL RUNNING AMPS: _____ GPM RATING: _____

VOLTAGE: _____ RPM: _____ TDH: _____

IMPELLOR DIAMETER: _____ PUMP WEIGHT: _____

PUMP INFORMATION #2

NAME: _____ TYPE (Model): _____

SERIAL NUMBER: _____ HORSEPOWER: _____

NORMAL RUNNING AMPS: _____ GPM RATING: _____

VOLTAGE: _____ RPM: _____ TDH: _____

IMPELLOR DIAMETER: _____ PUMP WEIGHT: _____

PUMP INFORMATION #3 (if Applicable)

NAME: _____ TYPE (Model): _____

SERIAL NUMBER: _____ HORSEPOWER: _____

NORMAL RUNNING AMPS: _____ GPM RATING: _____

VOLTAGE: _____ RPM: _____ TDH: _____

IMPELLOR DIAMETER: _____ PUMP WEIGHT: _____

PUMP SUPPLIER

NAME: _____

ADDRESS: _____

PHONE: _____ FAX: _____

CONTACT NAME: _____

PUMP CONTROL PANEL SUPPLIER

NAME: _____

ADDRESS: _____

PHONE: _____ FAX: _____

CONTACT NAME: _____

REMOTE TELEMETRY UNIT PANEL SUPPLIER

NAME: _____

ADDRESS: _____

PHONE: _____ FAX: _____

CONTACT NAME: _____

GENERATOR INFORMATION

MANUFACTURER: _____ TYPE (Model): _____

SERIAL NUMBER: _____ KW RATING: _____

FUEL TYPE AND CAPACITY: _____

FUEL USAGE RATING PER HOUR AT 100% LOAD: _____

GENERATOR SUPPLIER

NAME: _____

ADDRESS: _____

PHONE: _____ FAX: _____

24-HOUR EMERGENCY CONTACT NAME: _____

PHONE: _____

MOTOR CONTROL CENTER SUPPLIER (if applicable)

NAME: _____

ADDRESS: _____

PHONE: _____ FAX: _____

CONTACT NAME: _____

MOTOR CONTROL CENTER INFORMATION

MANUFACTURER: _____

MODEL: _____

VOLTAGE: _____ RATING (AMPS): _____

SERIAL NUMBER: _____

PACKAGED ENGINE GENERATORS

General

Summary

- A. This Section includes packaged diesel-engine generator sets with the following features and accessories:
 - 1. Battery charger.
 - 2. Engine-generator set.
 - 3. Muffler.
 - 4. Exhaust piping external to set.
 - 5. Outdoor, sound attenuating enclosure.
 - 6. Starting battery.

Submittals

- A. Submittals must be approved by the City of Winston-Salem.
- B. Product Data: For each generator set, enclosure and each accessory.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Provide four sets of shop drawings/submittals.
- D. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
- E. Operation and maintenance data shall be supplied to the City of Winston-Salem. Five (5) hard copies and two (2) electronic copies on CD-ROM of each operation and maintenance manual shall be prepared and delivered to the Owner. Hard copies shall be prepared in three-ring-post binders.
- F. Special warranty specified in this Section.
- G. Copies of inspections and reports shall be given to the City of Winston-Salem.

Quality Assurance

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 37.
- E. Comply with NFPA 70.
- F. Comply with NFPA 99.

- G. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

Warranty

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period. Verify available warranties for units and components.
 - 1. Warranty Period: Five years from date of Substantial Completion.

Products

Manufacturers

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Caterpillar; Engine Div.
 - 2. Kohler Co; Generator Division.
 - 3. MTU Detroit Diesel.
 - 4. Cummins.
- B. Generator shall be sized so that all pumps can be started individually and carry full load of all pumps running concurrently.

Engine-Generator Set

- A. Packaged engine-generator set shall be a coordinated assembly of compatible components.
- B. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
- C. Safety Standard: Comply with ASME B15.1.
- D. Nameplates: Each major system component shall be equipped with a nameplate to identify manufacturer's name and address, and model and serial number of component.
- E. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components.
- F. Generator vendor to supply automatic transfer switch.

Generator-Set Performance

- A. Steady-State Voltage Operational Bandwidth: 4% of rated output voltage from no load to full load.
- B. Steady-State Voltage Modulation Frequency: Less than 1 Hz.
- C. Transient Voltage Performance: Not more than 20% variation for 50% step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

- D. Steady-State Frequency Operational Bandwidth: 0.5% of rated frequency from no load to full load.
- E. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
- F. Transient Frequency Performance: Less than 5% variation for a 50% step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
- G. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5% total and 3% for single harmonics. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50%.
- H. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, the system shall supply a minimum of 250% of rated full-load current for not less than 10-seconds and then clear the fault automatically, without damage to generator system components
- I. Start Time: Comply with NFPA 110, Type 10, system requirements.

Service Conditions

- A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 1. Ambient Temperature: Minus 15 to plus 40°C
 2. Relative Humidity: 0 to 95%.
 3. Altitude: Sea level to 2000 feet.

Engine

- A. Fuel: Grade DF-2, non-highway, low sulfur #2 fuel oil.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 rpm.
- D. Lubrication System: The following items are mounted on engine or skid:
 1. Filter and Strainer: Rated to remove 90% of particles five micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
 1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.

2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity. Jacket heater to be cord and plug connected (Not hard wired)

Engine Cooling System

- A. Description: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
- B. Coolant: Solution of 50% ethylene-glycol-based antifreeze and 50% water, with anticorrosion additives as recommended by engine manufacturer.
- C. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- D. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 1. Rating: 50-psig maximum working pressure with coolant at 180°F, and non-collapsible under vacuum.
 2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

Fuel Supply System

- A. Comply with NFPA 30.
- B. Base-Mounted Fuel Oil Tank (double wall/double containment piping and tank): Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
 1. Tank level indicator.
 2. Capacity: Fuel for twenty-four hours continuous operation at 100% rated power output. Tank must be labeled with capacity in gallons.
 3. Vandal-resistant fill cap.
 4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

Engine Exhaust System

- A. Muffler (must be stainless steel): Internal, critical silenced type, sized as recommended by engine manufacturer.
- B. Connection from Engine to Exhaust System: Flexible section of corrugated stainless-steel pipe.
- C. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liner.
- D. Exhaust Piping External to Engine: ASTM A 53/A 53M, Schedule 40, welded, black steel, with welded joints and fittings.

Combustion-Air Intake

- A. Description: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and “blocked filter” indicator.

Starting System

- A. Description: 12/24-V (depending on generator size) electric, with negative ground and including the following items:
 - 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in “Environmental Conditions” Paragraph in “Service Conditions” Article.
 - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 - 4. Battery: Adequate capacity within ambient temperature range specified in “Environmental Conditions” Paragraph in “Service Conditions” Article to provide specified cranking cycle at least three times without recharging.
 - 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 - 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10°C regardless of external ambient temperature within range specified in “Environmental Conditions” Paragraph in “Service Conditions” Article. Include accessories required to support and fasten batteries in place.
 - 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 - 8. Battery Charger: 120 Volt current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236.

Control and Monitoring

- A. Functional Description: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of the generator set. When mode-selector switch is switched to the on position, the generator set starts. The off position of the same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.
- B. Functional Description: Switching on-off switch on the generator control panel to the on position starts the generator set. The off position of the same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down the generator set

and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.

- C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- D. Indicating and protective devices and controls shall include those required by NFPA 110 for a Level 1 system, and the following:
- E. Indicating and Protective Devices and Controls:
 - 1. AC voltmeter.
 - 2. AC ammeter.
 - 3. AC frequency meter.
 - 4. DC voltmeter (alternator battery charging).
 - 5. Engine-coolant temperature gage.
 - 6. Engine lubricating-oil pressure gage.
 - 7. Running-time meter.
 - 8. Ammeter-voltmeter, phase-selector switch (es).
 - 9. Generator-voltage adjusting rheostat.
 - 10. Start-stop switch.
 - 11. Overspeed shutdown device.
 - 12. Coolant high-temperature shutdown device.
 - 13. Coolant low-level shutdown device.
 - 14. Oil low-pressure shutdown device.
- F. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- G. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
- H. All engine alternator controls and instrumentation shall be fully solid state, microprocessor based and designed, built, wired, tested and shock mounted in a NEMA 1 enclosure to the engine-generator set by the manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set. It shall contain panel lighting, a fused DC circuit to protect the controls and a $\pm 5\%$ voltage adjusting control.
- I. Engine generator system shall provide dry contacts for the following conditions:
 - 1. Generator RUN
 - 2. Generator FAIL. This signal is a combination of provided failure conditions listed in section E above.
 - 3. Fuel Level LOW

Generator Overcurrent and Fault Protection

- A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100% rated; complying with NEMA AB 1 and UL 489.
 - 1. Tripping Characteristic: Designed specifically for generator protection.
 - 2. Trip Rating: Matched to generator rating.
 - 3. Mounting: Adjacent to or integrated with control and monitoring panel.
- B. Ground-Fault Indication: Comply with NFPA 70, Article 700-7(d). Integrate ground-fault alarm indication with other generator-set alarm indications.

Generator, Exciter, and Voltage Regulator

- A. Comply with NEMA MG 1 and specified performance requirements.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125% of rating, and heat during operation at 110% of rated capacity.
- F. Excitation shall use no slip or collector rings, or brushes, and shall be arranged to sustain generator output under short-circuit conditions as specified.
- G. Enclosure: Drip proof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Sub transient Reactance: 12%, maximum.

Outdoor Generator-Set Enclosure

- A. Description: Vandal-resistant, weatherproof aluminum housing, wind resistant up to 100 mph. multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure. Enclosure shall be of the critically silenced type, sound attenuation shall be provided as specified below.
- B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110% of rated load for two hours with ambient temperature at top of range specified in system service conditions.
 - 1. Louvers: Automatic, forced-air opened (“blow open”), gravity closed

cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.

- C. Interior Lights with Switch: Factory-wired, vapor proof, LED type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
- D. Convenience Outlets: Factory wired. Arrange for external electrical connection.
- E. Sound attenuation: Enclosure shall be critically silenced to attenuate sound to a level as follows:
 - 1. 62 dBa, full load, at 15 meters; 68 dBa, full load, at 7 meters; and 77 dBa, full load, at 1 meter.

Finishes

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard enamel over corrosion-resistant pretreatment and compatible standard primer.

Source Quality Control

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 energy converters in Paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2.
 - 2. Generator Tests: Comply with IEEE 115.
 - 3. Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype shall have been factory tested to demonstrate compatibility and reliability.
- B. Report factory test results within 10 days of completion of test.

Execution

Concrete Bases

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

Installation

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generators level on concrete base.
- C. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- D. Contractor to anchor generator set to concrete base.
- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

Identification

- A. Identify system components according to Section IV "Basic Electrical Materials and Methods."

Field Quality Control

- A. Manufacturer's Field Service: Engage a qualified factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports. Provide certification of proper installation and operations.
 - 1. Perform tests recommended by manufacturer.
 - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:
 - a. Single-step full-load pickup test. Testing shall be coordinated with Owner. Load test generator at 100% load for at least four hours continuously. Turn over documentation from load test to Owner.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
- D. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Remove and replace malfunctioning units and retest as specified above.
- G. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- H. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

Startup Service

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing and turn over to the Owner.
- C. Complete installation and startup checks according to manufacturer's written instructions.

Demonstration

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators and transfer switch.

BASIC ELECTRICAL MATERIALS AND METHODS

General

Summary

- A. This Section includes the following:
 - 1. Raceways.
 - 2. Building wire and connectors.
 - 3. Supporting devices for electrical components.
 - 4. Electrical identification.
 - 5. Cutting and patching for electrical construction.

Submittals

- A. Submittals must be approved by the City of Winston-Salem.
- B. Provide four sets of shop drawing/submittals.

Quality Assurance

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use (third party listed i.e. UL).
- B. Devices for Utility Company Electricity Metering: Comply with utility company published standards.
- C. Comply with NFPA 70.

Coordination

- A. Coordinate chases, slots, inserts, sleeves, and openings for electrical supports, raceways, and cable with general construction work.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment that requires positioning with all other trades.
- C. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

Products

Raceways

- A. EMT: Electrical metallic tubing; ANSI C80.3, zinc-coated steel, with compression fittings.
- B. FMC: Flexible metal conduit; zinc-coated steel.
- C. IMC: Intermediated metal conduit; ANSI C80.6, zinc-coated steel, with threaded fittings.
- D. LFMC: Liquidtight flexible metal conduit; zinc-coated steel with sunlight-resistant and mineral-oil-resistant plastic jacket.

- E. LFNC: Liquidtight flexible non-metallic conduit.
- F. RMC: Rigid metal conduit; galvanized rigid steel; ANSI C80.1.
- G. PVC coated rigid metallic conduit.
- H. RNC: Rigid nonmetallic conduit; NEMA TC 2, Schedule 40 PVC, with NEMA TC3 fittings.
- I. Aluminum rigid conduit.
- J. Raceway Fittings: Specifically designed for raceway type with which used.

Wires, Cables, and Connections

- A. Conductors, No. 10 AWG and Smaller: Stranded copper.
- B. Conductors, Larger than No. 10 AWG: Stranded copper.
- C. Insulation: Thermoplastic, rated 600 V, 75 degree Celsius minimum, Type THHN- THWN, or USE depending on application.
- D. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

Supporting Devices

- A. Material: 316 Stainless steel or concrete
- B. Metal Items for Use Outdoors or in Damp Locations: 316 stainless steel.
- C. Slotted-Steel Channel: Flange edges turned toward web, and 9/16-inch-diameter slotted holes at a maximum of two inches o.c., in webs. Strength rating to suit structural loading.
- D. Slotted Channel Fittings and Accessories: Recommended by the manufacturer for use with the type and size of channel with which used.
 - 1. Materials: Same as channels and angles, metal items must be stainless steel.
- E. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers.
- G. Expansion Anchors: Stainless-steel wedge or sleeve type.
- H. Toggle Bolts: Stainless-steel springhead type.
- I. Powder-Driven Threaded Studs: Stainless steel.

Electrical Identification

- A. Identification Device Colors: Use those prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than one inch wide by three mils thick.

- C. Tape Markers for Conductors: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- D. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
- E. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape compounded for permanent direct-burial service, and with the following features:
 - 1. Not less than six inches wide by four mils thick.
 - 2. Embedded continuous metallic strip or core.
 - 3. Printed legend that indicates type of underground line.
- F. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch minimum thickness for signs up to 20 sq. in. and 1/8-inch minimum thickness for larger sizes. Engraved legend in black letters on white background.
- G. Warning and Caution Signs: Preprinted; comply with 29 CFR 1910.145, Chapter XVII. Colors, legends, and size appropriate to each application.
 - 1. Interior Units: Aluminum, baked-enamel-finish, punched or drilled for mechanical fasteners.
 - 2. Exterior Units: Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate with 0.0396-inch, galvanized-steel backing. 1/4-inch grommets in corners for mounting.
- H. Fasteners for Nameplates and Signs: Self-tapping, stainless steel screws or No. 10/32 stainless steel machine screws with nuts and flat and lock washers.

Execution

Electrical Equipment Installation

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

Raceway Application

- A. Outdoor Installations:
 - 1. Exposed: RMC or Aluminum Rigid.
 - 2. Concealed: RMC.
 - 3. Underground, Single Run: RMC.

4. Underground, Grouped: RMC.
5. Connection to Vibrating Equipment: LFNC.
6. Boxes and Enclosures: NEMA 4X, 316 stainless steel minimum
6"H x 6"W x 4"D

Raceway and Cable Installation

- A. Raceways shall be surface mounted as indicated.
- B. Keep legs of raceway bends in the same plane and keep straight legs of offsets parallel.
- C. Install pull wires in empty raceways. Use No. 12 THHN stranded copper wire. Leave at least 12 inches of slack at each end of pull wires.
- D. Install telephone and signal system raceways, 2-inch trade size and smaller, in maximum lengths of 150 feet and with a maximum of two 90° bends or equivalent. Add pull boxes where necessary to accomplish this.
- E. All conduits entering or leaving the wet well shall have a seal off fittings installed at one end.
- F. No conduit shall be smaller than 3/4 inch. No conduit in duct bank shall be smaller than one inch.
- G. Conduit and/or wiring shall not be routed through one piece of equipment to get to another.
- H. Equipment grounding conductor shall be sized per NEC requirement in each conduit.

Wiring Methods for Power, Lighting, and Control Circuits

- A. Application: Use wiring methods specified below to the extent permitted by applicable codes as interpreted by authorities having jurisdiction.
- B. Exposed Feeders: Insulated single conductors in raceway.
- C. Exposed Branch Circuits: Insulated single conductors in raceway.
- D. Concealed Branch Circuits: Insulated single conductors in raceway.
- E. Underground Feeders and Branch Circuits: Insulated single conductors in raceway.
- F. Remote-Control Signaling and Power-Limited Circuits, Classes 1, 2, and 3: Insulated conductors in raceway unless otherwise indicated.

Wiring Installation

- A. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

Electrical Supporting Device Application

- A. All Locations: Stainless steel, slotted channel system components.

- B. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four with, 200-lb minimum design load for each support element.

Support Installation

- A. Support individual horizontal single raceways with separate, malleable-iron pipe hangers or clamps.
- B. Install sleeves for raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Secure electrical items and their supports to building structure, using the following methods unless other fastening methods are indicated.
 - 1. Masonry: Toggle bolts on hollow block and expansion bolts on solid block. Seal around sleeves with mortar, both sides of wall.
 - 2. New Concrete: Concrete inserts with stainless steel machine screws and bolts.
 - 3. Existing Concrete: Stainless steel expansion bolts, stainless steel light steel framing, stainless steel sheet metal screws.
 - 4. Fasteners for Damp, Wet, or Weather-Exposed Locations: Stainless steel.
 - 5. Fasteners: Select so load applied to each fastener does not exceed 25% of its proof-test load.

Identification Materials and Devices

- A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations and indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout project.
- C. Self-Adhesive Identification Products: Clean surfaces before applying.
- D. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.
- E. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control signal, and communication lines located directly above power and communication lines. Locate six to eight inches below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches, overall, use a single line marker.
- F. Install warning, caution, and instruction signs where required to comply with 29 CFR 1910.145, Chapter XVII, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Indoors install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

- G. Install engraved-laminated emergency-operating signs with white letters on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

Cutting and Patching

- A. Cut and drill concrete, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair, refinish and touch up disturbed finish materials and other surfaces to match adjacent undisturbed surfaces.
- C. All penetrations must be waterproof sealed by appropriate methods (grouting, link seal, etc.)

AUTOMATIC TRANSFER SWITCHES

General

Summary

- A. It is the intent of this specification to secure automatic transfer switches (ATS) that have been prototype tested, factory built, production tested, and site tested, together with all accessories necessary for a complete installation as shown on the plans and drawings and specified herein.
- B. Compliance With Codes and Standards: The ATS shall conform to the requirements of:
 - 1. UL 1008-Standard for Automatic Transfer Switches.
 - 2. NFPA 70-National Electrical Code, including use in emergency and standby systems in accordance with Article 700.
 - 3. NFPA 110-Standard for Emergency and Standby Power Systems.
 - 4. IEEE Standard 446-Recommended Practice for Emergency and Standby Power Systems (Orange Book).
 - 5. NEMA Standard ICS10-1993 (formerly ICS2-447) – AC Automatic Transfer Switches.
- C. Each ATS shall consist of an inherently double-throw power transfer switch unit and a control module interconnected to provide complete automatic operation. The transfer switch and control module shall be the product of the same manufacturer.
- D. All equipment shall be new and of current production by a company that will assume responsibility for factory-backed and approved warranty, parts and service through a local representative with factory-trained personnel, with 24-hour response time.

Submittals

- A. Four sets of submittal data shall include specification sheets showing all standard and optional accessories to be supplied, schematic and wiring diagrams, dimension drawing, and interconnection diagrams identifying by terminal number each required interconnection between the generator set and the transfer switch.
- B. Four sets of operating and maintenance instruction manuals shall be supplied for the ATS and components as specified herein.

Warranty and Service

- A. Each ATS shall be warranted by the manufacturer for five years from the date of the site start-up to be free from defects in material and workmanship in accordance with the manufacturer's published warranty. Where manufacturer's standard guarantees or warranties are written for a period of more than one year, at no additional cost to the Owner, such longer terms shall apply.

Products

Manufacturers

- A. Approved Manufacturers:
 - 1. ASCO
 - 2. Russelectric
 - 3. Zenith
 - 4. Cummins/Onan

Mechanical Requirements

- A. ATS shall be furnished in a NEMA 4X stainless steel pad lockable enclosure as indicated on the plans.
- B. Mechanical type lugs shall be provided for normal source, emergency source, and load connections. Lugs shall accommodate a range of conductor sizes centered on the ATS ampere rating
- C. All moveable parts of the operating mechanism shall remain in positive mechanical contact with the main contacts during the transfer operation without the use of separate mechanical interlocks.
- D. All main contacts shall be of silver composition.
- E. All contacts, coils, springs, and control elements shall be conveniently removable from the front of the transfer switch without major disassembly or disconnection of power conductors.

Electrical Requirements

- A. Automatic transfer switches not intended for continuous duty or repetitive load transfer switching are not acceptable.
- B. The ATS shall be rated in amperes for total system transfer including control of motors, electric-discharge lamps, electric heating, and tungsten-filament lamp load.

Transfer Switch Control System

- A. The control module shall direct the operation of the transfer switch. The module's sensing and logic shall be a built-in microprocessor-based system for maximum reliability, minimum maintenance, and inherent digital communications capability. The module shall contain an integral programmable clock and calendar. The control module shall have a keyed disconnect plug to enable the control module to be disconnected from the transfer mechanism for routine maintenance. The control module shall be mounted separately from the transfer mechanism unit for safety and ease of maintenance. Interfacing relays shall be industrial control grade plug-in type with dust cover.
- B. The control module shall include programming keypad, alpha-numeric display for monitoring settings and diagnostic values, key-lockable program selector switch, light-emitting diode status indication, and user instructions. These features shall be user accessible when the enclosure door is closed.

Operation

A Source Voltages. The voltage of each phase of the normal source and single phase of the emergency source shall be monitored with pickup adjustable from 75% to 100% and dropout adjustable from 70% to 95% of nominal. Adjustment must be digital.

1. An automatic minimum differential of 2% shall be maintained between pickup and dropout settings.
2. Repetitive accuracy of the setting shall be $\pm 2\%$ or better over an operating temperature range of -20°C to 70°C .
3. Voltage and Frequency settings shall be fully field-adjustable by keypad or keyboard (local or remote) in increments of 1% without opening the enclosure door and without the use of special tools or separate meters.
4. Factory settings shall be pickup at 90% and dropout at 85%.
5. A light-emitting diode shall indicate that normal and/or emergency voltage is within the set point parameter. The indication shall be viewable when the enclosure door is closed.

B. Time Delays

1. The control module shall include time delays that are fully field-adjustable by keypad or keyboard in increments of one second over the entire range.
2. Adjustments and viewing of the time delay values shall be accessible when the enclosure door is closed.
3. Light emitting diodes shall indicate when the timing feature is running and when the time delay has ended.
4. Required Time Delays
 - a. Time delay for engine start to delay initiation of transfer for momentary source outages: Range 0-60 seconds. Factory set at 5 seconds.
 - b. Time delay for transfer to emergency: Range 0-30 minutes. Coordinate setting of this time delay for each site with the Owner.
 - c. Time delay for transfer back to normal: Range 0-30 minutes. Factory set at 15 minutes. Coordinate setting of this time delay for each site with the Owner.
 - d. Time delay for engine cool-down: Range 0-30 minutes. Set time shall be five minutes.

C. The user shall have the ability to manually program an engine start. The time delay transfer to emergency and/or normal may be bypassed during the run period. A numeric indication shall be displayed of the run time remaining in hours and minutes. The run period may be stopped at any time with a single key stroke. After the run period has stopped, the engine shall run unloaded for the cool-down time.

D. User terminal shall be available to:

1. Connect a normally closed contact that, when opened, signals the control module to start and transfer load to the engine-generator. Closing this contact shall initiate a retransfer and engine cool-down sequence.
2. Monitor an external normally open contact that, when closed, signals the control module via the ATS to start and transfer load to the engine-generator. Opening this contact shall initiate a retransfer and engine cool-down sequence. This feature would be used to monitor an external peak shaving controller, for example.

The load shall transfer to an available utility source immediately upon failure of the generator source.

E. The following features shall be built into the control module logic. These features shall be enabled at the factory or in the field by installing an insulated program jumper provided by the vendor as standard.

1. Extended Time Delay: Allows the time delay settings to be extended to 99 minutes.
2. All phases of normal and all or single phases of emergency shall be monitored for over voltage and single phase of normal and emergency for over-and-under frequency. The values shall be programmed with the enclosure door closed.
3. Anti-single phasing protection shall detect regenerative voltage as a failed source condition.
4. In-phase monitoring shall continuously monitor the contactor transfer times, source voltage, frequency and phase angle to provide a self- adjusting, zero crossing contactor transfer signal.
5. Manual operation override shall function to bypass any manual switch accessories if the source to which the transfer switch is positioned fails. This program jumper shall be factory installed.

F. Status Indicators: Light-emitting diodes shall indicate the status of the following:

1. Contactor Position.
2. System Status:
 - a. Transfer Switch Position Sensing Fault.
 - b. Transfer Switch Fail to Transfer.
 - c. Internal Control Module Fault.
 - d. Manual Transfer Operation.
 - e. External Fault Condition (two inputs).
 - f. Not in Automatic.
 - g. Programming Switch Not in Off.

The system status messages shall also be shown on the alpha-numeric display.

3. Accessory Active:
 - a. Plant Exerciser.
 - b. In-Phase Monitor.
 - c. Area Protection.
4. A lamp test push button shall light all light-emitting diodes.
- G. A momentary-type test switch shall be provided to simulate a normal source failure.
- H. A set of gold-flashed contacts rated 10 amps, 28VDC shall be provided for a low-voltage engine start signal when the normal source fails.
- I. Supplier shall provide a dry contact for the following conditions for remote monitoring:
 1. ATS in Utility
 2. ATS in Standby Power

Withstand Ratings:

- A. The ATS shall be rated to withstand available rms symmetrical short-circuit current at the ATS terminals with the type of over-current protection shown on the plans.
- B. The control panel shall meet or exceed the voltage surge withstand capability in accordance with IEEE Standard 472-1974 (ANSI C37.90a-1974) and the impulse withstand voltage test in accordance with the proposed NEMA Standard ICS 1-109. The control panel shall conform to the test requirements of UL 991 for transient overvoltage, electromagnetic susceptibility, and electrostatic discharge.

Test and Certification: All production units shall be subjected to the following factory test:

- A. The complete ATS shall be tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
- B. The switch shall be subjected to a dielectric strength test per NEMA Standard ICS 1-109.21.

Manufacturer's Responsibility

- A. The supplier shall provide the services of a field technician to test and adjust the system for satisfactory operation. The supplier shall be factory warranted and trained to work the complete system.
- B. The Owner and/or Owner's representative shall have the option of witnessing the testing of the equipment. Notification shall be provided one week prior to the test.