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**SECTION 16285**

**TRANSFER SWITCHES**

1. **GENERAL**
	1. **WORK INCLUDED**
		1. Drawings and general provisions of the contract, including general and supplementary conditions and Division 01 specification sections, apply to this section.
	2. **SUMMARY**
		1. Section includes transfer switches rated 600 v and less, including the following:
			1. Automatic transfer switches.
			2. Double throw switches.
			3. Remote annunciation systems.
	3. **SUBMITTALS**
	4. Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.
		1. Action Submittals
			1. Product data: for each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
			2. Shop drawings: dimensioned plans, elevations, sections, and details showing minimum Clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
			3. Single-Line diagram: show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch.
		2. Informational submittals
		3. Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as may be supplemented in "Quality Assurance" Article.
			1. Qualification data: for manufacturer.
			2. Field quality-control reports.
		4. Closeout submittals
			1. Operation and maintenance data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified other sections, include the following:
			2. Features and operating sequences, both automatic and manual.
			3. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.
	5. **QUALITY ASSURANCE**
		1. Manufacturer qualifications: maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
		2. Testing qualifications: the electrical contractor and trained manufacturers field service technician with the experience and capability to conduct the testing indicated and that is acceptable to authorities having jurisdiction for both testing and commissioning the electrical generator set.
		3. Source limitations: obtain automatic transfer switches, non-automatic transfer switches, and remote annunciators from the generator manufacturer.
		4. Electrical components, devices, and accessories: listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
		5. Comply with NEMA ICS 1.
		6. Comply with NFPA 70, 2008 edition.
		7. Retain one or both of first two paragraphs below if applicable to Project.
		8. Comply with NFPA 99.
		9. Comply with NFPA 110.
		10. Comply with UL 1008 unless requirements of these specifications are stricter.
	6. **FIELD CONDITIONS**
		1. Interruption of existing electrical service: do not interrupt electrical service to facilities occupied by owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service when outage exceeds owner's requirements:
		2. Notify owner no fewer than three business days in advance of proposed interruption of electrical service.
		3. Do not proceed with interruption of electrical service without owner's written permission.
2. **PRODUCTS**
	1. See Editing Instruction No. 1 in the Evaluations for cautions about named manufacturers and products. For an explanation of options and Contractor's product selection procedures, see Section 016000 "Product Requirements."
		1. Manufactured units
			1. As the PSA has procured all generators through them and has standardized on parts, supplies, and service; subject to compliance with requirements, provide products by Kohler Power Systems Generator Division. All automatic transfer switches shall be provided by the generator set manufacturer. All transfer switches are to be automatic unless otherwise shown on drawings.
		2. General Transfer Switch Product Requirements
		3. Coordinate paragraph below with Drawings and indicate percentage of tungsten filament lamp load for switches where it exceeds 30 percent. This percentage may affect switch selection. Some manufacturers' ratings for some switch lines apply to all classes of load, including tungsten lamps.
			1. Indicated current ratings: apply as defined in UL 008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
			2. Tested fault-current closing and withstand ratings: adequate for duty imposed by protective devices at installation locations in project under the fault conditions indicated, based on testing according to UL 1008.
			3. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
			4. Solid-state controls: repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
			5. Resistance to damage by voltage transients: components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
			6. Electrical operation: accomplish by a momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
			7. Switch characteristics: designed for continuous-duty repetitive transfer of full-rated current between active power sources.
			8. Delete first subparagraph below if units using switching components designed for molded-case switches or insulated-case circuit breakers are permissible.
			9. Limitation: switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
			10. Switch action: double throw; mechanically held in both directions.
			11. Contacts: silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
			12. Neutral terminal: solid and fully rated, unless otherwise indicated (4-pole transfer switches required at the dominion pump station and the water treatment plant).
			13. Heater: equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.
			14. Annunciation, control, and programming interface components: devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
			15. Factory wiring: train and bundle factory wiring and label, consistent with shop drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in section 16075 - "Identification for Electrical Systems."
			16. Designated terminals: pressure type, suitable for types and sizes of field wiring indicated.
			17. Power-terminal arrangement and field-wiring space: suitable for top, side, or bottom entrance of feeder conductors as indicated.
			18. Control wiring: equipped with lugs suitable for connection to terminal strips.
			19. Enclosures: general-purpose NEMA 250, Type 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.
		4. Automatic transfer switches
			1. Switching arrangement: double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
			2. Manual switch operation: under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
			3. Manual switch operation: unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
			4. In-Phase monitor: factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
		5. Automatic Transfer Switch Features:
			1. Under voltage sensing for each phase of normal source: sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
			2. Adjustable time delay: for override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
			3. Voltage/frequency lockout relay: prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
			4. Time delay for retransfer to normal source: adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained under voltage of emergency source, provided normal supply has been restored.
			5. Test switch: simulate normal-source failure.
			6. Switch-position pilot lights: indicate source to which load is connected.
			7. Unassigned auxiliary contacts: two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240 VAC.
			8. Transfer override switch: overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
			9. Engine starting contacts: one isolated and normally closed, and one isolated and normally open; rated 10 A at 32 VDC minimum.
			10. Engine shutdown contacts: time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
			11. Engine-generator exerciser: solid-state, programmable-time switch initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
			12. Exerciser transfer selector switch: permits selection of exercise with and without load transfer.
			13. Push-button programming control with digital display of settings.
			14. Integral battery operation of time switch when normal control power is not available.
		6. Source Quality Control
			1. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.
3. **EXECUTION**
	1. **INSTALLATION**
		1. Annunciator and control panel mounting: surface mount, unless otherwise indicated.
		2. Identify components according to Section - "Identification for Electrical Systems.”
		3. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
		4. Connections
		5. Retain first paragraph below if connections are to remote annunciator, control panel, or motor controller. Coordinate with Drawings.
			1. Wiring to remote components: match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to owner if necessary to accommodate required wiring.
			2. Ground equipment according to Section - "Grounding and Bonding for Electrical Systems."
			3. Connect wiring according to Section - "Low Voltage Electrical Power Conductors and Cables."
		6. Field quality control
		7. Retain "Testing Agency," "Manufacturer's Field Service," and "Perform the following tests and inspections" paragraphs below to identify who shall perform tests and inspections. If retaining second option in "Testing Agency" Paragraph or if retaining "Manufacturer's Field Service" or "Perform the following tests and inspections" Paragraph, retain "Field quality-control reports" Paragraph in "Informational Submittals" Article.
		8. Retain "Manufacturer's Field Service" Paragraph below to require a factory-authorized service representative to perform tests and inspections.
			1. Manufacturer's field service: engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
			2. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
			3. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
			4. Perform each visual and mechanical inspection and electrical test stated in NETA acceptance testing specification. Certify compliance with test parameters.
			5. Check for electrical continuity of circuits and for short circuits.
			6. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
			7. Verify that manual transfer warnings are properly placed.
			8. Perform manual transfer operation.
			9. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
			10. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
				1. Retain test in first subparagraph below if three-phase undervoltage sensing is specified in Part 2. Test requires advance preparation by testing agency.
			11. Simulate loss of phase-to-ground voltage for each phase of normal source.
			12. Verify time delay settings.
			13. Verify pickup and dropout voltages by data readout or inspection of control settings.
				1. Usually require test in first subparagraph below only for critical and extensive installations and for switches rated 1600 A and more in other installations.
			14. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
			15. Retain subparagraph and associated subparagraph below if protective devices for circuits connected to transfer switches include ground-fault protection.
			16. Ground-Fault tests: coordinate with testing of ground-fault protective devices for power delivery from both sources.
			17. Verify grounding connections and locations and ratings of sensors.
		9. Tests and Inspections
			1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
			2. Perform each visual and mechanical inspection and electrical test stated in NETA acceptance testing specification. Certify compliance with test parameters.
			3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
			4. Check for electrical continuity of circuits and for short circuits.
			5. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
			6. Verify that manual transfer warnings are properly placed.
			7. Perform manual transfer operation.
			8. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
			9. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
				1. Retain test in first subparagraph below if three-phase undervoltage sensing is specified in Part 2. Test requires advance preparation by testing agency.
			10. Simulate loss of phase-to-ground voltage for each phase of normal source.
			11. Verify time-delay settings.
			12. Verify pickup and dropout voltages by data readout or inspection of control settings.
				1. Usually require test in first subparagraph below only for critical and extensive installations and for switches rated 1600 A and more in other installations.
			13. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
			14. Retain subparagraph and associated subparagraph below if protective devices for circuits connected to transfer switches include ground-fault protection.
			15. Ground-Fault tests: coordinate with testing of ground-fault protective devices for power delivery from both sources.
			16. Verify grounding connections and locations and ratings of sensors.
			17. Coordinate tests with tests of generator and run them concurrently.
			18. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
			19. Remove and replace malfunctioning units and retest as specified above.
			20. Prepare test and inspection reports.
	2. Edit paragraph and subparagraphs below to suit types of switches specified.
		1. Demonstration
			1. Engage a factory-authorized service representative to spend time as necessary to train owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below.
		2. Retain paragraph below if generators are in Project.
			1. Coordinate this training with that for generator equipment.

END OF SECTION