9.15.1.3 The fuse mentioned in 9.15.2.11 shall not open.

9.15.1.4 There shall be no breakage of the switch base to the extent that the integrity of the mounting of live parts is impaired.

9.15.1.5 The door shall be restricted by its latch, without bolt or lock installed therein, from opening.

9.15.1.6 No conductor shall have pulled out of a terminal connector, and there shall not be any damage to the conductor insulation or the conductor.

9.15.1.7 For a plug-in or draw-out unit, the point of contact shall be the same both mechanically and electrically as before the test.

9.15.2 Tests conducted on both normal and alternate source circuits

9.15.2.1 Other than as noted in 9.15.2.2, the tests specified in 9.15.2.3 – 9.15.2.19 shall be performed on both the normal source and alternate source circuits.

9.15.2.2 If the construction of the normal and alternate source circuits are representative of each other, the test is only required on one circuit.

9.15.2.3 A transfer switch intended for use on an alternating current system shall be tested with alternating current at a frequency in accordance with Table 15. The circuit shall be as indicated in Figure 9.13.3.1. The test shall be performed in accordance with the following:

a) The open circuit voltage of the power supply shall not be less that the maximum rated voltage of the switch;

b) The available short-time rms symmetrical current in amperes at the test source terminals shall not be less than the short-time current rating, as specified by the manufacturer, for the device under test;

c) The test source circuit shall include the required measuring equipment;

d) The power factor of the circuit shall be 0.40 – 0.50 for currents of 10,000 A or less, 0.25 – 0.30 for currents of 10,001 – 20,000 A, and 0.20 or less for currents greater than 20,000 A. Lower power factors may be used if agreeable to those concerned, and

e) The test source terminals shall be included in the circuit for the connections described in 9.15.2.5. In determining the available short-circuit current of the circuit, these terminals shall be short-circuited by bus bars.

9.15.2.4 The reactive components of the impedance may be paralleled in the line shown in Figure 9.13.3.1 if of the air-core type. No reactance shall be connected in parallel with the resistance, except that an air-core reactor in any phase may be shunted by resistance as determined in accordance with Annex H, H5.20.

9.15.2.5 For the performance of the test, the line terminals of the switch shall be connected to the corresponding test circuit terminals by the conductor or conductors described in 9.8.5. Lengths shall be in accordance with 9.13.3.26 – 9.13.3.28 and as specified in Annex H, H2.4. The load terminals shall be similarly connected to a short-circuiting bus bar.

9.15.2.6 Other than as noted in 9.15.2.7 – 9.15.2.10, separate short-circuit tests shall be conducted with copper cable and with compact aluminum cable. The cable shall enter the line end of the enclosure at a point that provides the maximum length of unsupported cable within the enclosure. The line terminals shall be wired and tightened to the torque used in the investigation of the terminals in accordance with Annex A1, Item 4. There shall be no bracing of the cable inside the enclosure unless the design includes instructions for bracing the conductors as covered in 5.2.1.31. The provision for bracing may be provided with the transfer switch. Bracing hardware not provided as part of the switch shall be available to the installer. A cable shall be braced as it leaves the enclosure on the supply side.

9.15.2.7 The representative transfer switch shall be tested with copper cable when the transfer switch is restricted to use with copper cable in accordance with 5.2.1.15.

9.15.2.8 The representative transfer switch shall be tested with aluminum or copper cable when the short-circuit current rating divided by the number of cables per phase results in a current of 50,000 A per cable or less.

9.15.2.9 A representative transfer switch that does not have provision for wire connection shall be connected with bus bars in accordance with Table 17.

9.15.2.10 When the short-circuit test current rating is greater than 50,000 A per conductor, the representative transfer switch shall be tested with either compact aluminum or copper cable when the type of cable used for the short-circuit test has a lower pull out force than the untested cable material.

9.15.2.11 The enclosure shall be connected through a 30 A, non delay type cartridge fuse to the line lead of the pole least likely to arc to the enclosure. The fuse shall have a voltage rating not less than the rated voltage of the equipment being tested. This connection shall be made on the load side of the limiting impedance by a 5.3 mm^2 (10 AWG) copper wire 1.2 – 1.8 meters (4 – 6 feet) long. Refer to Figure 9.13.3.1.

9.15.2.12 For the test specified in 9.15.1.1, the transfer switch contacts shall be closed. The test circuit closing switch shown in Figure 9.13.3.1 shall then be used to apply the test voltage to the circuit. The test circuit closing switch shall remain closed until current passes through the transfer switch continuously for the rated time duration. A separate main device (see Figure 9.13.3.2) shall not be used to conduct the test.

9.15.2.13 A three-phase transfer switch shall be tested on a three-phase circuit.

9.15.2.14 A single-phase transfer switch, including a design employing adjacent poles of a three-phase construction, shall be tested on a single-phase circuit.

9.15.2.15 When the test in 9.15.2.12 is conducted on a single-phase circuit, it shall be controlled so that the closing angle with respect to the zero point of the supply voltage is within +10 degrees.

9.15.2.16 The transfer switch subjected to the short-time withstand test in 9.15.1.1 shall also be subjected to a short-time closing test. The short-time closing test shall be conducted on the same set of contacts used in the short-time withstand test. The conditions shall be the same as for the short-time withstand test. The test circuit-closing switch shown in Figure 9.13.3.1 shall be used to apply the test voltage to the circuit before the transfer switch is closed. The test circuit-closing switch shall remain closed until current passes through the transfer switch continuously for the time duration intended for marking. A separate main device as shown in Figure 9.13.3.2 shall not be used to conduct the test.

9.15.2.17 A transfer switch that has been subjected to the tests in 9.15.1.1 and 9.15.2.16 shall comply with the requirements in the Dielectric voltage-withstand test, 9.9, except that the test potential shall be twice the rated voltage of the switch, but not less than 900 V.

9.15.2.18 Using the contacts subjected to the tests described in 9.15.1.1 and 9.15.2.16, the switch shall be subjected to a temperature test in accordance with Temperature rise test, 9.8. The test current shall be passed through the contacts without maintenance, and the temperature rise shall not exceed the values given in Table 16, increased by 10°C or 18°F.

9.15.2.19 The transfer switch markings shall be marked as specified in 5.2.3.3, 5.2.3.4, 5.2.4.4, or 5.2.5.3. The marked time duration shall be equal to lowest time duration measured in either the short-time withstand test or the short-time closing test.

9.16 Receptacle withstand test

Note: In Mexico and the United States, these requirements are applicable. In Canada, these requirements do not apply.

9.16.1 Other than as noted in 9.16.2 and 9.16.3, a receptacle provided as part of a transfer switch shall be tested as specified in 9.16.5 – 9.16.7 and shall comply with the requirements as specified in 9.16.4.

9.16.2 A non-GFCI type receptacle in a transfer switch marked with a short-circuit current rating of 10,000 amperes or less is not required to be tested if the overcurrent protective device ahead of the receptacle has a minimum short-circuit rating of 10,000 amperes.

9.16.3 A GFCI-type receptacle with a marked short-circuit current rating of 5,000 or 10,000 amperes in a transfer switch having the same short-circuit rating is not required to be tested if the overcurrent protective device ahead of the receptacle has a minimum short-circuit current rating of 5,000 or 10,000 amperes, respectively.

9.16.4 Upon completion of the tests specified in 9.16.3 – 9.16.7:

a) A transfer switch shall comply with the withstand requirements specified in 9.13.3.1;

b) The cord shall not be visibly damaged and, after removing the shorting pressure wire connector, the cord shall withstand a 900-volt potential applied between the individual conductors;

c) A GFCI-type receptacle, if included, shall either open the circuit when the test button is pushed or at the completion of the short-circuit test, have permanently opened the circuit; and

d) A GFCI-type receptacle, if included, shall withstand a 900-volt potential applied between the line and load sides after opening as specified in (c).

9.16.5 The attachment plug shall be wired with 254 mm (10 inches) per terminal of the cord of wire gauge as specified in Table 26 and inserted into the receptacle as intended in service. At the end of the attachment plug, the cord connectors shall be joined in a pressure wire connector rated for the size of conductors involved.

9.16.6 The branch circuit overcurrent protective device, consisting of either a fused switch or a circuit breaker, and all the main overcurrent devices, integral or separate, shall be in the fully closed position. The test circuit shall be closed on the switch by an external switching means.

9.16.7 All switches and overcurrent protective devices, integral or separate, shall be in the fully closed position. The attachment plug, wired with the maximum-sized cord, shall close the circuit by being mechanically inserted into the receptacle.

9.17 Strength of insulating base and support tests

9.17.1 General

9.17.1.1 The insulating base of a transfer switch shall not be damaged when wire connectors securing short lengths of conductors of rated ampacity are torqued to 110 percent of the value marked on the transfer switch.

9.17.1.2 Damage is considered to have occurred if the base insulating material cracks or rotates; bosses, recesses, or other means to prevent turning do not perform their intended function; straps or bus bars bend or twist; or members move at electrical joints. Minor chipping or flaking of brittle insulating material is acceptable if the performance is not otherwise impaired. Momentary flexing of metallic members without permanent deformation is acceptable.

9.17.2 Strain relief tests for leads

9.17.2.1 In order to determine compliance with 6.13.3.3, there shall not be any breakage, damage, or loosening of any component that is detrimental to the use of the switch, including, but not limited to the terminals, strain relief, field-wiring leads, conduit, and similar items, when tested as required in 9.17.2.2.

9.17.2.2 A lead shall be exposed to a direct pull increased gradually to 156 N (35 lbf) and maintained at that value for 5 minutes. If factory attached conduit is provided, the free end of the conduit shall be fixed with the force applied to the lead.

10 Test Requirements – Routine Tests

Note: In Mexico and the United States, this clause is normative. In Canada, this clause is informative.

10.1 Ground-fault protection

10.1.1 Other than as noted in 10.1.2, a factory test shall be conducted on each transfer switch incorporating ground-fault protection equipment to determine that the ground-fault sensing and protective equipment functions. The primary of the control transformer, if any, shall be energized at 57 percent of its voltage rating. The relay may be set for any convenient pick-up value. Following this test, with simulated ground-fault current no longer flowing, an attempt shall be made to close the main switch or circuit breaker without pushing any reset button. If the switch or breaker stays closed, the simulated ground-fault current shall be reapplied and the ground-fault protection system shall function.

10.1.2 When conducting the test in 10.1.1, the applied voltage may be approximately rated voltage if the particular combination of transformer, ground-fault sensing and relaying equipment, and disconnecting means has been previously tested at 57 percent of rated voltage.

Tables

Table 1
Available fault current rating – RMS symmetrical amperes

(refer to 4.2.2 and Table 25)

5,000
7,500
10,000
14,000
18,000
22,000
25,000
30,000
35,000
42,000
50,000
65,000
85,000
100,000
125,000
150,000
200,000

Table 2
Marking locations

(refer to 5.2.1.1, 5.2.1.10, 5.2.1.12, and 5.2.8.1)

Reference	Required marking[a]	Location[b, c]	
		Enclosed	Open
5.2.1.2(a)	Manufacturer name or trademark	B	B
5.2.1.2(b)	Catalog number	B	B
5.2.1.2(c)	The words ″Transfer Switch″	B	B
5.2.1.2(d)	Date code	B	B
5.2.1.4	Factory identification	B	V
5.2.1.5	WARNING – More than one live circuit. Disconnect all sources of supply before servicing.	A	B
5.2.1.6	Type of load	B	B
5.2.1.7	Total System transfer	B	B
5.2.1.8	80 or 100 percent current rating	B	B
5.2.1.34	Plenum rating	B	B
5.2.2.1	Transfer voltage	B	B
5.2.2.2	Transfer frequency	B	B
5.2.2.3	Transfer delay time	B	B
5.2.2.4	Adjustment and configuration instructions	B or E	B or E
5.2.2.5	Transfer delayed until generators are on-line	B	B
5.2.2.6	Transfer switch does not transfer if overcurrent device opens	B	B
5.2.3.1	Short-circuit rating for integral overcurrent protection	B	B
5.2.4.1	Short-circuit rating without integral overcurrent protection	B	B
5.2.5.1	Short-circuit rating (specific overcurrent device)	B	B
5.2.1.10	Connection diagram	B	B

Table 2 Continued on Next Page

Table 2 Continued

Reference	Required marking[a]	Location[b, c]	
		Enclosed	Open
5.2.1.11	Use of conduit required between units	B	B
5.2.1.12	Instructions for periodic testing	B	B
5.2.1.13 – 5.2.1.20	Type of wire (Cu and/or Al)	B	B
5.2.1.21 – 5.2.1.22	Temperature rating of conductors	B	B
5.2.1.23	Terminal kit markings	G	G
5.2.1.24	Ventilation requirements	–	B or E
5.2.1.25	Ground-fault circuit protection	B and E	B and E
5.2.1.26	Neutral bus markings	I	I
5.2.1.27	Tightening torque for terminals	B	B
5.2.1.28	Replacement of barriers	F	F
5.2.1.29	Environmental markings	B	B
5.2.1.30	Closed transition transfer	B	B
5.2.1.31	Cable bracing	B	B
5.2.1.32	Automatic transfer switch for emergency systems	B	B
5.2.1.33	Optional Standby only	B	B
5.2.1.35	Manual Transfer Switch	B	B
5.2.1.36	Verify condition of power source before manual transfer	B	B
5.2.1.37	Field installed bus connections	J	J
5.2.6.1.1, 5.2.6.1.7	Suitable for use as service equipment	B	B
5.2.6.1.2	Separate service disconnect label	C	C
5.2.6.1.3	Suitable only for use as service equipment	B	B
5.2.6.1.4, 5.2.6.1.5	Service disconnect	H	H
5.2.6.1.6	Bonded neutral – Remove bonding device for test purposes only	B	B
5.2.6.1.8	Required terminals	B	B
5.2.6.1.9	Service disconnect with transformer connected to line side	H	H
5.2.6.1.10	Connection of ground-fault protection	B and E	B and E
5.2.6.1.11	Service equipment without ground-fault protection	B	B
5.2.6.1.12	No ground-fault protection for alternate source	B	B
5.2.6.1.13	Service disconnect does not disconnect control and instrument circuits	H	H
5.2.6.2.1	Suitable for use as service equipment	B	B
5.2.6.2.2	Compartment for Supply Authority use	B	B
5.2.6.2.3	Bonded neutral	B	B
5.2.6.2.4	Service Disconnect	H	H
5.2.6.2.5	Service Disconnect Inside	A	NA
5.2.7.1	External branch overcurrent protection	B	B
5.2.7.2	Unswitched neutral	B and E	B and E
5.2.7.3	Switched neutral	B and E	B and E
5.2.7.4	Not for indoor use	B and E	B and E
5.2.7.5	Single pole seperable connectors	B	B
5.2.7.6	Order of connection	B	B
5.2.7.8	Generator connection	B	B
5.2.7.9	Temporary wiring	B	B
5.2.7.10	Inlets	A	NA
5.2.7.11	Use with a transfer switch	K	NA
5.2.8.1	Kit identification	K	K
5.2.8.2	Kit catalog number	G	G
5.2.8.3	Connector kit conductor size	G	G

Table 2 Continued on Next Page

Table 2 Continued

Reference	Required marking[a]	Location[b, c]	
		Enclosed	Open
5.2.8.4	Kit installation instructions	G	G
5.2.8.5	Kit parts and components identification	G	G
5.3.1	Instructions for ground-fault testing	D	D
D14.1	Bypass/isolation operating instructions	A	A
D14.3	Parts energized in isolation mode	A	A
E5.1	Fire pump power transfer switch	B	B
E5.5	Open all disconnecting means	A	A

In this table, references provided to original clauses indicate that the full clause and any national deviations are applicable. Where specific different marking requirements are contained in national deviations, those national deviation clauses are separately referenced in the table. Where the national deviation replaces the original clause, only the national deviation clause is referenced in the table. Those original clauses not considered to be applicable are not referenced in the table.

[a] This is a brief summary of marking requirements. For complete details, see the specific requirement reference.

[b] For marking locations identified below, ″A″ is the highest order of location, and ″I″ is the lowest order of location. At the option of the manufacturer, a higher order of location category may be used. Location ″J″ is not part of the order of locations.

[c] For the purpose of location of markings, a device which, upon installation, completes an overall enclosure (such as a device mounted to a junction box), shall be considered an enclosed device.

A. Marking shall be visible when the enclosure cover is on and the door is closed.

B. Marking shall be visible:

1) When the enclosure cover is removed or the door is open;

2) When other devices are mounted nearby as intended;

3) When devices are installed side by side with intended clearances; and

4) Without being obscured by attachments such as disconnect switch operating handles.

C. Marking is on a separable, self-adhesive permanent label that is shipped with the device in an envelope or on a card.

D. Marking is on the device or separate sheet provided with the device.

E. Marking is in instructional manual shipped with the device. A marking on the device refers to the specific instruction manual.

F. Marking is provided on the removable barrier.

G. Marking is provided on the kit or shipped separately with the kit.

H. Marking is on or immediately adjacent to the service-disconnect handle and is visible after installation.

I. Marking is on or adjacent to the neutral bus.

J. Marking is on a permanent drawing which is visible after installation or is on a removable tag attached to the bus.

K. Information shall be marked on the transfer switch or in instructions provided with the transfer switch.

Table 3
Minimum acceptable spacings in millimeters (inches)

(refer to 5.2.6.1.6, 6.3.1.1, 6.3.1.2, 6.3.1.3, 6.3.1.4, 6.3.1.6, 6.3.1.8, 6.3.1.10, 6.3.2.1, 6.5.22, 6.9.2, 6.10.2, 8.1.3.6, 8.2.3.3, and Table 4)

Potential involved, in volts		Power circuits rated 400 A maximum and control circuits					
		51 – 150		151 – 300		301 – 1000	
Between any uninsulated live part and an uninsulated live part of opposite polarity	Through air or oil	3.2[a]	(1/8)[a]	6.4	(1/4)	9.5	(3/8)
	Over surface[d,e]	6.4	(1/4)	9.5	(3/8)	12.7	(1/2)
Between any uninsulated live part and an uninsulated grounded part, other than the enclosure, or exposed metal part	Through air or oil	3.2[a]	(1/8)[a]	6.4	(1/4)	9.5	(3/8)
	Over surface[d,e]	6.4	(1/4)	9.5	(3/8)	12.7	(1/2)
Between any uninsulated live part and the walls of a metal enclosure, including fittings for conduit or armored cable	Shortest distance[d,e]	12.7	(1/2)	12.7	(1/2)	12.7	(1/2)
Potential involved, in volts		**Power circuits rated over 400 A**					
		50 – 150		**151 – 300**		**301 – 1000**	

Table 3 Continued on Next Page

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Table 3 Continued

Between any uninsulated live part and an uninsulated live part of opposite polarity	Through air or oil	12.7	(1/2)	19.1	(3/4)	25.4	(1)
	Over surface[d,e]	19.1	(3/4)	31.8	(1-1/4)	50.8	(2)
Between any uninsulated live part and an uninsulated grounded part, exposed metal part, or walls of a metal enclosure, including fittings for conduit or armored cable[b]	Through air or oil	12.7	(1/2)	19.1	(3/4)	25.4[c]	(1)[c]
	Over surface[d,e]	12.7	(1/2)	12.7	(1/2)	25.4	(1)

[a] The spacing between wiring terminals of opposite polarity and the spacing between a wiring terminal and a grounded part shall not be less than 6.4 mm (1/4 inch) if short-circuiting or grounding of such terminals can result from projecting strands of wire.

[b] For the purpose of this requirement, a metal piece attached to the enclosure shall be considered a part of the enclosure if deformation of the enclosure is likely to reduce spacings between the metal piece and uninsulated live parts.

[c] A through-air spacing of not less than 12.7 mm (1/2 inch) is acceptable:

1) At the main terminals, and

2) Between grounded dead metal and the neutral of a 277/480 V, or 347/600 V, 3-phase, 4-wire transfer switch.

[d] In measuring over-surface spacings, any slots, grooves, and the like, 0.33 mm (0.013 inch) wide or less in the contour of insulating material shall be disregarded.

[e] An air space of 0.33 mm (0.013 inch) or less between a live part and an insulating surface shall be disregarded and the part shall be considered in contact with the insulating material when measuring spacings.

Table 4
Minimum spacings for live parts of special components

(refer to 6.3.1.5, 6.3.1.6, and 6.3.1.7)

	Minimum spacing between bare parts of opposite polarity and between bare live parts and grounded metal parts[a], mm		
Type of spacing	51 – 150 V	151 – 375 V	376 – 750 V
Through-air	1.6	1.6	4.8
Over-surface	1.6	3.2	9.4
To enclosure (through-air and over-surface)[b]	6.4	6.4	12.7

[a] Metal parts that are likely to be grounded when the special component is installed shall be considered to be grounded metal parts.

[b] If a special component has a metal enclosure, it shall be protected by the outer enclosure of the complete equipment unless spacings meet the requirements of Table 3.

NOTES:

1 – In Mexico and the United States, this requirement is applicable.

2 – In Canada, this requirement does not apply.

3– Spacings for equipment rated at voltages below 51 V are not specified in this table, but are subject to investigation.