5.21.10 The fuses in the test circuit shall be non time-delay, general-use cartridge type fuses. The fuse in the grounding/bonding conductor circuit shall have a 15 ampere rating if the device under test is rated at 30 amperes or less. If the device under test is rated at more than 30 amperes, the grounding/bonding fuse shall have a rating of 30 amperes. For the line fuse, the next higher commercial fuse rating than the value shall be used.

5.22 Abnormal overload

5.22.1 When rated for disconnecting use only, not for current interrupting (see Clause 6.1.5), a receptacle or cable connector and a plug shall be subjected to the overload test described in Clauses 5.22.4 – 5.22.10. This requirement does not apply to a receptacle interlocked with an integral switch or circuit breaker, in which the switch or circuit breaker is opened before the plug can be inserted or withdrawn.

5.22.2 The device need not function after the completion of the test, and shall not be used for any further tests. The ground/bond fuse shall not open during the test. The line fuse is not prohibited from opening during the test.

5.22.3 Contacts of the plug or the receptacle shall not be adjusted, lubricated, or otherwise conditioned before or during the test. An additional material intended to reduce or confine the arcing in the contact chamber of a plug and receptacle that decomposes or is otherwise affected by the arcing shall be removed for all of the overload tests.

5.22.4 The device under test shall be subjected to the overload condition by manually or mechanically inserting and withdrawing the plug into and out of the receptacle or connector. A device rated for use with direct current shall be subject to one cycle of operation. A device rated for use with alternating current shall be subject to three cycles of operation at a rate not faster than 10 cycles per minute.

5.22.5 The plugs shall be connected to a load such that the devices shall make and break 150 percent of the rated current. The test shall be conducted using direct current or be conducted using alternating current if the device is marked in accordance with Clause 7.1.6.1. When alternating current is used, the power factor of the load shall be from 0.75 to 0.80.

5.22.6 The potential of the test circuit shall be from 95 to 105 percent of the rating of the device in volts.

5.22.7 The test on a receptacle and a plug that have multiple voltage and ampere ratings shall be performed at:

a) 150 percent of the rated current that corresponds to the maximum rated voltage;

b) 150 percent of the maximum rated current at the corresponding rated voltage; and

c) 150 percent of the rated current at the corresponding rated voltage that results in maximum power per pole.

5.22.8 A test on alternating current may be waived if adequate results have been obtained from an equivalent or higher volt-ampere test at a direct current potential equal to or greater than the alternating current potential rating.

5.22.9 The device shall be mounted and wired to represent service conditions. Exposed metal parts shall be connected through a fuse to:

a) Ground;

b) The grounded/bonded conductor of the test circuit; or

c) A circuit conductor that differs by at least the rated potential from one or more of the remaining conductors in the circuit.

5.22.10 The fuses in the test circuit shall be non time-delay, general use, cartridge type fuses. The fuse in the grounding/bonding conductor circuit shall have a 15 ampere rating if the device under test is rated at 30 amperes or less. If the device under test is rated at more than 30 amperes, the grounding/bonding fuse shall have a rating of 30 amperes. For the line fuse, the next higher commercial fuse rating than the value of the test current in the test circuit shall be used.

5.23 Horsepower rated locked rotor

5.23.1 A device with one or more motor rating(s) shall perform in an overload test making and breaking the locked-rotor current corresponding to each horsepower rating of the device. There shall be no electrical or mechanical failure of the device, no burning or pitting of the contacts that would affect the intended function, and no welding of the contacts.

5.23.2 The test shall be conducted in accordance with Clause 5.21, except that the value of the test current corresponding to a horsepower rating shall be as specified in:

a) NMX-J-005-ANCE/CSA C22.2 No. 111/UL 20 for two horsepower or less; and

b) UL 508, CSA C22.2 No. 14, or NMX-J-515-ANCE for an alternating-current rating of more than two horsepower.

The load for an alternating-current horsepower rating shall have a power factor of 0.40 – 0.50.

5.24 Electromagnetic (pilot contacts)

5.24.1 The pilot contacts of a plug, connector, inlet, and receptacle for controlling a contactor, a relay, or other magnetically operated device shall perform satisfactorily when subjected to an overload test consisting of 50 operations, making and breaking the inrush current based on the contact rating, followed by 6,000 operations at normal rated current, in a circuit of 110 percent of the test potential indicated test in Table 17. The load shall be as indicated in Table 17 and shall consist of an electromagnet representative of the load that the device is intended to control.

5.24.2 A load other than one of those described in Table 17 may be used after due consideration of:

a) The need for a device to control an electromagnetic load having other characteristics;

b) The means utilized for matching the rating of the device to that of the load; and

c) The manufacturer's markings.

5.24.3 Devices employing more than 2-pilot pins or contacts shall be tested as described in Clauses 5.24.1 and 5.24.2, using the Appliance Wiring Material (AWM) style as identified by the manufacturer and tested simultaneously with multiple supply and loads present to represent actual service conditions.

5.24.4 Devices having two or fewer pilot contacts that are also intended for use with an AWM cord or cable shall be additionally tested as described in Clauses 5.24.1 and 5.24.2 using the appliance wiring material (AWM) style as identified by the manufacturer and employing multiple supply and loads simultaneously as required to represent actual service conditions.

5.25 Temperature rise

5.25.1 If the tests are conducted at an ambient temperature of other than 25°C, the results shall be adjusted to an ambient temperature of 25°C by adding the appropriate variation between 25°C and the ambient.

5.25.2 The temperature rise of a device measured at the points described in Clause 5.25.5 shall not exceed 30°C when the device is carrying its maximum rated current. This temperature rise is based on devices intended to be wired with conductors rated 60°C.

5.25.3 A temperature rise of 45°C shall be permitted when the device is intended to be wired with conductors sized based on the ampacity of wire rated 75°C or higher, and so marked. Devices intended for use with conductors rated 75°C or higher and so marked shall not intermate with similar devices not so marked. See Clauses 7.1.1.3 and 7.1.1.4.

5.25.4 A device intended for use with conductors sized based on the ampacity of wire rated 75°C, and intended to intermate with devices not so marked, shall not exceed 30°C rise when the device is carrying its maximum rated current, when wired with 75°C ampacity conductors. See Clause 7.1.1.5.

5.25.5 The temperature measurement shall be made on the wiring terminals of the equipment, if they are accessible for mounting thermocouples. If the equipment has no wiring terminals or if they are inaccessible, temperatures shall be measured as close as possible to the face of the equipment on the plug contacts inserted in the receptacle.

5.25.6 The temperature test shall be made following the overload test on the equipment, and shall continue for 4 h or until thermal stabilization is attained. Thermal stabilization shall be considered to have occurred when three successive readings, taken at intervals of not less than 10 minutes, show no further increases. Each connection to the equipment under test shall be made by means of at least 0.46 m (18 inches) of the intended type and size of wire or cord (see Clauses 4.11.1 and 7.1.1.2) with the terminals of the device tightened using a torque as specified by the manufacturer's instructions. In the case of a connector body, conductors of the indicated ampacity shall be used regardless of the size of the cord that is intended to be used with the device. The contacts of equipment under test shall be connected together by means of an inserted plug. A previously untested plug may be used. The terminals of the plug shall be short-circuited by means of the shortest feasible lengths of the wire as previously described.

5.25.7 For devices employing more than 2-pilot pins or contacts, the temperature test as described in Clauses 5.25.1 – 5.25.6, shall be conducted using the Appliance Wiring Material (AWM) style as identified by the manufacturer and with all pilot pin and contacts fully energized based upon their maximum rated current when wired with their maximum AWM conductor size.

5.25.8 Devices having two or fewer pilot contacts that are also intended for use with an AWM cord or cable shall be additionally tested as described in Clauses 5.25.1 – 5.25.6 using the Appliance Wiring Material (AWM) style as identified by the manufacturer and with the pilot pin and contacts fully energized based upon their maximum rated current when wired with their maximum AWM conductor size.

5.26 Resistance to arcing

5.26.1 If a material, other than ceramic, is used in the construction of the face of an outlet device in a way that the material is likely to be exposed to arcing while in service, the devices that were subjected to 50 cycles of operation in the overload test described in Clause 5.21 shall perform acceptably when subjected to an additional 200 cycles of operation under the overload-test conditions following the temperature test. There shall be no electrical tracking, formation of a permanent carbon conductive path, or ignition of the material. The attachment plug used for this test may be changed after every 50 operations. If a contact failure occurs after the first 50 operations, the contact may be replaced to permit the remainder of the test operations to be completed.

5.26.2 An interlocked receptacle (outlet) or a device identified as not intended for interrupting current need not be subjected to this test; see Clause 7.1.4.1.

5.26.3 Alternatively, one set of devices may be subjected to the 50 cycles of operation in the overload test described in Clause 5.21, followed by the temperature test on the devices, and then, to determine resistance to arcing, a second set of devices, previously untested, may be subjected to 250 cycles of operation under the overload-test conditions.

5.27 Polarization integrity

5.27.1 Compliance with the requirements specified in Clause 4.9.11 shall be determined by using the device assembled in its intended housing with the polarization feature removed. With the axis of the mating devices aligned, the devices shall not be able to mate in any manner that would energize the grounding/bonding feature of the device when a force of 180 N (40 lbf) is applied.

5.28 Resistance to corrosion

5.28.1 Ferrous parts, including enclosures, shall be adequately protected against corrosion.

5.28.2 Compliance shall be checked by the following test. All grease shall be removed from the parts to be tested, by immersion in ethyl acetone, acetone, or methylethyl ketone for 10 minutes. The parts shall then be immersed for 10 minutes in a 10 percent solution (by weight) of ammonium chloride in water at a temperature of 20 ±5°C.

5.28.3 The parts shall then be dried for 10 minutes in a heating cabinet at a temperature of 100 ±5°C, and their surfaces shall not show any signs of rust.

5.28.4 Traces of rust on sharp edges and yellowish film removable by rubbing shall be ignored.

5.28.5 Small helical springs and the like, and inaccessible parts exposed to abrasion, shall be considered protected against corrosion by a coating of grease. Such parts shall be tested only when the effectiveness of the grease film is in doubt, and the test shall then be made without previous removal of the grease.

5.29 Moisture resistance

5.29.1 Details

5.29.1.1 Marine-type and water-tight plugs, receptacles, and connectors requiring a degree of moisture protection shall not permit the entrance of water when subjected to the tests associated with their classifications, as described in Clauses 5.29.2 and 5.29.3. Water shall not:

a) Enter the devices to any appreciable extent;

b) Collect on the interior of the box;

c) Interfere with the intended performance of the device; or

d) Reach live parts.

5.29.1.2 When tested as described in Clause 5.29.2.1, a device or assembly of parts (hereinafter referred to as the test assembly), as mentioned in Clause 5.29.1.3, shall comply with Clause 5.29.2.1.

5.29.1.3 The test assembly shall be fitted with cable or conduit and installed as intended in actual service in accordance with the assembly and installation instructions. Receptacles shall be mounted on a vertical surface, with any drains present in the lowest position.

5.29.2 Marine type (shipboard use)

5.29.2.1 The test assembly shall be subjected to a solid stream of water from a nozzle not less than 25.4 mm (1.0 in) inside diameter and under a pressure of 103 kPa (15 pounds-per-square-inch). The nozzle shall be directed at the test assembly from a distance of 3.05 m (10 ft) for 5 minutes.

5.29.2.2 If the device employed in the test assembly is an outlet, the test described in Clause 5.29.2.1 shall be conducted both with and without an attachment plug in the outlet.

5.29.3 Watertight

5.29.3.1 The test assembly shall consist of a mated plug and receptacle, a mated plug and connector, a mated connector and power inlet, an individual device with a cap or cover, or any other combination of mating devices.

5.29.3.2 The test assembly shall be immersed for 24 hours in water at a temperature of 25 ±5°C, the highest point of the assembly being approximately 51 mm (2.0 in) below the water level and the longitudinal axis being parallel to the surface of the water.

5.30 Environmental enclosure type designators

5.30.1 A device marked with an enclosure type designation shall be subjected to the tests specified in NMX-J-235/2-ANCE/CSA C22.2 No. 94.2/UL 50E and shall comply with the construction requirements applicable to an enclosure of the type number or numbers with which it is marked. See Clauses 7.1.14.1 – 7.1.14.5.

5.30.2 A watertight connection at conduit entrances shall be a conduit hub or the equivalent, such as a knockout or fitting, located so that when conduit is connected and the enclosure is mounted in the intended manner, the enclosure is found to be acceptable when subjected to the tests specified in NMX-J-235/2-ANCE /CSA C22.2 No. 94.2/UL 50E.

5.30.3 When a panel mounted device is tested, it shall be mounted on a panel of the appropriate enclosure type, in accordance with the manufacturer's instructions.

5.31 Pin-type (insulation-piercing) or insulation-displacement terminals

5.31.1 General

5.31.1.1 In addition to the general performance requirements for attachment plugs and cord connectors, an attachment plug or cord connector employing either pin-type (insulation-piercing) or insulation-displacement terminals shall comply with the requirements in Clauses 5.31.2 – 5.31.7.

5.31.2 Assembly

5.31.2.1 An attachment plug or cord connector with pin-type (insulation-piercing) or insulation-displacement terminals shall be able to be readily assembled to the flexible cords or cables with which it is intended to be used.

5.31.2.2 Except as noted in Clause 5.31.2.3, twenty-four unmated devices shall be subjected to this test. Twelve of the 24 devices shall be assembled and tested with the minimum diameter flexible cord or cable and the remaining 12 shall be assembled and tested with the maximum diameter flexible cord or cable as specified by the manufacturer. For other types of flexible cord or cable, consideration shall be given to the need for testing different types of cords or cables and the effects of variations on insulation material and thickness for each type of flexible cord or cable. Proper assembly shall be determined by visual examination and compliance with the tests described in Clauses 5.31.3 – 5.31.7.

5.31.2.3 The device is not required to be assembled and tested with those cord or cable types and sizes excluded by the marking specified in item (d) of Clause 7.1.1.2.

5.31.3 Temperature test

5.31.3.1 The temperature rise shall not be more than 30°C (54°F) when an attachment plug or cord connector with either pin-type (insulation-piercing) or insulation-displacement terminals is carrying the current corresponding to the ampacity of the size cord or cable that the device is intended to accommodate.

5.31.3.2 The test shall be conducted on devices assembled to the minimum and maximum size flexible cord or cable as specified by the manufacturer.

5.31.3.3 Six of the 24 devices from the Assembly Test shall be tested for temperature rise. Thermocouples shall be attached to the terminals. The assemblies shall be tested for 15 days without interruption. The device temperature shall be measured at the end of each working day.

5.31.3.4 Following the completion of this test, the same six devices using each of the flexible cord sizes and types specified in Clause 5.31.2.2 shall be selected and subjected to the Dielectric Voltage-Withstand Test described in Clause 5.31.6.

5.31.4 Strain relief test

5.31.4.1 When assembled to the intended flexible cord or cable, an attachment plug or cord connector with either pin-type (insulation-piercing) or insulation-displacement terminals shall withstand the straight pull described in Clause 5.31.4.4 without detachment of any cord or cable conductor or any other evidence of damage that increases the risk of fire or electric shock.

5.31.4.2 The test shall be conducted on devices assembled to the minimum and maximum size flexible cord or cable as specified by the manufacturer.

5.31.4.3 Twelve of the 24 devices from the Assembly Test shall be subjected to this test. One set of six devices, three assembled to the minimum flexible cord or cable size and three assembled to the maximum flexible cord or cable size, shall be subjected to the test described in Clause 5.31.4.4 following assembly in the as-received condition. The second set of six devices, three assembled to the minimum flexible cord or cable size and three assembled to the maximum flexible cord or cable size, shall be tested after being conditioned in a full-draft air-circulating oven for 30 days at 67.0°C (152.6°F).

5.31.4.4 While the attachment plug or cord connector is securely supported by the pins or contacts respectively, a pull of 133 N (30 lbf) shall be applied to the flexible cord or cable for 1 minute. The direction of the force shall be perpendicular to the plane of the cord entrance.

5.31.5 Fault current test

5.31.5.1 When assembled to the intended flexible cord or cable, an attachment plug or cord connector with either pin-type (insulation-piercing) or insulation-displacement terminals shall withstand the applied fault current without ignition of the cotton or cord insulation. The circuit breaker shall operate when the test circuit is closed.

5.31.5.2 The test shall be conducted on devices assembled to flexible cords or cables representing each size and type of cord as specified by the manufacturer. Consideration shall be given to the effects of variations in cord insulation material and thickness in selecting cords or cables for the tests. Three sets of two devices each shall be tested using each representative size and type of cord or cable.

5.31.5.3 The attachment plugs and cord connectors shall be assembled to a 0.6 m (2-ft) length of each size and type of flexible cord or cable twisted and soldered at the end. The assemblies shall be tested as follows:

a) The first set shall be subjected to the test described in Clause 5.31.5.4 following assembly in the as-received condition.

b) The second set shall be subjected to the test described in Clause 5.31.5.4 after being subjected to a 67 N (15 lbf) strain relief test for 1 minute.

c) The third set shall be subjected to the test described in Clause 5.31.5.4 after being conditioned in an oven at 67.0°C (152.6°F) for 30 days.

5.31.5.4 A mating receptacle (in the case of a plug being tested) or a mating inlet (in the case of a cord connector being tested), shall be wired in a circuit capable of delivering 1000 A rms at the voltage rating of the device under test when the system is short-circuited at the testing terminals. The receptacle shall be wired to the testing terminals by 1.2 m (4 ft) of 10 AWG (6 mm^2) wire. A thermal-type 30-A circuit breaker shall be connected between the receptacle and the testing terminals. The circuit breaker shall comply with NMX-J-266-ANCE/CSA C22.2 No. 5/UL 489. Cotton shall be placed around the attachment plug or cord connector being tested. The representative device shall be mated to corresponding mating device as intended. The test circuit shall be closed by means of an external switching device.

5.31.6 Dielectric voltage-withstand test

5.31.6.1 The same six devices from the Temperature Test specified in Clause 5.31.3.4 shall be capable of withstanding without breakdown, for a period of 1 minute, the application of a 60 Hz essentially sinusoidal potential of 1000 V plus 2 times the rating of the device or 1500 V (whichever is greater) between individual conductors of the flexible cord or cable.

5.31.6.2 The test potential shall be supplied from a 500 VA or larger capacity testing transformer whose output is essentially sinusoidal and can be varied. The applied potential shall be increased from zero until the required test voltage is reached, and shall be held at that voltage for a period of 1 minute. The increase in the applied potential shall be at uniform rate and as rapid as is consistent with its value being correctly indicated by the voltmeter.

5.31.7 Heat cycling and vibration tests

5.31.7.1 General

5.31.7.1.1 Following the Heat Cycling and Vibration Tests described in this Clause, an attachment plug or cord connector employing either pin-type (insulation-piercing) or insulation-displacement terminals shall comply with the thermal stability criteria described in Clause 5.31.7.5 and not have demonstrated a temperature rise of more than 100°C (180°F).

5.31.7.1.2 Following the manufacturer's instructions, six representative attachment plugs or cord connectors shall be assembled onto the maximum size flexible cord or cable as specified by the manufacturer.

5.31.7.1.3 The devices shall be connected with 610 to 686 mm (24 to 27 inches) of flexible cord or cable between each device and wired in series so that the test current passes through the connection point of the entering conductor, the device internal structure, and the exiting conductor.

5.31.7.1.4 Three of the six devices shall be rigidly supported and secured to a mounting rack attached to a vibration platform.

5.31.7.1.5 The pins or contacts of the devices under test shall be mated as intended to corresponding mating device. The mating device shall be assembled to the shortest feasible length of maximum size flexible cord or cable.

5.31.7.2 Heat cycling test (initial)

5.31.7.2.1 The six devices shall be subjected to the Initial Heat Cycling Test. Each heating cycle shall consist of 1-1/2 hours ″on″ time and 1/2 hour ″off″ time with a total of 500 cycles on each device. The test current shall equal 200 percent of the current rating of the device.

5.31.7.2.2 The temperature rises shall be measured using thermocouples placed on the terminals.

5.31.7.2.3 Temperature readings shall be obtained by means of thermocouples consisting of 28 – 32 AWG (0.08 – 0.032 mm^2) iron and constantan wires. It is a common practice to employ thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires with a potentiometer type of indicating instrument.

5.31.7.2.4 The temperature of the connection shall be recorded at the following intervals: commencing with the 25th cycle and approximately every 25 cycles thereafter for a total of five measurements (approximately 125 cycles). This yields 5 data points for each device tested.

5.31.7.3 Vibration test

5.31.7.3.1 Following approximately 125 cycles of heat cycling as described in Clause 5.31.7.2, the three devices mounted to the test rack shall be disconnected from the circuit and subjected to vibration testing as described in Clause 5.31.7.3.2. Vibration shall be applied for two hours in each of three mutually perpendicular directions for a total of 6 hours of testing.

5.31.7.3.2 Each device mounted to the test rack shall be fastened to a vibration platform and subjected to simple harmonic motion of amplitude 0.76 mm (0.03 inch), 1.52 mm (0.06 inch) peak-to-peak, with the frequency varied uniformly in one minute from 10 to 55 cycles per second and back to 10 cycles per second.

5.31.7.3.3 At the conclusion of the vibration conditioning, each device shall be reconnected to the test circuit to complete the approximately 375 remaining cycles of the Heat Cycling Test as described in Clause 5.31.7.4.1, for a total of 500 cycles.

5.31.7.4 Heat cycling test (final)

5.31.7.4.1 The remaining 6 data points for each device shall be obtained by recording the temperature of the connection at the following intervals:

a) Approximately every 45 cycles for a total of three measurements (approximately 135 cycles); and

b) Approximately every 80 cycles for a total of three measurements (approximately 240 cycles).

5.31.7.5 Calculations

5.31.7.5.1 The thermal stability shall be evaluated as follows for each thermocouple location:

a) Find the average temperature rise for all 11 data points obtained (from Clause 5.31.7.2.4 and Clause 5.31.7.4.1), and

b) Find the deviation of each of the 11 data points from the calculated average.

5.31.7.5.2 None of the 11 data points shall deviate above the average temperature by more than 10°C (18°F). There shall not be a temperature rise greater than 100°C (180°F) above the room ambient temperature on any device during the Heat Cycling Test.

6 Ratings

6.1 General

6.1.1 Devices shall be rated in amperes and in volts, ac or dc, or both. A device may have multiple voltage and current ratings unless designed for a single voltage and current rating.