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STANDARDS PUBLICATION NO. FB 11

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Plugs, Receptacles and Connectors of the Pin and Sleeve Type for Hazardous Locations

NEMA

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ■ 2101 L STREET, N.W., WASHINGTON, D.C. 20037

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NEMA Standards Publication FB 11-1983 (R1989, R1995)

Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations

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Foreword

This Standards Publication applies to plugs, receptacles, and connectors of the pin and sleeve type for use in hazardous locations. These standards are used by the industry to provide guidelines for the manufacture and proper application of reliable plugs and connectors. They allow widespread product availability and competitive manufacturing, and supplement the requirements given in the NEMA Standards Publication for *Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type for Industrial Use*, PR 4.

One of the primary purposes of this Standards Publication is to encourage the production of reliable plugs, receptacles, and connectors of the pin and sleeve type.

Correctly constructed wiring devices are, however, only one factor in minimizing potential hazards which may be associated with the use of electricity. The reduction of hazard involves the joint efforts of the various equipment manufacturers, the installer and the user. The manufacturer of these devices has limited or no control over the following:

1. Environmental conditions.
2. System design.
3. Equipment selection and application.
4. Installation.
5. Operating practices.
6. Maintenance.

This publication is not intended to instruct the user of wiring devices with regard to these factors, except insofar as suitable equipment to meet needs can be recognized in this publication. This Standards Publication is necessarily confined to defining the construction requirements for plugs, receptacles, and connectors of the pin and sleeve type. It also provides recommendations for proper selection and use under normal and certain specific abnormal conditions. Since any wiring devices can be installed, operated and maintained in such a manner that hazardous conditions may result, conformance with this publication does not by itself assure safe operation. When, however, devices conforming with these standards are properly selected and installed in accordance with the *National Electrical Code* and properly maintained, the hazards to persons and property will be minimal. These recommendations represent a consensus of good safe practice.

These standards provide information on performance and testing of plugs, receptacles, and connectors, thus providing information to the manufacturer and user as to the functional capability of the products.

NEMA Standards Publications are subject to periodic review. They are revised frequently to meet changing conditions and technical progress. The user should secure the latest editions.

Proposed or recommended revisions should be submitted to:

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Scope

The requirements in this publication apply to all plugs, receptacles, and connectors up to 600 volts alternating current, 250 volts direct current and all current ratings up to 200 amperes.

This publication covers the ratings, materials, construction, performance, and tests of pin and sleeve devices that are used for the connection of circuits to transmit and distribute electrical energy for normal conditions of installation and service in hazardous locations as defined by Article 500 of the *National Electrical Code.* This publication does not apply to devices used in flammable anesthetizing locations.

This publication is not intended to be used for third party certification of pin and sleeve devices.

This publication should be used in conjunction with the NEMA Standards Publication for *Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type for Industrial Use,* PR 4.

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PLUGS, RECEPTACLES, AND CONNECTORS OF THE PIN AND SLEEVE TYPE FOR HAZARDOUS LOCATIONS

Section 1
REFERENCED STANDARDS

American National Standards Institute
1430 Broadway
New York, NY 10018

ANSI B46.1-1985	*Surface Texture*
ANSI/NFPA 70-1990	*National Electrical Code*
ANSI/UL 20-1986	*General-Use Snap Switches*
ANSI/UL 98-1987	*Enclosed and Dead-Front Switches*
ANSI/UL 486A-1980	*Wire Connectors and Soldering Lugs for Use with Copper Conductors*
ANSI/UL 498-1986	*Attachment Plugs and Receptacles*
ANSI/UL 514A-1983	*Metallic Outlet Boxes*
ANSI/UL 1010-1986	*Receptacle-Plug Combinations for Use in Hazardous Locations*

American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103

E 28-67 (R 1982)	*Softening Point by Ring-and-Ball Apparatus, Test for*

Canadian Standards Association
178 Rexdale Boulevard
Rexdale, Ontario M9W 1R3 CANADA

C22.2 No. 0-M1982	*General Requirements – Canadian Electrical Code, Part II*
C22.2 No. 159-(M1987)	*Plugs and Receptacles for Use in Class I, Groups A, B, C, D, and Class II Groups E, F, and G*
C22.2 No. 182.1-1988	*Industrial Type Use Attachment Plugs, Receptacles, and Connectors*
C22.2 No. 182.2-1988	*Industrial Locking Type, Special Use Attachment Plugs, Receptacles, and Connectors*
C22.2 No. 182.3-M1987	*Special Use Attachment Plugs, Receptacles, and Connectors*

National Electrical Manufacturers Association
2101 L Street, N.W.
Washington, DC 20037

PR 4-1983 (R 1989)	*Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type for Industrial Use*
250-1985	*Enclosures for Electrical Equipment (1000 Volts Maximum)*

National Fire Protection Association
Batterymarch Park
Quincy, MA 02269

(See ANSI/NFPA standard listed above.)

Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062

(See ANSI/UL standards listed above.)

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Section 2
DEFINITIONS

See the NEMA Standards Publication for *Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type for Industrial Use,* PR 4.

For definitions of hazardous locations, see Article 500 of the *National Electrical Code.*

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Section 3
MANUFACTURING AND RATING STANDARDS

3.1 GENERAL

Pin and sleeve plugs, receptacles, and connectors shall comply with the manufacturing and rating standards set forth in NEMA Publication No. PR 4 and with those set forth in this Publication No. FB 11. Where there is a conflict between PR 4 and FB 11, the requirements given in FB 11 shall apply.

NEMA Standard 9-20-1972.

3.2 METAL ENCLOSURES

Metal enclosures shall be of iron, steel, copper, brass, bronze, aluminum, or aluminum alloy containing not less than 80 percent aluminum. Metals such as zinc or magnesium or their alloys shall not be used.

Copper or copper alloys shall not be used as an enclosure material for devices intended for use in Class I Group A hazardous locations unless such an alloy is coated with tin, nickel, or other coating or unless the copper content of such an alloy is limited to not more than 30 percent.

NEMA Standard 9-20-1972.

3.3 SUPPLY SYSTEM

Receptacles shall have provision for the connection of one of the wiring systems that would be suitable for the device in accordance with the *National Electrical Code.*

Portable devices shall have provision for the connection of extra-hard-usage flexible Type S, SO, ST, STO, G, or W cord with grounding conductor. The terminal enclosure shall be of a construction that will allow the cord to be readily replaced.

NEMA Standard 11-16-1989.

3.4 CONDUIT CONNECTIONS

Threaded joints for the attachment of threaded rigid conduit shall be in accordance with Table 3-1.

NEMA Standard 9-20-1972.

3.5 STRAIN RELIEF

Portable devices shall be provided with an integral clamp or cord grip for strain relief to prevent a pull on the cord from being transmitted directly to the terminal connections. If a range of flexible cord sizes is intended to be used, the strain relief means shall be suitable for all sizes in the range.

NEMA Standard 9-20-1972.

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3.6 FLAME JOINTS

Receptacles and connectors for use in Class I Division I hazardous areas which have passages leading from the terminal enclosure to the exterior or outer atmosphere shall have one of the following types of joints:

1. Metal to metal.
2. Metal to polymeric.
3. Polymeric to polymeric.
4. Potted.
5. Packed.

Paint, sealing material, or insulating compound shall not be used in metal-to-metal joints.

NEMA Standard 9-20-1972.

3.7 THREADED-TYPE FLAME JOINTS

Threaded-type flame joints shall meet the requirements given in Table 3-2.

3.8 SERRATED-TYPE FLAME JOINTS

Joints of the serrated type with a thread contour shall have at least 5 fully engaged and clamped serrations. There shall be not more than 20 serrations per inch.

NEMA Standard 9-20-1972.

3.9 FLAT-TYPE FLAME JOINTS

The surface of flat-type flame joints shall have an arithmetical average roughness of not more than 250 microinches when measured in accordance with the American National Standard for *Surface Texture*, B46.1. The width of the flame paths shall be not smaller than that shown in Table 3-3. The free inside volume shall exclude potting compounds.

3.10 SHAFT-TYPE FLAME JOINTS

The surface of shaft-type flame joints shall have an arithmetical average roughness of not more than 250 microinches when measured in accordance with the American National Standard for *Surface Texture*, B46.1. The length of the flame paths shall be not smaller than that shown in Table 3-4.

3.11 RABBETED FLAME JOINTS

See Table 3-5.

3.12 GASKETED FLAME JOINTS

Gasketed flame joints shall be used only in Class II Group G devices and shall be formed of material such as polytetrafluoroethylene, woven asbestos, plant fiber sheet packing material, or other materials having similar performance characteristics. The gasket shall be designed so that it is mechanically attached and protected from abuse and so that a minimum width of ⅜ inch will be provided at all points around the joint.

NEMA Standard 9-20-1972.

3.13 POTTED FLAME JOINTS

Where conductor leads are potted, the sealing compound shall be not less than ⅝ inch deep and shall be capable of performing its intended function where conductor leads pass.

NEMA Standard 11-16-1989.

3.14 ELECTRICAL SPACINGS

Spacings shall be in accordance with Table 3-6.

Table 3-1

Hazardous Location		Conduit Openings With Integral Conduit Bushings		Conduit Openings Without Integral Conduit Bushings		
Class	Group	Thread Form	Minimum Number of Full Threads	Thread Form	Minimum Number of Full Threads	Maximum Number of Full Threads
I	A	NPT	5	NPT	5	*
I	B	NPT	5	NPT	5	*
I	C	NPT or NPS	5	NPT	5	*
I	D	NPT or NPS	5	NPT	5	*
II	G	NPT or NPS	3½	NPT	3½	*

NPT—National pipe taper thread form having a ¾-inch taper per foot.
NPS—National pipe straight thread form having no taper.
* The maximum number of threads is based upon thread pitch—7 threads maximum for 14 pitch, 8 threads maximum for 11½ pitch, and 9 threads maximum for 8 pitch.

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Table 3-2

Hazardous Location		Number of Threads	Maximum Number of Threads Per Inch	Type Thread	Class of Thread
Class	Group				
I	A and B	8	20	Straight	1
		7	20	Straight	2
		6	20	Straight	3
		5	20	Tapered	. . .
I	C and D	5	20	Straight	1
		6*	24*	Straight	1
		7	28	Straight	1
		8	32	Straight	1
		5	20	Tapered	. . .

* A ⅜-inch diameter or smaller thread with a maximum of 24 threads per inch need have only 5 threads engaged.

NEMA Standard 9-20-1972.

Table 3-3

Hazardous Location		Maximum Free Internal Volume, Cubic Inches	Minimum Width of Material Flame Path, Inches	Maximum Joint Clearance, Inches
Class	Group			
I	B	30	⅜	0.0015*
		100	⅝	0.0015*
		350	1	0.0015
I	C and D	300	⅜	0.0015*
		. . .	¾	0.002
		. . .	1	0.0033
		. . .	1⅛	0.004
		. . .	1¼	0.0045
II	G	. . .	3/16	0.002
		. . .	¼	0.003

* The joint clearance shall be less than 0.0015 inch or such that a 0.0015-inch-thick feeler gage will not enter the joint more than ⅛ inch at any point.

NEMA Standard 9-20-1972.

Table 3-4

Hazardous Location		Maximum Free Internal Volume, Cubic Inches	Minimum Length of Path, Inches	Maximum Total Diametrical Clearance, Inches
Class	Group			
I	A and B	30	1.00	0.0033
		30	1.125	0.004
		30	1.250	0.0045
I	C and D	. . .	1.00	0.0033
		. . .	1.125	0.004
		. . .	1.250	0.0045
II	G	. . .	0.50	0.005
		. . .	0.75	0.0065
		. . .	1.00	0.008

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Table 3-5

Hazardous Location		Maximum Free Volume, Cubic Inches	Minimum Total Width of Joint, Inches	Minimum Width of a Joint Section, Inches	Maximum Diametrical Clearance at Axial Section, Inches	Maximum Clearance at Radial or Clamped Section Inches
Class	Group					
I	B	100	7/8	3/8	0.0025	0.0015
I	C and D	300	1/2	3/64	0.002	0.002

NEMA Standard 9-20-1972.

Table 3-6

MINIMUM SPACINGS, INCHES

Parts Involved	Voltage Rating of Device	
	0–250 Volts	251–600 Volts
Between any uninsulated live metal part and (1) an uninsulated live metal part of opposite polarity, (2) an uninsulated grounded dead metal part other than the enclosure, or (3) an exposed dead metal part which is isolated (insulated)		
Through air	3/16	3/16
Over surface	3/16	3/16
Between any uninsulated live metal part and the walls of a metal enclosure		
Shortest distance	1/4	1/4

NOTE—These spacings do not apply to the inherent spacings of a component part of the device. Such spacings shall meet the requirements for the component in question.

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Section 4
PERFORMANCE

4.1 GENERAL

Pin and sleeve connectors, plugs and receptacles shall comply with the performance standards set forth in NEMA Publication No. PR 4 and shall be investigated in accordance with this Publication No. FB 11 for suitability for the specific hazardous environment in which they will be utilized. Where there is a conflict between PR 4 and FB 11, the requirements given in FB 11 shall apply.

NEMA Standard 9-20-1972.

4.2 MATERIALS FOR ENCLOSURES

The factors to be considered in determining the suitability of nonmetallic material shall be its (1) physical strength, (2) resistance to impact, (3) moisture absorptive properties, (4) combustibility, (5) resistance to corrosion, (6) resistance to solvents as covered by hazardous area and group classifications, and (7) resistance to distortion at temperatures to which the enclosures may be subjected under conditions of normal and abnormal use. All of these factors shall be considered with respect to thermal aging.

Enclosures made from rigid polymeric materials shall not exhibit the capability of holding a static electrical charge.

Sealing and potting compounds shall have a softening point of at least 93°C (200°F) as determined in accordance with ASTM Test for Softening Paint, E 28. The compounds shall not exhibit any creep or flow characteristics during any tests on the devices.

NEMA Standard 9-20-1972.

4.3 GROUNDING

Receptacles, plugs, and connectors shall have a separate contact for interconnection of the grounding conductor.

Unless the plug, receptacle, or connector is of the interlocked type which requires disconnection of the supply circuit before the plug can be inserted or removed, the grounding contact in the receptacle shall be located and formed so that the electrical continuity is established through the mating grounding contacts before it is established in the other current-carrying contacts. Concurrently, the continuity through the mating grounding contacts shall not be broken until the continuity through the current-carrying contacts has been broken.

NEMA Standard 9-20-1972.

4.4 STRENGTH (SEE 5.11 HYDROSTATIC TEST)

The enclosures of terminal boxes and device boxes intended for use in Class I, Division I, Group A, B, C, and D hazardous locations, shall be capable of withstanding, without rupture of permanent distortion, an internal hydrostatic pressure of four times the maximum internal pressure generated by a series of explosion tests with an appropriate gas or vapor-air mixture.

NEMA Standard 9-20-1972.

4.5 PORTABLE DEVICES

Portable devices shall be subjected to the rough usage, impact, and strain relief tests, and shall exhibit no loosening of or damage to their parts during the tests.

NEMA Standard 9-20-1972.

4.6 WEAR

Wear shall be determined with the samples used in the 12 000-cycle endurance-under-load tests (see 4.10). The measurement shall be made on the contacts and insulators of the samples used before the start of the test and after the completion of the tests.

NEMA Standard 9-20-1972.

4.7 FLAME PROPAGATION

Plug and receptacle combinations shall be subjected to overload, endurance and overload (contact welding) tests in the appropriate hazardous environments. In the case of hazardous gases, the flame and sparks produced during the making and breaking of contacts shall be prevented from passing to a surrounding flammable atmosphere. During the test, there shall be no failure of the mating contact assemblies.

Devices for Class II Division I Group G locations shall not ignite the surrounding grain-dust air atmosphere, and the contacts shall not weld together during the test.

During the explosion tests on terminal boxes and device enclosures, all of the joints leading from the inside of the enclosure to the exterior of the enclosure shall prevent the passage of flame or sparks which may ignite the surrounding flammable mixture.

NEMA Standard 9-20-1972.

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Table 4-1

	Maximum Allowable Temperature Rises	
	Degrees C	Degrees F
1. Female contacts on receptacles	30	54
2. Cord connection blades on plugs	30	54
3. Field wiring terminals	30	54
4. Varnished cloth insulation	60	108
5. Fiber employed as electrical insulation	65	117
6. Phenolic composition employed as electrical insulation or as a part where failure would be hazardous*	125	225
7. All rubber or thermoplastic insulated wire and cords except those in item 8†	50	90
8. Types RFH, FFH and RH wires†	50	90
9. Other types of insulated wire	25°C (77°F) less than its recognized temperature rating	
10. Sealing compounds	40 less than melting point	72 less than melting point

*The limitation on phenolic composition and on rubber and thermoplastic insulation does not apply to compounds having special heat-resistant properties.
†For insulated conductors other than those mentioned in Items 7 and 8, reference should be made to the *National Electrical Code;* and the maximum allowable temperature rise in any case is 25°C less than the recognized temperature limit of the wire in question.

4.8 DUST PENETRATION

A plug and receptacle connector for use in a Class II Division I Group G hazardous location shall exhibit no entrance of dust into the device, as determined by visual examination, after being operated at full rated load and voltage or equivalent heating, while being exposed to a circulating grain dust-air atmosphere.

NEMA Standard 9-20-1972.

4.9 NO-LOAD ENDURANCE

During this test, there shall be no mechanical or visual damage to any of the parts. The duration of the test shall be 10 000 cycles.

NEMA Standard 9-20-1972.

4.10 ENDURANCE UNDER LOAD

A plug, receptacle, or connector which de-energizes the circuit when the plug is withdrawn shall exhibit no impairment of the explosion-proof or dust-ignition-proof features and no arcing to ground under completion of 12 000 cycles of operation while being subjected to normal full-load conditions.

NEMA Standard 9-20-1972.

4.11 TEMPERATURE RISE

When tested in accordance with 5.3, the device shall not attain a temperature at any point that is high enough to constitute a fire hazard or to affect injuriously any materials used in the device, nor show temperature rises at specific points greater than those given in Table 4-1.

All of the values for temperature rises given in Table 4-1 are based on a 25°C ambient (room) temperature; however, the tests may be performed at any ambient temperature within the range of 10°C to 40°C (50°F to 104°F).

NEMA Standard 9-20-1972.

4.12 EXPOSED SURFACE TEMPERATURES

When tested under the conditions described in 5.3, the device shall not attain a temperature on any exposed surface greater than those given in Table 4-2, based on an ambient (room) temperature of 40°C (104°F).

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4.13 ARC-SUSTAINING

When a device is subjected to 15 minutes of attempts to sustain arcing between mating contacts in the hazardous atmosphere, the contacts shall not weld together nor shall the surrounding hazardous atmosphere be ignited.

NEMA Standard 9-20-1972.

Table 4-2

Hazardous Location		Maximum Temperature	
Class	Group	Degrees C	Degrees F
I	A and B	288	536
I	D	215	419
I	C	160	320
II	G	165	329

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Section 5
TESTING

5.1 TEST SAMPLES

Performance shall be investigated by means of tests on sets of six representative samples. Samples tested in hazardous atmospheres shall have contact insulator clearances consisting of the maximum clearance as determined from the manufacturer's drawings, plus the wear obtained from the wear tests, plus an additional 0.005-inch clearance to provide a factor of safety.

NEMA Standard 9-20-1972.

5.2 OVERLOAD

5.2.1 General

Plugs and receptacles shall be capable of performing their intended function after being subjected to an overload test. There shall be no electrical or mechanical failure of the device and no undue burning, pitting or welding of the contacts. This requirement does not apply to a plug and receptacle having an interlocked integral switch or circuit breaker which must be opened before the plug can be inserted or withdrawn.

When a plug and a receptacle contains an additional material which is intended to reduce or confine the arcing in the contact chambers and which decomposes or is otherwise affected by the arcing, such material shall be removed for all of the overload tests.

A separate sample of the plug and receptacle may be used for each overload test.

5.2.2 Devices Rated In Volts and Amperes—Test No. 1

The device under test shall be operated manually or mechanically by inserting the plug into the receptacle portion while the plug is connected to the rated load and then withdrawing the plug. The equipment grounding pin shall be connected to ground through a fuse. The device shall be operated so as to make and break 150 percent of its rated current for 50 cycles of operation at a rate no higher than 10 cycles per minute.

The potential of the test circuit shall be 100 percent to 105 percent of the test voltage given in Table 5-1.

If the rating of the device does not fall within any of the voltage ranges given in Table 5-1, the device shall be tested at its rated voltage.

Except as indicated in the following paragraphs, the test on a plug and receptacle which has a multiple voltage and current rating shall be performed at:

Table 5-1

Voltage Rating of Device, Volts	Test Potential, Volts
110–120 AC	120 AC
110–125 DC	125 DC
208 AC	208 AC
220–240 AC	240 AC
220–250 DC	250 DC
265–277 AC	277 AC
440–480 AC	480 AC
550–600 AC	600 AC
550–600 DC	600 DC

1. 150 percent of the rated currents corresponding to the maximum rated voltage.
2. 150 percent of the maximum rated current with the corresponding rated voltage.
3. 150 percent of the rated current and corresponding rated voltage which results in maximum power per pole.

A test on alternating current need not be made if test results have been obtained from an equivalent or higher voltampere test at a direct-current potential which is equal to or greater than the alternating-current potential rating.

This overload test need not be made if it is fully represented by the following tests.

5.2.3 Devices Rated in Volts and Amperes—Test No. 2

The pin and sleeve of the plug and receptacle shall not be adjusted, lubricated or otherwise conditioned before or during the test.

The device shall be mounted and wired as it would be in service. If the device is rated at 250 volts or less, exposed metal parts shall be connected through a fuse to ground, to the grounded conductor of the test circuit, or to a circuit conductor which differs by at least 125 volts in potential from one or more of the remaining conductors in the circuit.

In a similar manner, if the device is rated above 250 volts, the exposed metal parts shall be connected to a circuit conductor which differs by at least the rated voltage from one or more of the remaining conductors in the circuit.

The fuse in the grounding conductor shall be a 15-ampere fuse if the device under test is rated at 30 amperes or less and shall be a 30-ampere fuse if the

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device under test is rated above 30 amperes. The fuse in the test circuit shall be of the next higher commercial fuse rating than the value of the test current. If either the line fuse or the grounding fuse opens during the test, the device shall not be considered to have failed the test.

The test is to be conducted with direct current, except that alternating current shall be used if the device is rated for alternating current only. When alternating current is used for the test, the power factor of the load shall be in the range from 0.75 to 0.80 for an ampere-rated device.

5.2.4 Devices Rated in Horsepower

A plug and receptacle that has a horsepower rating shall be capable of performing when subjected to an overload test while making and breaking the locked rotor current corresponding to the horsepower rating of the device. The test shall be conducted in accordance with the foregoing paragraphs, except that the value of the test current corresponds to a horsepower rating and shall be as specified in the Underwriters Laboratories, Inc., Standard for *Snap Switches,* UL 20, for ratings of 2 horsepower or less and as specified in the Underwriters Laboratories, Inc., Standard for *Enclosed Switches,* UL 98, for an alternating current rating of more than 2 horsepower. The load for and alternating current horsepower rating shall have a power factor within the range of 0.40 to 0.50.

This overload test may be omitted if it is fully represented by the other overload tests.

5.2.5 Plugs and Receptacles Controlling Magnetically Operated Devices

A plug and receptacle for controlling a contactor, relay or other magnetically operated device shall be capable of performing when subjected to an overload test consisting of 50 operations of making and breaking a circuit of 110 percent of the test potential given in Table 5-1. The load shall consist of an electromagnetic load as given in Table 5-2 and shall be representative of the load which the device is intended to control.

NEMA Standard 9-20-1972.

A load other than those given in Table 5-2 may be used after due consideration of a need for a device to control an electromagnet having other characteristics, the means utilized for matching the rating of the device to that of the load, and the completeness of the marking.

Authorized Engineering Information 9-20-1972.

5.3 TEMPERATURE

Plugs and receptacles shall not attain a temperature at any point that will constitute a fire hazard or affect injuriously any materials employed in the device and shall not show temperature rises at specific points greater than those indicated in Table 4-1.

For devices where an overload test is necessary, the temperature test shall be made following the overload test and shall continue for 4 hours even though stabilized temperatures may be obtained in a shorter interval of time.

All values for temperature rises given in Table 4-1 apply to equipment that is intended for use in ambient temperatures of 25 °C. Tests may be conducted at any ambient temperature of 10 °C to 40 °C. If equipment is intended specifically for use in a prevailing ambient temperature constantly more than 40 °C, the test shall be made at that higher temperature, and the allowable temperature rises specified in Table 4-1 shall be reduced by the amount of the difernce between that higher ambient temperature and 40°C.

A low-potential source of supply may be utilized for conducting the temperature test. The test shall be made simultaneously on all parts as the heating of one part may affect the heating of another part.

Tests shall be made with thermocouples consisting of No. 30 AWG iron and constantan wire and a potentiometer-type instrument.

A temperature shall be considered to be constant when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test (but no less than 5-minute intervals) indicate no change.

Thermocouple junctions and the adjacent thermocouple lead wire shall be securely held in good thermal contact with the surface of the material whose temperature is being measured.

NEMA Standard 9-20-1972.

Table 5-2

ELECTROMAGNETIC LOADS, AMPERES

Test Potential, Volts	Standard Duty		Heavy Duty	
	Normal Current	Current Inrush	Normal Current	Current Inrush
120 AC*	3.0	30	6.0	60
240 AC*	1.5	15	3.0	30
480 AC*	0.75	7.5	1.5	15
600 AC*	0.6	6	1.2	12
125 DC	1.1	...	2.2	...
250 DC	0.55	...	1.1	...
600 DC	0.2	...	0.4	...

* Power factor = 0.35 or less.

NEMA Standard 9-20-1972.

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5.4 STRAIN RELIEF

There shall be no strain at the cord conductor connections or damage to the cord when a direct pull is applied to the extension of the flexible cord for 1 minute. The strain relief clamp shall withstand a force of 150 pounds applied to the cord if the device is rated 30 amperes or less and 300 pounds if the device is rated over 30 amperes.

NEMA Standard 9-20-1972.

5.5 NO-LOAD ENDURANCE

A plug and receptacle having an interlock switch or circuit breaker shall be subjected to a no-load endurance test in which the plug is completely inserted and withdrawn manually or mechanically for 10000 cycles at a rate not greater than ten per minute. During this test there shall be no mechanical or visual damage to any of the parts, including the interlocking mechanism.

NEMA Standard 9-20-1972.

5.6 ENDURANCE UNDER FULL LOAD

A plug and receptacle, which de-energizes the circuit when the plug is withdrawn shall be subjected to a full load endurance test in which the plug is manually or mechanically inserted into the receptacle, operated, and completely withdrawn for 12000 cycles at a rate not greater than ten per minute. The dead metal parts of the plug and receptacle and parts in the grounding path shall be connnected to ground through a fuse of the size specified in 5.2.

The test circuits shall be those previously described in 5.2, except that the test current shall be set at 100 percent of the current rating of the device if it is rated in amperes or 100 percent of the full-load current if the device is rated in horsepower. In each case the power factor shall be in the range from 0.75 to 0.80.

There shall be no deterioration of the explosion-proof or dust-ignition-proof features and no arcing to ground during this test. The amount of wear between the plug contact and receptacle openings shall be determined upon completion of the test.

If discontinuity between mating surfaces of the plug and receptacle contacts occurs during the test, the test samples may be replaced to permit completion of the test, provided that the initial assemblies have completed at least 6000 cycles of operation, no arcing to ground has occurred as a result of wear, and no impairment of the explosion-proof or dust-ignition-proof, or both, features of construction has occurred.

NEMA Standard 9-20-1972.

5.7 ARC-SUSTAINING

A plug and receptacle which is intended for use in Class I locations and in which the circuit is broken between the plug contacts and the receptacle contacts in openings in the insulating body shall not ignite the surrounding explosive gas- or vapor-air atmosphere, and the contacts shall not weld together, when the device is subjected to 15 minutes of attempts to sustain arcing between the contacts in the presence of the specific gas- or vapor-air mixtures.

This test is not required if the plug and receptacle is so designed that snap action is obtained in the making and breaking of the contacts between the plug and receptacle.

This test shall be conducted on a plug and receptacle assembly having the maximum clearance between the plug contacts and the insulating receptacle body as determined from manufacturer's drawings, plus the maximum wear obtained during the 12000-cycle endurance test, plus an additional 0.005-inch clearance to provide a factor of safety.

The test shall be conducted by inserting the plug into the receptacle and withdrawing the plug until its contacts barely touch the receptacle contacts.

It shall be conducted in accordance with the sequence given in Table 5-3.

NEMA Standard 9-20-1972.

5.8 ARC-SUSTAINING IN PRESENCE OF GRAIN DUST

A plug and receptacle without an interlocked switch or circuit breaker and intended for use in Class II, Group G hazardous locations shall be subjected to an arcing test as outlined in 5.7. This arcing test shall be conducted in the presence of grain-dust air atmospheres. The samples shall be specially prepared with the maximum tolerances specified in 5.7.

The receptacle and plug shall not ignite the surrounding grain-dust air atmosphere, and the contacts shall not weld together.

Temperatures on the exterior surface of the plug and receptacle shall not exceed 165°C in a 40°C ambient when the device is blanketed with grain dust and subjected to the arcing test described in 5.7. Temperature readings shall be obtained by means of thermocouples.

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Table 5-3

SEQUENCE FOR ARC-SUSTAINING TEST

Number of Tests With Different Test Mixtures	Number of Operations Under Overload Test Conditions	Period of Time of Attempts to Sustain Arc	Length of Time Between Each Sustained Arcing Operation	Total Time of Sustained Arcing Operations
10*	10	15 seconds‡	...	2½ minutes
1*	15 sustaining	30 seconds	5 minutes	7½ minutes
1†	5 sustained arcing	60 seconds	5 minutes	5 minutes

*Effective mixtures from lean to rich of the explosive atmosphere representative of the group classification involved.
†Approximately stoichiometric mixture of the explosive gas- or vapor-air mixtures representative of those under consideration.
‡This test shall be made following ten insertions and withdrawals of the plug, without attempting to sustain the arc, at a rate not greater than 10 cycles per minute.

5.9 OVERLOAD IN HAZARDOUS GAS ATMOSPHERES

A plug and receptacle without an interlocked switch or circuit breaker which is intended for Class I locations and which is designed so that a snap action is automatically obtained in making and breaking the circuit between the plug and receptacle contacts shall be subjected to a series of tests in the presence of specific gas- or vapor-air mixtures. The device shall be operated under overload conditions based on the electrical ratings of the device.

During this test, the plug and receptacle shall prevent the passage of flame or sparks which may ignite the surrounding atmospheres, and there shall be no electrical failure of the mating contact assemblies.

A series of at least fifteen tests within the explosive or flammable range of the gas- or vapor-air mixture shall be conducted. The device shall be operated for 5 cycles of "on" and "off" operation in each test, at a rate no greater than 10 cycles per minute.

The tests shall be conducted on a plug and receptacle having joint clearance as specified in Section 3.

NEMA Standard 9-20-1972.

5.10 EXPLOSION

A receptacle terminal box for use in Class I locations shall be subjected to a series of explosion tests in the presence of the specific gas- or vapor-air mixtures over the range of flammable or explosive concentrations which cover the maximum pressure effects of the gas- or vapor-air mixtures, and the maximum propagation effects of the gas- or vapor-air mixture.

The terminal box shall be installed in a test chamber that has a gas inlet and outlet connection to the explosive mixture. The enclosure of the device shall be tapped with threaded holes for connection to the inlet or outlet lines carrying the explosive vapor-air mixture; attachment of explosion-pressure recording devices; and insertion of a spark plug for ignition. The length of conduit attached to the device shall be used for inlet and outlet connection to the pipe carrying the explosive mixture. A spark plug shall be located in the length of conduit at a distance of about 4 inches from the outer end of the conduit. The explosive mixture shall be prepared by suitable auxiliary equipment capable of preparing and maintaining predetermined concentrations of the mixture.

The explosive gas- or vapor-air mixture shall flow into the device being tested and into the surrounding test chamber until all of the original air has been displaced. Samples of the gas-air mixture shall be taken for analysis. The mixture within the device enclosure being subjected to tests shall then be fired by sparks from the spark plug.

An enclosure for Class I Group A or B, or both, locations and having flat or rabbet-type joints shall be tested with the joints cut to 75 percent of the total joint width and with the joints shimmed to give a clearance 50 percent greater than the clearance to be used. For enclosures having threaded joints, the device shall be tested with a threaded engagement of 75 percent of the total number of engaging threads to be used. The lateral clearance at the threaded joints shall be the maximum clearance which is obtainable in production devices, including maximum manufacturing tolerances. A drain or vent fitting, or a fitting having special threaded joints, shall be tested with joints reduced 25 percent in order to provide a factor of safety in the explosion tests.

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During the explosion tests, the enclosure shall prevent the passage of flame or sparks which may ignite the surrounding atmosphere. A series of at least ten tests shall be conducted on each device subjected to explosion tests. These tests shall be conducted without wires or cables in the device.

Conduit lengths shall be connected to the enclosure. The lengths of conduit to be connected shall be in accordance with Table 5-4.

The circuit breaker enclosure of a receptacle which is interlocked with a circuit breaker for use in Class I locations shall be subjected to a series of explosion tests as previously described, except that no conduit length shall be attached to the circuit breaker enclosure during the explosion tests.

The mixture within the circuit breaker enclosure shall be fired either by arcs from the circuit breaker or by a spark from the spark plug. Explosion tests shall be conducted under overload conditions, based on the electrical ratings of the receptacle.

In addition to complying with the foregoing requirements, there shall be no electrical failure or damage to the mechanism enclosure.

The switch enclosure of a device having the plug interlocked with the switch for use in Class I hazardous locations shall be subjected to the same tests as the circuit breaker enclosure.

NEMA Standard 9-20-1972.

5.11 HYDROSTATIC

The enclosure subjected to the explosion tests described in 5.10 shall withstand, for 1 minute, without rupture or permanent distortion an internal hydrostatic test pressure not less than four times the maximum pressure obtained in the device during the explosion tests.

The hydrostatic pressure shall be applied at a rate of about 100 pounds per square inch per minute until the required internal pressure is reached. Gaskets or other suitable means may be employed when necessary to prevent the leakage of water during the application of pressure.

NEMA Standard 9-20-1972.

5.12 DUST PENETRATION

A plug and receptacle shall be operated at full rated load and voltage, or equivalent heating, while continuously exposed to the circulating non-conductive-dust air atmospheres to determine that the device is dust-tight. During this test there shall be no entrance of the dust into the device as determined by visual examination after the device is subjected to free circulation of dust-air mixtures around the device. The test shall be continued for at least six heating and cooling cycles and for at least 30 hours. The grain dust shall have passed through 100 mesh screen.

NEMA Standard 11-16-1989.

Table 5-4

CONDUIT LENGTHS FOR EXPLOSION TESTS

Class I Hazardous Location	Conduit Sizes	Conduit Length
Group A, B, C	Less than 2 inches	5, 10 and 15 feet
Group D	Less than 2 inches	24 inches
Group A, B, C, D	Over 2 inches	18 inches

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5.13 RAINTIGHTNESS

If an enclosure is to be tested for the raintight feature, the device shall be subjected to a water spray which is approximately equivalent to a beating rain and which is applied to the enclosure from the top and sides for 1 hour. If this results in the entrance of water into the enclosure, the enclosure has failed the test.

The enclosure shall be mounted with conduit connections as in actual service. The tightening torque for rigid conduit threaded into the opening in the enclosure shall be 800 pound-inches for ¾-inch and smaller trade sizes, 1000 pound-inches for 1-, 1¼-, and 1½-inch trade sizes, and 1600 pound-inches for 2-inch and larger trade sizes.

NEMA Standard 9-20-1972.

5.14 ACCELERATED AGING TESTS FOR GASKETS

If gaskets for raintight devices are used and are of rubber, neoprene or a composition thereof, they shall be exposed for 96 hours to oxygen at a pressure of 300 pounds per square inch and a temperature of 70°C. The gasket shall be considered adequately resistant to aging if there is no visible evidence of deterioration, such as softening, hardening, or cracking after flexing.

A gasket of thermoplastic material or a composition thereof may be tested if equal to rubber or similar compounds in regard to the effects of heat, aging, distortion under conditions of use, and the means of securing the gasket to the cover or enclosure.

NEMA Standard 9-20-1972.

5.15 ROUGH USAGE

A portable device which is not provided with a base or stand shall be subjected to a rough usage test. The device and terminal enclosures and the cord clamp shall not be impaired nor shall thread engagements be loosened during this test.

NEMA Standard 9-20-1972.

5.16 IMPACT

Portable devices shall be subjected to a drop test consisting of ten drops to a concrete floor from a height of 3 feet. There shall be no loosening of the assembly or damage to parts during this test.

NEMA Standard 9-20-1972.

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Section 6
RATING AND MARKING

6.1 RATING

A combination plug and receptacle shall be rated in amperes, volts, frequency, and, when required, horsepower.

The number of wires shall indicate the number of current-carrying pins or sleeves available in the device. The number of poles shall indicate the total number of pins or sleeves in the device.

If a device includes a snap switch or a circuit breaker which controls the receptacle, the rating of the device as a whole shall be no higher than the rating of the switch or the circuit breaker.

NEMA Standard 9-20-1972.

6.2 MARKING

The plug and receptacle shall be marked with the manufacturer's catalog number and his name (trade mark or other identification symbol), the electrical rating and special performance characteristics or limitations. The device shall also be marked for the particular Class and Group of hazardous location in which it is intended to be used. The receptacle enclosure shall have a cautionary statement as needed.

The markings shall be legible and prominent and shall be so located that they will be visible after installation of the equipment.

A plug which requires a twisting, turning, pushing, pulling, etc., motion to lock or unlock it after the contacts have been inserted into the receptacle and the receptacle body designed to accommodate such a plug shall be marked with the appropriate operating instructions. This marking shall be visible while the device is in use.

NEMA Standard 9-20-1972.

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NEMA STANDARDIZATION

The purpose of NEMA Standards, their classification and status, are set forth in certain clauses of the NEMA *Standardization Policies and Procedures* manual and are referenced below.

Purpose of Standards

National Electrical Manufacturers Association standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist purchasers in selecting and obtaining the proper product for their particular needs. Existence of a National Electrical Manufacturers Association standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard. *(Standardization Policies and Procedures, p. 1)*

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process, or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.
(Standardization Policies and Procedures, p. 2)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the Standards Publication may be capable of otherwise equivalent performance.
(Standardization Policies and Procedures, p.8)

Categories of Standards

National Electrical Manufacturers Association Standards are of two classes:

1. NEMA Standard, which relates to a product, process, or procedure commercially standardized and subject to repetitive manufacture, which standard has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon;
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote thereon.

(Standardization Policies and Procedures, pp. 7 & 16)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote on the standard.
(Standardization Policies and Procedures, pp. 7 & 16)

Official Standards Proposal

An Official Standards Proposal is an official draft of a proposed standard which is formally recommended to an outside organization(s) for consideration, comment, and/or approval, and which has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon.
(Standardization Policies and Procedures, pp. 7 & 16)

Identification of Status

Standards in NEMA Standards Publications are identified in the foreword or following each standard as "NEMA Standard" or "Suggested Standard for Future Design." These indicate the status of the standard. These words are followed by a date which indicates when the standard was adopted in its present form by the Association.

The material identified as "Authorized Engineering Information" and "Official Standards Proposal" is designated similarly.

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