

PURPOSE:

To summarize the following four standards dealing with the degree of protection for electrical equipment. Two are IEC standards, and two are NEMA standards:

1. IEC 34-5, "Rotating Electrical Machines, Part 5, Classification of Degrees of Protection Provided by Enclosures of Rotating Electrical Machines."
2. NEMA MG-1, Part 5, "Rotating Electrical Machines - Classification of Degrees of Protection Provided by Enclosures for Rotating Machines."
3. IEC 529, "Degrees of Protection Provided by Enclosures."
4. NEMA 250, "Enclosures for Electrical Equipment (1000 Volts Maximum).

IEC 34-5

This standard covers enclosures for rotating electrical machines such as electric motors. It uses the designator of IP followed by two numerals that signify the degree of protection.

First Numeral: The first numeral indicates the degree of protection provided by the enclosure to persons and to the parts of the machine inside the enclosure. This numeral can range from 0 to 5, with 0 indicating least amount of protection and 5 signifying the most. In simple terms 0 indicates a non-protected machine. The numbers 1, 2, 3, and 4 indicate a machine with increasing protection against solid objects. The number 5 indicates a dust-protected machine.

Second Numeral: The second numeral indicates the degree of protection provided by the enclosure with respect to harmful effects due to ingress of water. This numeral can range from 0 to 8, with 0 indicating the least amount of protection and 8 signifying the most. Some important issues to note with regard to the second numeral:

1. Compliance of an enclosure with an indicated degree of protection implies that the enclosure will also comply with all lower degrees of protection.
2. IEC 34-5 specifies "Type Tests" for proving the machine meets the claimed degree of protection. Note that the acceptance criteria for these tests allows some ingress of water.
3. A simplification of what the numbers 4, 5, and 6 mean for the second numeral is presented in the Table 1-1. The purpose of these simplified descriptions is to allow a better understanding of what the number assignments mean with the intent to minimize to potential for misapplications. Do not use these simplified descriptions for evaluation or analysis of applications - refer to IEC 34-5.

NEMA MG-1, Part 5

This standard is essentially identical to IEC 34-5.

IEC 529

This standard covers degrees of protection provided by enclosures of electrical equipment up to 72.5 kV. It does not cover enclosures for rotating machines. Like IEC 34-5 and NEMA MG-1, this standard uses the designator of IP followed by two numerals that signify the

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degree of protection. However, IEC 529 has different definitions for the first and second numerals.

First Numeral: The first numeral indicates that

- a) the enclosure provides protection of persons against access to hazardous parts by preventing or limiting the ingress of a part of the human body or an object held by a person;

and simultaneously

- b) the enclosure provides protection of equipment against the ingress of solid foreign objects.

This numeral can range from 0 to 6, with 0 indicating least amount of protection and 6 signifying the most. In simple terms 0 indicates an enclosure that provides no such protection per (a) and (b) above. The numbers 1, 2, 3, 4, 5 and 6 indicate an enclosure that provides increasing protection per (a) and (b) above. Here are two examples.

- The number 3 indicates (a) protection against access to hazardous parts with a tool, and (b) protection against solid foreign objects 0.1 inch in diameter.
- The number 6 indicates (a) protection against access to hazardous parts with a 0.04 inch diameter wire, and (b) complete protection against ingress of solid foreign objects - "dust tight".

Second Numeral: The second numeral indicates the degree of protection provided by enclosures with respect to harmful effects on the equipment due to ingress of water. This numeral can range from 0 to 8, with 0 indicating the least amount of protection and 8 signifying the most. Some important issues to note with regard to the second numeral:

1. Up to the number 6 compliance of an enclosure with an indicated degree of protection implies that the enclosure will also comply with all lower degrees of protection.
2. IEC 529 specifies "Type Tests" for proving the enclosure meets the claimed degree of protection. Note that the acceptance criteria for these tests allows some ingress of water.
3. A simplification of what the numbers 4, 5, and 6 mean for the second numeral is presented in Table 1-2. The purpose of these simplified descriptions is to allow a better understanding of what the number assignments mean with the intent to minimize to potential for misapplications. Do not use these simplified descriptions for evaluation or analysis of applications - refer to IEC 529.

NEMA 250

NEMA 250 covers enclosures for electrical equipment rated at not more than 1000 volts. It does not cover: (a) enclosures for rotating apparatus, (b) the protection of devices against conditions such as condensation, icing, corrosion, or contamination which may occur within the enclosure or enters via conduit or unsealed openings.

This standard uses a different designator system than the previous three standards. The official designator is the word "Type" followed by a number and sometimes a letter – for

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example Type 3R. In practice, the acronym NEMA is often substituted for Type – for example NEMA 3R.

This standard addresses designator assignments in two groups: Non-Hazardous Locations, and Hazardous Locations. The latter are locations that fit the Hazardous Area Classifications of the National Electrical Code (NFPA 70). Table 1-3 presents the designator definitions for these two groups.

The assignment of a designator depends on a combination of features and test conditions that the enclosure must comply with. Table 1-4 contains an abridged and simplified presentation of these features and test conditions for Type 3, Type 3R, Type 3S, Type 4, and Type 4X enclosures.

Summary

1. Two standards bodies that produce standards governing electrical enclosures are the IEC and NEMA. The electrical enclosure standards produced by these organizations are in two groups. One is for rotating electrical machines like electric motors. The other is for electrical boxes, panels and the like.

IEC: IEC 34-5 for rotating electrical machines including electric motors.
IEC 529 for electrical boxes, panels and the like.

NEMA: NEMA MG-1 for rotating electrical machines including electric motors.
NEMA 250 for electrical boxes, panels and the like.
2. For electric motors, including the electric motors on electric chain hoists, the IP rating of IEC 34-5 (or NEMA MG-1, which is identical to IEC 34-5) applies.
3. For control panels, including the control panel and pendant of an electric chain hoist, either IEC 529 or NEMA 250 applies.
4. An electric chain hoist should have three ratings addressing electrical enclosures:
 - IP rating for the motor per IEC34-5 (or NEMA MG-1).
 - Either an IEC 529 IP rating or a NEMA 250 Type rating for the control panel.
 - Either an IEC 529 IP rating or a NEMA 250 Type rating for the pendant.
5. For electrical boxes, panels and the like: Differences in the definitions, tests, and criteria between the IEC 529 IP rating and the NEMA Type rating make it difficult to compare and cross-reference between the two rating systems.

TABLE 1-1

IEC 34-5

2ND NUMERAL PARTIAL/SIMPLIFIED DESCRIPTION

2nd Numeral	Description	Brief & Simplified Description of Test
3	Protected against spraying water – Water falling as a spray at an angle up to 60° from vertical shall have no harmful effect.	Use special spray equipment as specified to soak the machine for about 10 minutes with a spray of about 3 gpm at about 15 psi. Spray equipment situated so that spray limited to 60° from vertical.
4	Protected against splashing water – Water splashing against the machine from any direction will have no harmful effect.	Same as for 3 but now the spray equipment is arranged to deliver the spray at the machine from all angles.
5	Protected against water jets - Water projected by a nozzle against the machine from any direction shall have no harmful effect.	Use special nozzle as specified to direct a 1½” diameter 3½ gpm water jet at the machine from all angles. The distance from the nozzle to the machine must be no more than 9 ft. and the test must last at least 3 minutes.
6	Protected against heavy seas - Water from heavy seas or water projected in powerful jets shall not enter the machine in harmful quantities.	Use special nozzle as specified to direct a 4¾” diameter 26 gpm water jet at the machine from all angles. The distance from the nozzle to the machine must be no more than 9 ft. and the test must last at least 3 minutes.

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TABLE 1-2

IEC 529

2ND NUMERAL PARTIAL/SIMPLIFIED DESCRIPTION

2nd Numeral	Description	Brief & Simplified Description of Test
3	Protected against spraying water – Water sprayed at an angle up to 60° on either side of vertical shall have no harmful effects.	Use special spray equipment as specified to soak the enclosure for at least 5 minutes with a spray of about 3 gpm at about 15 psi. Spray equipment situated so that spray limited to 60° from vertical.
4	Protected against splashing water – Water splashed against the enclosure from any direction will have no harmful effects.	Same as for 3 but now the spray equipment is arranged to deliver the spray at the enclosure from all angles.
5	Protected against water jets - Water projected in jets against the enclosure from any direction shall have no harmful effects.	Use special nozzle as specified to direct a 1½" diameter 3½ gpm water jet at the enclosure from all angles. The distance from the nozzle to the enclosure must be between 8 and 10 ft. and the test must last at least 3 minutes.
6	Protected against powerful jets – Water projected in powerful jets against the enclosure from any direction shall have no harmful effects.	Use special nozzle as specified to direct a 4¾" diameter 26 gpm water jet at the enclosure from all angles. The distance from the nozzle to the enclosure must be between 8 and 10 ft. and the test must last at least 3 minutes.

Note: Test Acceptance Criteria as follows.

In general, if any water has entered it shall not:

- be sufficient to interfere with the correct operation of the equipment or impair safety;
- deposit on insulation parts where it could lead to tracking along the creepage distances;
- reach live parts not designed to operate when wet;
- accumulate near the cable end or enter the cable (if any).

**TABLE 1-3
NEMA 250
DESIGNATOR DEFINITIONS**

Designators for Non-Hazardous Locations	Designators for Hazardous Locations
Type 1 Intended for indoor use primarily to provide a degree of protection against limited amounts of falling dirt.	Type 7 Intended for indoor use in locations classified as Class I, Groups A, B, C, or D.
Type 2 Intended for indoor use primarily to provide a degree of protection against limited amounts of falling water and dirt.	Type 8 Intended for indoor or outdoor use in locations classified as Class I, Groups A, B, C, or D.
Type 3 Intended for outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust, and damage from external ice formation.	Type 9 Intended for indoor use in locations classified as Class II, Groups E, F, or G.
Type 3R Intended for outdoor use primarily to provide a degree of protection against rain, sleet, and damage from external ice formation.	Type 10 Constructed to meet the applicable requirements of the Mine Safety and Health Administration.
Type 3S Intended for outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust, and to provide for operation of external mechanisms when ice laden.	
Type 4 Intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation.	
Type 4X Intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation.	
Type 5 Intended for indoor use primarily to provide a degree of protection against settling airborne dust, falling dirt, and dripping non-corrosive liquids.	

TABLE 1-3 (CONTINUED)
NEMA 250
DESIGNATOR DEFINITIONS

Designators for Non-Hazardous Locations	Designators for Hazardous Locations
Type 6 Intended for indoor or outdoor use primarily to provide a degree of protection against hose-directed water, the entry of water during occasional temporary submersion at a limited depth, and damage from external ice formation.	
Type 6P Intended for indoor or outdoor use primarily to provide a degree of protection against submersion at a limited depth, and damage from external ice formation.	
Type 12 Intended for indoor use primarily to provide a degree of protection against circulating dust, falling dirt, and dripping non-corrosive liquids.	
Type 12K Same as Type 12 but the enclosure has knockouts.	
Type 13 Intended for indoor use primarily to provide a degree of protection against dust, spraying water, oil, and non-corrosive coolant.	

**TABLE 1-4
NEMA 250
PARTIAL/SIMPLIFIED DESCRIPTIONS OF
FEATURES AND TESTS**

Type	Abridged Features, Tests, and Criteria
3	<p><u>Features:</u></p> <ol style="list-style-type: none"> 1. Shall require the use of a tool to gain access to the cavity, or have provisions for locking. 2. If mounting means are provided, these means shall be external to the cavity. 3. Can have a conduit hub or equivalent to exclude water at the conduit entrance.
	<p><u>Tests:</u></p> <ol style="list-style-type: none"> 1. Shall exclude water under test conditions that simulate rain. 2. Shall exclude dust under test conditions that simulate windblown dust. 3. Shall be undamaged after being encased in ice under test conditions. 4. Shall provide corrosion protection in accordance with UL50, Part 13.
	<p><u>Conditions for the Water-related Test:</u></p> <ol style="list-style-type: none"> 1. Continuous water spray applied against the entire top and all exposed sides. 2. Water spray: Pressure = 5 psi. Rate = 18 inches per hour. 3. Acceptance Criteria: No water shall have entered the enclosure.
3R	<p><u>Features:</u></p> <ol style="list-style-type: none"> 1. Shall require the use of a tool to gain access to the cavity, or have provisions for locking. 2. Can have a conduit hub or equivalent to exclude water at the conduit entrance. 3. Shall have provisions for drainage.
	<p><u>Tests:</u></p> <ol style="list-style-type: none"> 1. Shall prevent water from contacting live parts, insulation, and wiring under test conditions that simulate rain. 2. Shall be undamaged after being encased in ice under test conditions. 3. Shall prevent the insertion of the end portion of a straight rod of the specified diameter into the equipment cavity. 4. Shall provide corrosion protection in accordance with UL50, Part 13.
	<p><u>Conditions for the Water-related Test:</u></p> <ol style="list-style-type: none"> 1. Continuous water spray applied against the entire top and all exposed sides. 2. Water spray: Pressure = 5 psi. Rate = 18 inches per hour. 3. Acceptance Criteria: No significant accumulation of water within the enclosure. No water has entered the enclosure at a level higher than the lowest live part unless, (a) the electrical equipment is so constructed that no water is visible on the live parts, insulating material, or mechanism parts, and (b) no water has entered any space above the live parts within the enclosure in which wiring may be present under any proper installation conditions.

**TABLE 1-4 (CONTINUED)
NEMA 250
PARTIAL/SIMPLIFIED DESCRIPTIONS OF
FEATURES AND TESTS**

Type	Abridged Features, Tests, and Criteria
3S	<p><u>Features:</u></p> <ol style="list-style-type: none"> 1. Shall require the use of a tool to gain access to the cavity, or have provisions for locking. 2. If mounting means are provided, these means shall be external to the cavity. 3. Can have a conduit hub or equivalent to exclude water at the conduit entrance. 4. Shall have external operating mechanisms that can be manually operated while ice laden
	<p><u>Tests:</u></p> <ol style="list-style-type: none"> 1. Shall exclude water under test conditions that simulate rain. 2. Shall exclude dust under test conditions that simulate windblown dust. 3. Shall be undamaged after being encased in ice under test conditions. 4. Shall provide corrosion protection in accordance with UL50, Part 13.
	<p><u>Conditions for the Water-related Test:</u> Same as for Type 3.</p>
4	<p><u>Features:</u></p> <ol style="list-style-type: none"> 1. If mounting means are provided, these means shall be external to the cavity. 2. Can have a conduit hub or equivalent to exclude water at the conduit entrance.
	<p><u>Tests:</u></p> <ol style="list-style-type: none"> 1. Shall exclude water under test conditions that simulate a hosedown condition. 2. Shall be undamaged after being encased in ice under test conditions. 3. Shall provide corrosion protection in accordance with UL50, Part 13.
	<p><u>Conditions for the Water-related Test:</u></p> <ol style="list-style-type: none"> 1. Continuous stream of water from a hose with a 1 inch diameter nozzle. 2. Water stream: 65 gpm 3. The water stream shall be directed at all joints from all angles from a distance of 10 to 12 feet for a minimum of 5 minutes. 4. Acceptance Criteria: No water shall have entered the enclosure. 5. An enclosure that meets this hosedown test is also considered to meet the dust test.
4X	<p><u>Features:</u></p> <ol style="list-style-type: none"> 1. If mounting means are provided, these means shall be external to the cavity. 2. Can have a conduit hub or equivalent to exclude water at the conduit entrance. 3. Made from Type 304 Stainless Steel, or a polymeric with equivalent corrosion resistance.
	<p><u>Tests:</u></p> <ol style="list-style-type: none"> 1. Shall exclude water under test conditions that simulate a hosedown condition. 2. Shall be undamaged after being encased in ice under test conditions. 3. Shall provide corrosion protection in accordance with UL50, Part 37.
	<p><u>Conditions for the Water-related Test:</u> Same as for Type 4.</p>