IEEE Standards

**IEEE Std C37.40™-2003**
(Revision of
IEEE Std C37.40-1993)

# C37.40™

# IEEE Standard Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

**IEEE Power Engineering Society**

Sponsored by the
Switchgear Committee

IEEE

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**Switchgear Committee**
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**IEEE Power Engineering Society**

Approved 11 September 2003

**IEEE-SA Standards Board**

Approved 15 January 2004

**American National Standards Institute**

**Abstract:** Service conditions and definitions for high-voltage fuses (above 1000 V), distribution enclosed single-pole air switches, fuse disconnecting switches, and accessories for ac distribution systems are covered. These include enclosed, open, and open-link types of distribution cutouts and fuses; distribution current-limiting fuses; distribution enclosed single-pole air switches; power fuses, including current-limiting types; outdoor and indoor fuse disconnecting switches; fuse supports, mountings, switch sticks, and links, all of the type used exclusively with the above; and removable switch blades for certain products among the above.
**Keywords:** distribution enclosed single-pole air switch, fuse accessories, fuse disconnecting switch, high-voltage fuse

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# Introduction

(This introduction is not part of IEEE Std C37.40-2003, IEEE Standard Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.)

This standard is a revision of IEEE Std C37.40-1993, to bring it up-to-date and in-line with present day requirements for high-voltage fuses and switches. Supplement IEEE Std C37.40B™-1996 has been incorporated. Temperature rise requirements presently used in IEC fuse standards have been adopted, while altitude correction factors have been removed from the standard, due to the current controversy surrounding their use. Historically used altitude correction factors, together with proposals from the IEEE Switchgear Committee Common Clauses Working Group, have been put in informative Annex A and informative Annex B.

This standard was prepared by the Revision of Fuse Standards Working Group of the IEEE Subcommittee on High-Voltage Fuses. Liaison was maintained with the National Electrical Manufacturers Association (NEMA) and the International Electrotechnical Commission (IEC) during the development of the revisions in order to incorporate the latest activities at the time of publication. It is one of a series of complementary standards covering various types of high-voltage fuses and switches, arranged so that certain standards apply to all devices while other standards provide additional specifications for a particular device. For any device, IEEE Std C37.40-2003, IEEE Std C37.41™-2000, plus the additional standard covering that device, constitute a complete standard for the device. In addition, IEEE Std C37.48™-1997 is an application, operation, and maintenance guide for all the devices, and IEEE Std. C37.48.1™-2002 is an operation, classification, application, and coordination guide for current-limiting fuses.

The following standards make up this series:

ANSI C37.42-1996, American National Standard Specification for High Voltage Expulsion Type Distribution Class Fuses, Cutouts, Fuse Disconnecting Switches, and Fuse Links.

ANSI C37.45-1981 (Reaff 1992), American National Standard Specifications for Distribution Enclosed Single-Pole Air Switches.

ANSI C37.46-2000, American National Standard for High Voltage Expulsion and Current-Limiting Type Power Class Fuses and Fuse Disconnecting Switches.

ANSI C37.47-2000, American National Standard for High-Voltage Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches.

IEEE Std C37.40-2003, IEEE Standard Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.

IEEE Std C37.41-2000, IEEE Standard Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.

IEEE Std C37.48-1997, IEEE Guide for Application, Operation, and Maintenance of High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.

IEEE Std C37.48.1-2002, IEEE Guide for the Operation, Classification, Application, and Coordination of Current-Limiting Fuses with Rated Voltages 1–38 kV.

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# IEEE Standard Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

## 1. Overview

### 1.1 Scope

This standard applies to high-voltage (above 1000 V) fuses and equipment. This includes distribution class and power class fuses, distribution class enclosed single-pole air switches, distribution class and power class fuse disconnecting switches, and associated accessories that are intended for use on ac distribution systems. This standard applies to the following specific types of equipment:

a) Distribution class and power class expulsion type fuses

b) Distribution class and power class current-limiting fuses

c) Distribution class and power class fuse disconnecting switches

d) Items a) through c) used in fuse enclosure packages

e) Fuse supports, fuseholders, fuse units, switch sticks and other parts and devices intended for use with distribution class and power class fuse disconnecting switches

f) Switch blades of the type used exclusively with distribution class and power class fuses and distribution class and power class fuse disconnecting switches

g) Fuse links when used exclusively with distribution class and power class fuses and distribution class and power class fuse disconnecting switches

h) Distribution class enclosed single-pole air switches

i) Distribution class and power class expulsion, current-limiting, and combination types of external capacitor fuses used with a capacitor unit, groups of units, or capacitor banks

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### 1.2 Background

The distribution class and power class expulsion type fuses listed in 1.1 are similar to those now covered in IEC 60282-2: 1997.[1] The distribution class expulsion type fuses are similar to the class "A" fuse covered in the IEC standard and the power class fuses are similar to their class "B" fuses. At present, IEEE/ANSI standards do not cover the class "C" fuses listed in the IEC standard. Some of the current-limiting type fuses listed in 1.1 are similar to those now covered in IEC 60282-1: 2002. Use caution if devices specified and tested per IEC standards are compared to those specified and tested per IEEE/ANSI standards. Differences in test requirements between the two groups of standards may result in devices tested to IEC not being suitable for applications where devices tested to IEEE/ANSI standards are required, or vice versa.

Following certain definitions in Clause 4, there will be terms in brackets []. The information in the brackets is a term used in IEC standards that may be similar to the term used in this standard, a term that is common in some parts of the world, or a term that has been used previously in IEEE or ANSI standards. Caution is again advised when making comparisons.

## 2. References and related standards

This standard is intended to be used in conjunction with the following referenced standards. When the standard referenced below is superseded by an approved revision, the revised standard may or may not apply. At the time of publication of this standard, the editions listed below were valid. Since all standards are subject to revision at varying times, a revised standard may or may not apply. In the interim period prior to revision of this standard, all parties making agreements based on these standards are encouraged to investigate the possibility of using the most recent editions of the relevant standards.

ANSI C37.42-1996, American National Standard Specifications for High Voltage Expulsion Type Distribution Class Fuses, Cutouts, Fuse Disconnecting Switches and Fuse Links.[2]

ANSI C37.45-1981, American National Standard Specifications for High Voltage Distribution Class Enclosed Single-Pole Air Switches.

ANSI C37.46-2000, American National Standard for High Voltage Expulsion and Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches.

ANSI C37.47-2000, American National Standard for High Voltage Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches.

ANSI C37.53.1-1989 (Reaff 1996), American National Standard for High-Voltage Current-Limiting Motor-Starter Fuses—Conformance Test Procedures.

ANSI C84.1-1995 (Reaff 2001), American National Standard for Electric Power Systems and Equipment—Voltage Ratings (60 Hz).

IEC 60282-1: 2002, High Voltage Fuses—Part 1, Current-Limiting Fuses.[3]

IEC 60282-2: 1997, High Voltage Fuses—Part 2, Expulsion Fuses.

[1]Information on references can be found in Clause 2.

[2]ANSI publications are available from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (http://www.ansi.org/).

[3]IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (http://www.iec.ch/). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, 6th Floor, New York, NY 10036, USA.


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IEEE Std C37.41™-2000, IEEE Standard Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.[4,5]

IEEE Std C37.48™-1997, IEEE Guide for Application, Operation, and Maintenance of High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.

IEEE Std C37.48.1™-2002, IEEE Guide for the Operation, Classification, Application, and Coordination of Current-Limiting Fuses with Rated Voltages 1–38kV.

IEEE Std C37.100™-1992, IEEE Standard Definitions for Power Switchgear.

## 3. Service conditions

The capabilities, as defined in this standard, for fuses and other devices is predicated on the device being used and applied in accordance with the manufacturer's recommendations and under circuit conditions that are equal to or less severe than the conditions required by the specifications and testing standards for the device. The environment where the fuse is used may affect its performance and shall be carefully considered for all applications. Devices covered by this standard should not be closed into an energized circuit since they do not have making-current ability, and devices that do not have load-breaking means should not be opened with the circuit energized.

### 3.1 Usual service conditions

#### 3.1.1 For fuses and switches rated for use at a maximum application temperature of 40 °C

Equipment conforming to this standard that is rated for use in a maximum application temperature of 40 °C or less shall be suitable for operation at its assigned ratings, provided the ambient temperature of the surrounding medium is not above 40 °C or below –30 °C, the altitude does not exceed 1000 m, and the frequency of the power system is 60 Hz.

#### 3.1.2 For fuses and switches rated for use at a maximum application temperature above 40 °C

Equipment conforming to this standard that is rated for use in a maximum application temperature of greater than 40 °C shall be suitable for operation at its assigned ratings, provided the ambient temperature of the surrounding medium is not above its assigned maximum application temperature and it is not below –30 °C, the altitude does not exceed 1000 m, and the frequency of the power system is 60 Hz.

### 3.2 Other service conditions

The majority of fuses presently manufactured conform to the service conditions listed in 3.1. Fuses can be designed for other service conditions and still conform to this standard and the specification standards and applications guidelines listed in Clause 2, providing they are designed and tested with those other conditions considered in the design and testing process. Fuses are routinely designed for higher altitudes and power frequencies that are different from 60 Hz. Applications with conditions other than those listed in 3.1 should be brought to the attention of those responsible for the design and application. The following is a listing of some of the conditions that fuses have in the past been designed to accommodate:

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a) Altitudes in excess of 1000 m (see 3.3)

b) Power system frequencies other than 60 Hz

c) Ambient temperatures less than –30 °C

d) Exposure to damaging fumes or vapors, excessive or abrasive dust, explosive mixtures of dust or gases, steam, salt spray, excessive moisture, or dripping water

e) Exposure to abnormal vibration, shocks, or tilting

f) Exposure to abnormal transportation or storage conditions

g) Abnormal space limitations

h) Abnormal operating duty, frequency of operation, difficulty of maintenance, etc.

### 3.3 Correction of altitudes in excess of 1000 m

Equipment covered by this standard that depends on air at atmospheric pressure for its insulating and cooling medium will have a higher temperature rise and a lower dielectric withstand when operated at altitudes higher than 1000 m. Historically, equipment covered by this standard has used correction factors for dielectric strength and rated continuous current when applied at altitudes above 1000 m. In addition, equipment designed for standard temperature use could be used at its normal rated continuous current without exceeding ultimate standard temperature limits, provided that the ambient temperature did not exceed the maximum ambient temperature assigned to the device in accordance with 3.1, multiplied by an appropriate factor. Altitude correction factors are being studied by the Switchgear Committee and will be added to this standard directly or by reference when they are approved. In the meantime, users should consult the manufacturer for appropriate derating when the equipment is applied above 1000 m. The historically used factors (from IEEE Std C37.40-1993 [B3])[6] are listed in Annex A, and the factors proposed in the initial draft of IEEE PC37.100.1 [B1] are contained in Annex B.

## 4. Definitions

These definitions are recognized as standard only for the purposes of this particular standard and the fuse and switch standards listed in Clause 2.

### 4.1 General definitions

**4.1.1 air switch:** A switching device designed to close and open one or more electric circuits by means of guided separable contacts that separate in air. These devices have no load-break ability if they are not equipped with a load-breaking means.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.2 allowable continuous current (of replaceable fuse links, fuses that include the fusible element, fuse units, refill units, and other assemblies that include a fusible element):** The allowable continuous current is the designated value of rms current, in amperes, at rated frequency, assigned by the manufacturer to these devices for a specific ambient temperature. The device shall be capable of carrying this allowable continuous current without exceeding the allowable total temperature specified in Table 1 when it is in the normal service position. *See also:* **rated continuous current.**

[6]The numbers in brackets correspond to those of the bibliography in Annex C.

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**Table 1—Limits of temperature and temperature rise for components and materials where the rated maximum application temperature for the device is 40 °C or less**

| Component or material[a,b] | Maximum value of | |
|---|---|---|
| | Temperature °C | Temperature rise °C |
| a) Contacts in air or other insulating gasses | | |
| 1) Spring-loaded contacts (copper or copper alloy) | | |
| – Bare | 75 | 35 |
| – Tin coated | 95 | 55 |
| – Silver or nickel coated | 105 | 65 |
| – Other coatings[a] | | |
| 2) Bolted contacts or equivalent (copper, copper alloy and aluminum alloy) | | |
| – Bare | 90 | 50 |
| – Tin coated | 105 | 65 |
| – Silver or nickel coated | 115 | 75 |
| – Other coatings[a] | | |
| b) Contacts in liquid insulating material (copper or copper alloy) | | |
| 1) Spring-loaded contacts | | |
| – Bare | 80 | 40 |
| – Silver, tin, or nickel coated | 90 | 50 |
| – Other coatings[a] | | |
| 2) Bolted contacts | | |
| – Bare | 80 | 60 |
| – Silver, tin, or nickel coated | 100 | 40 |
| – Other coatings[a] | | |
| c) Bolted terminals in air[c] | | |
| – Bare | 90 | 50 |
| – Silver, tin, or nickel coated | 105 | 65 |
| – Other coatings[a] | | |
| d) Metal parts acting as springs[d] | | |
| e) Materials used as insulation and metal parts in contact with insulation of following classes: | | |
| Bone fiber | 70 | 30 |
| 90 | 90 | 50 |
| 105 | 105 | 65 |
| 130 | 130 | 90 |
| 155 | 155 | 115 |
| 180 | 180 | 140 |
| 220 | 220 | 180 |
| Over 220[e] | | |

[a]If the manufacturer uses coatings other than those indicated in this table, the properties of these materials should be taken into consideration.
[b]Where engaging contact surfaces have different coatings, the permissible temperatures and temperature rises shall be those of the component having the lowest values permitted.
[c]The temperature of a terminal should be no higher than that of the nearest device contact also subject to temperature limits covered by this table.
[d]The temperature or the temperature rise should not reach such a value that the elasticity of the metal is impaired.
[e]Limited only by the requirement not to cause any damage to surrounding parts.

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2—The maximum value of current that the device will carry without the device exceeding the total temperature may be higher, or it may be lower, than the assigned rated continuous current. The allowable continuous current is associated with a specific ambient temperature. The value of allowable continuous current varies with ambient temperature, and therefore, the device may have many allowable continuous currents. Higher values of allowable continuous current are normally associated with certain types of distribution fuse links and are allowed for specific application conditions. Lower values of allowable continuous current are normally associated with elevated ambient temperatures and specific application conditions.

3—Depending on the design of the device, the allowable continuous current and the rated continuous current may be the same at the rated maximum application temperature of the device.

3—For current-limiting fuses immersed in the top liquid of a liquid filled transformer, when the fuse is carrying the allowable continuous current assigned by the manufacturer, the temperatures specified in Table 1 may or may not be exceeded. This deviation from usual application procedures is allowable because of the fuse's particular design features and the use of solidly bolted current connection techniques.

4—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.3 ambient temperature:** The temperature of the surrounding medium that comes in contact with the device or equipment.

**4.1.4 arcing time (of a fuse):** The time that elapses from the initiation of arcing in the current-responsive element(s) to the final interruption of the circuit, i.e., the length of the time that the fuse arcs.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.5 available short-circuit current (at a given point in a circuit):** *See:* **prospective short-circuit current (at the point of test).**

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.6 backup current-limiting fuse:** A current-limiting fuse capable of interrupting all currents from its rated maximum interrupting current down to its rated minimum interrupting current. *See also:* **current-limiting fuse.**

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.7 barrier:** A partition for the insulation or isolation of electric circuits or electric arcs.

**4.1.8 base:** The supporting member of the equipment to which the insulator unit or units are attached. A base also normally has a means for attaching the equipment to the crossarm(s) or other mounting structure(s).

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.9 basic impulse insulation level (BIL):** *See:* **impulse withstand voltage; rated lightning impulse withstand voltage.**

NOTES

1—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

2—[rated impulse withstand voltage] See 1.2.

**4.1.10 blade; disconnecting blade (of a switch or disconnecting cutout):** A nonfusible electrically conducting part that, when in the closed position, bridges the fixed or stationary contacts or contact clips of the switch, allowing current to be conducted through the switch and the blade. Removing or repositioning this conducting part opens the connection between the contacts or contact clips of the switch. This isolates the fixed or stationary contacts, and thus prevents current from flowing through the switch.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.


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**4.1.11 break distance (of a device):** The minimum open-gap distance between the main circuit contacts and conducting parts connected to them, when the device is in the full open position.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.12 breaking capacity:** *See:* **rated maximum interrupting current**.

NOTES

1—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

2—[breaking current] See 1.2..

**4.1.13 capacitor bank overcurrent protection:** Common name for all or part of the overcurrent protective equipment at a capacitor installation.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.14 capacitor group fuse:** *See:* **capacitor line fuse.**

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.15 capacitor line fuse:** A fuse applied to disconnect a faulted phase of a capacitor bank from a power system.

NOTES

1—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

2—[capacitor group fuse] See 1.2..

**4.1.16 capacitor(s) stored energy:** The value of energy, measured in Joules, that is stored in a capacitor or group of capacitors at a given instantaneous value of voltage, as shown in the following equation:

$$E = \frac{CV^2}{2}$$

where

*E* is energy in Joules,
*C* is the capacitance in microfarads,
*V* is the instantaneous voltage in kilovolts.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.17 capacitor unbalance protection:** A protective system sensitive to unbalanced voltages and/or currents in a normally balanced capacitor bank. The imbalance may be the result of blown fuses or due to an insulation failure within the capacitor bank.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.18 capacitor unit fuse:** A fuse applied to disconnect an individual faulted capacitor from its bank.

NOTES

1—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

2—[capacitor fuse; individual capacitor fuse] See 1.2.

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**4.1.19 clearing time:** The time that elapses from the initiation of a current that will melt the element to the final interruption of the circuit.

NOTES

1—Clearing time is the sum of the melting time and the arcing time.

2—Total clearing time-current-characteristic curves are developed at rated maximum voltage for the device.

3—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

4—[operating time; total clearing time] See 1.2.

**4.1.20 contacts:** *See:* **fuse support contacts.**

**4.1.21 current-limiting fuse; current-limiting fuse unit:** A current-carrying protective device that, when its current-responsive element(s) is (are) melted by a current within its specified current-limiting range, abruptly introduces sufficient resistance into the circuit that the first current peak is reduced. The current is interrupted significantly earlier than the normal current zero of the circuit, and the fuse subsequently withstands the circuit's recovery voltage. The ratio of actual peak current to prospective peak current decreases significantly as the prospective current increases from the value where current limitation first occurs (threshold current) up to the rated interrupting current of the fuse. Certain items are included in the fuse to facilitate this current limitation and the interruption of the current in the circuit.

NOTES

1—Measures of the current-limiting ability of fuses include the ratio of threshold current to rated continuous current (threshold ratio), peak let-through current versus prospective short-circuit current characteristic curves, and $I^2t$ characteristics. Values of some or all of these parameters should be available from the fuse manufacturer.

2—There are two classes of current-limiting fuses, power and distribution.

3—Some current-limiting fuses, such as general-purpose or full-range, use some type of mechanism or scheme to provide the fuse with current interruption capabilities in the current range where the melting current is lower than the current-limiting range of the fuse.

4—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.22 current-responsive element (of a fuse):** The total element portion of the fuse that is primarily responsible for the melting characteristics. The melting of the fusible element portion of the current-responsive element(s) initiates the arcing and the eventual interruption of the current in the circuit by the fuse. *See also:* **fusible element.**

NOTES

1—Some fuses may have two or more current-responsive elements in parallel. In this case the parallel combination determines the total melting characteristic. Certain types of fuses may have a series combination of current-responsive elements, each controlling a portion of the total melting characteristic. Two or more series combination elements may be used in parallel.

2—The parallel strain element used in some fuses also may be a factor in the total melting characteristics. The effect is more predominant in the smaller ratings of these types of fuses.

3—Certain fuses use a current-responsive element made up of two wires or ribbons in series that are attached together by an additional conducting structure. The heating of this structure by the wires or ribbons controls the lower current melting characteristics, and the melting characteristics of the wires or ribbons determines the higher current melting.

4—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.23 cutout (open and enclosed types):** An assembly that consists of a fuse support and either a fuseholder or a disconnecting blade capable of being operated with the use of a switch stick. The fuseholder or disconnecting blade normally rotates in a hinge, and for most devices, it is removable when it is in the full open position. Cutouts are distribution class devices. *See also:* **disconnecting cutout; fuse cutout.**


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NOTES

1—When the fuse support is assembled with a fuseholder it is a fuse cutout, and when it uses a nonfusible member it is a disconnecting cutout.

2—These devices have no load-break ability if they are not equipped with a load-breaking means.

3—Some cutouts may be equipped with additional parts that allow them to interrupt load current when opened, and others may be equipped with parts that allow them to be opened with a portable load-breaking device.

4—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.24 dielectric withstand-voltage tests:** Tests made to determine the ability of the insulating materials and the spacing between parts to withstand a specified voltage for a specified time without flashover or puncture. The tests required for a device are specified in the appropriate standard for the device, and typically are power frequency, impulse, and dc voltages.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.25 disconnecting cutout:** A cutout having a disconnecting blade. It is used for changing the connections in a circuit or system, or for isolating purposes.

NOTES

1—A disconnecting cutout is required to carry load current continuously and also abnormal or short-circuit currents for short intervals as specified. These devices have no load-break ability if they are not equipped with a load-breaking means.

2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

3—[solid blade cutout] See 1.2.

**4.1.26 disconnecting switch:** A switch used for changing the connections in a circuit or for isolating purposes.

NOTES

1—A disconnecting switch is required to carry load current continuously and also abnormal or short-circuit currents for short intervals as specified. These devices have no load-break ability if they are not equipped with a load-breaking means.

2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.27 distribution; distribution class (when used as an adjective to define or describe electrical equipment):** A general term used, by reason of specific physical or electrical characteristics, to denote application and/or restriction of the modified term, to that part of an electrical system used for conveying energy from a source to the point of utilization. The types of construction for these areas may be all or partially overhead or underground construction. A distribution device is identified by the following characteristics:

a) Operating voltage limits corresponding to distribution system voltages

b) Rated lightning impulse withstand voltage [basic impulse insulation level (BIL)] corresponding to distribution system levels

c) Primary applications are with distribution feeders and circuits

d) For many of these devices, a mechanical construction that is basically adaptable for pole or crossarm mounting

NOTES

1—For a utility system, the area described is between the closest source (generating source or an intervening substation) and the customer’s entrance equipment.

2—For a customer’s internal system, the area described is between the customer’s entrance equipment and the point of utilization of electrical energy.

3—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

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**4.1.28 distribution class current-limiting fuse:** *See:* **current-limiting fuse; distribution.**

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.29 distribution class cutout:** *See:* **cutout; distribution**.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.30 distribution class disconnecting cutout:** *See:* **disconnecting cutout; distribution.**

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.31 distribution class enclosed single-pole air switch:** *See:* **distribution; enclosed single-pole air switch.**

NOTES

1—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

2—[distribution enclosed air switch] See 1.2..

**4.1.32 distribution class fuse cutout:** *See:* **cutout; distribution.**

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.33 distribution class fuse link:** *See:* **distribution; fuse link.**

**4.1.34 dropout fuse:** A fuse in which the fuseholder or fuse unit automatically drops into an open position after the fuse has interrupted the circuit.

**4.1.35 enclosed cutout:** A cutout in which the fuse clips and contacts and the fuseholder or disconnecting blade are mounted completely contained within an insulating enclosure. *See also:* **cutout.**

**4.1.36 enclosed single-pole air switch:** A single-pole air switch in which the live parts of the switch are completely contained within an insulating enclosure. *See also:* **air switch.**

**4.1.37 expendable cap (of an expendable-cap cutout):** A replacement part or assembly for clamping the button head of a fuse link and closing one end of the fuseholder. It includes a pressure-responsive section that opens to relieve the pressure within the fuseholder when a predetermined value is exceeded during circuit interruption.

**4.1.38 expendable-cap cutout:** An open cutout having a fuse support designed for, and equipped with, a fuse holder having an expendable cap.

**4.1.39 expulsion fuse:** A current-carrying device with a current-responsive fusible element that when heated by a particular current passing through it, causes the melting of this fusible part. Melting of the fusible element causes it to sever, and this creates a current-carrying arc within the fuse. The interaction of this arc with certain current interruption facilitating items included in the fuse produces a gas. The expulsion effect and other properties of this gas, either alone or aided by other mechanisms, results in interruption of the current in the circuit very near the circuit's normal current zero and subsequent withstanding of the recovery voltage of the circuit.

NOTES

1—There are two classes of expulsion fuses, power and distribution.

2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.40 external capacitor fuse:** A fuse external to, and in series with, a capacitor unit or group of capacitor units.

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NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.41 full-range current-limiting fuse:** A current-limiting fuse capable of interrupting, under specified conditions, all currents from its rated maximum interrupting current down to the minimum continuous current that can cause the fusible element to melt. For the purpose of demonstrating the low current capability, the fuse shall be capable of interrupting a minimum test current when it is surrounded by a temperature that is equal to its rated maximum application temperature. This test current is less than the lowest current that will melt the fuse's element(s) when it is applied at its rated maximum application temperature. *See also:* **current-limiting fuse.**

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.42 fuse; fuse unit:** A current-carrying protective device with a current-responsive fusible element that when heated by a particular current passing through it, causes the melting of this fusible part. Melting of the fusible element causes it to sever, and this creates a current-carrying arc within the fuse. The interaction of this arc with certain items included in the fuse to facilitate current interruption results in interruption of the current in the circuit and subsequent withstanding of the circuit's recovery voltage.

NOTES

1—A fuse or fuse unit comprises all the parts that form a device capable of performing the prescribed functions. It may or may not be the complete device that is necessary to connect into an electrical circuit.

2—Fuses that use a replaceable fuse link require that the fuse link be assembled into the fuseholder, so it is then a current-carrying and interrupting device.

3—A fuse unit is an assembly comprised of the current-responsive element, the items that facilitate current interruption, and the remaining parts normally requiring replacement after each fuse circuit-interrupting operation so that the fuse is restored to its original operating condition. A fuse unit may or may not require additional reusable parts, so that it can connect to the fuse's contacts or into the electrical circuit.

4—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.43 fuse-container:** A close fitting container that supports the fuse or fuse unit and restricts the air, gas, or liquid flow surrounding the fuse.

NOTES

1—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

2—[fuse-canister] See 1.2.

**4.1.44 fuse cutout:** A device that consists of a fuse support, fuseholder, and usually a mounting means. Fuse cutouts do not include the replaceable fuse link.

NOTE—These devices have no load-break ability if they are not equipped with a load-break means.

**4.1.45 fuse disconnecting switch:** A disconnecting switch in which a fuse unit, or fuseholder with a fuse link, form all or part of the blade. *See also:* **cutout; disconnecting switch**.

NOTES

1—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

2—[disconnecting fuse] See 1.2.

**4.1.46 fuse-enclosure package (FEP):** An enclosure supplied with one or more fuses as a complete package and where the application data covering the specific fuse(s) and enclosure is available. Depending on the particular application, the fuse(s) also may or may not be mounted in a fuse-container that is then assembled into the enclosure. *See also:* **fuse-container.**

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NOTES

1—When the fuse is mounted directly inside an enclosure, it has relatively free air, gas, or liquid flow surrounding the fuse. A fuse-container restricts the flow of the medium immediately surrounding the fuse.

2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.47 fuse exhaust control device:** An attachment that, when added to a vented fuse, confines and condenses the gasses developed during circuit interruption, and consequently, substantially reduces the venting of the fuse.

NOTES

1—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

2—[muffler] See 1.2.

**4.1.48 fuseholder:** An assembly that provides a means of making contact between the fuse link, refill unit, or fuse unit and the contacts or clips of the fuse support.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.49 fuse link:** A replaceable part or assembly, made up entirely or principally of the current conducting fusible element. Some fuse links include the parts necessary to facilitate current interruption. The fuse link needs to be replaced after each interruption to restore the fuse to operating condition.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.50 fuse support:** An assembly that consists of a base or mounting hardware, insulator(s) or insulator unit(s), the fuse support contacts, and required parts and terminals for connecting the device into the circuit. Some supports will also use parts to align or guide the fuseholder, fuse, or blade into the support.

NOTES

1—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

2—[fuse mount; fuse mounting] See 1.2.

**4.1.51 fuse support contacts:** The current-carrying parts of a fuse support that engage the contacts of the fuseholder, fuse unit, or disconnecting blade.

NOTES

1—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

2—[contact clips; fuse-base contacts; fuse clips] See 1.2.

**4.1.52 fuse time-current-characteristic:** The correlated values of time and current that designate the performance of all or a stated portion of the functions of the fuse. The time-current-characteristics for fuses are generally presented as a curve. The most useful curves plot the minimum melting time and total clearing time versus current. For some applications, average melting and maximum melting data may also be useful.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.53 fuse tube:** A tube of insulating material that encloses the current-responsive fusible element. For some devices, the tube may be made up of multiple materials with the portion nearest the fusible element having the properties that facilitate the interruption process and the other portion providing the structural properties.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.54 fuse unit:** *See:* **fuse; fuse unit.**


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**4.1.55 fusible element:** The part(s) of a fuse designed so that melting occurs here first when the current exceeds a definite current for a definite period of time. This portion of the fuse may or may not be the total current-responsive element. In the cases where it is not the total current-responsive element, this portion melts first, and the remainder of the total element melts partially or totally as the interruption process proceeds.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.56 general-purpose current-limiting fuse:** A current-limiting fuse capable of interrupting all currents from its rated interrupting current down to the current that causes melting of the fusible element(s) in one hour or more. *See:* **current-limiting fuse.**

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.57 groundable parts:** Those parts that may be connected to ground, either intentionally or inadvertently, without affecting operation of the device.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.58 grounded parts:** Parts that are intentionally connected to ground.

**4.1.59 guide:** An attachment used to ensure proper alignment of the parts when the device is opened or closed.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.60 homogeneous series (of fuses, fuse units, or refill units):** A homogeneous series is a group of fuses that have prescribed similarities. A complete range of fuses may be organized into one or more homogeneous series, such that the testing of a reduced number of fuses will qualify all of the fuses in that series.

NOTES

1—For any particular test, more than one homogeneous series may be required to represent the total range of available current ratings of these devices.

2—The homogeneous series for one particular test may be different from the homogeneous series for another particular test.

3—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.61 impulse withstand voltage:** The crest voltage of an impulse that, under specified conditions, can be applied without causing flashover or puncture of any solid dielectric material.

NOTES

1—An impulse is an intentionally applied aperiodic transient voltage wave that usually rises rapidly to a peak value and then falls more slowly to zero. A distinction is made between lightning and switching impulses on the basis of duration of the wave front. Impulses with front durations up to 20 microseconds are defined as lightning impulses, and those with longer fronts are switching impulses. Switching impulses also have longer total durations. The type of test to be applied to various devices is specified in the device's specification standard.

2—A flashover is an abnormal disruptive electrical discharge that occurs over the surface of a solid dielectric material and/or through a gas or liquid dielectric, such as air or oil, and it is between parts that have different voltages.

3—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.62 indicating fuse:** A fuse that automatically provides an indication that the fuse has operated.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.63 indicator (of a disconnecting cutout):** A device, included on some enclosed disconnecting cutouts, that provides an indication that the switch blade is in the open position.

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NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.64 indicator (of a fuse):** A device that is a part of some types of fuses, fuse units, or refill units that operates when the fuse is clearing the circuit. This device provides an indication that this particular fuse has operated.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.65 indoor (when used to define fuses or other equipment covered by this standard, IEEE Std C37.40-2003):** Designed for use inside buildings or weatherproof (weather-resistant) enclosures.

NOTES

1—Because of the wide variety of enclosures available, when a fuse that is designed for indoor application is installed inside an outdoor enclosure, such installations should be verified with the fuse manufacturer.

2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.66 insulating-material classifications (for some of the materials used for insulating the devices covered in this standard, IEEE Std 37.40-2004):** For the purpose of establishing temperature limits, insulating materials shall be classified as follows:

*Class 90.* Materials or combinations of materials such as cotton, silk, and paper without impregnation. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 90 °C.

*Class 105.* Materials or combinations of materials such as cotton, silk and paper when suitably impregnated or coated or when immersed in a dielectric liquid such as oil. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 105 °C.

*Class 130.* Materials or combinations of materials such as mica, glass fiber, asbestos, etc., with suitable bonding substances. Other materials or combinations of materials, not necessarily inorganic, may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 130 °C.

*Class 155.* Materials or combinations of materials such as mica, glass fiber, asbestos, etc., with suitable bonding substances. Other materials or combinations of materials, not necessarily inorganic, may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 155 °C.

*Class 180.* Materials or combinations of materials such as silicone elastomer, mica, glass fiber, asbestos, etc., with suitable bonding substances such as appropriate silicone resins. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 180 °C.

*Class 220.* Materials or combinations of materials that by experience or accepted tests can be shown to be capable of operation at 220 °C.

*Over Class 220.* Insulation that consists entirely of mica, porcelain, glass, quartz, and similar inorganic materials. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at temperatures over 220 °C.

NOTES

1—Insulation is considered to be impregnated when a suitable substance provides a bond between components of the structure and also a degree of filling and surface coverage sufficient to give adequate performance under the extremes of temperature, surface contamination (moisture, dirt, etc.), and mechanical stress expected in service. The impregnant shall not flow or deteriorate enough at operating temperature so as to seriously affect performance in service.

2—The electrical and mechanical properties of the insulation shall not be impaired by the prolonged application of the limiting insulation temperature permitted for the specific insulation class. The word impaired is used here in the sense of


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causing any change that could disqualify the insulating material for continuously performing its intended function, whether it is creepage, spacing, mechanical support, or dielectric barrier action.

3—In the preceding descriptions of insulating materials classifications, the words “accepted tests” refer to recognized test procedures established for the thermal evaluation of materials by themselves or in simple combinations. Experience or test data, used in classifying insulating materials, are distinct from the experience or test data derived for the use of materials in complete insulation systems. The thermal endurance of complete systems may be determined by test procedures specified by the responsible technical committees. A material that is classified as suitable for a given temperature in the above tabulation may be found suitable for a different temperature other than the given one, either higher or lower, by an insulation system test procedure. For example, it has been found that some materials suitable for operation at one temperature in air may be suitable for a higher temperature when used in a system operated in an inert gas atmosphere.

4—It is important to recognize that other characteristics, in addition to thermal endurance, such as mechanical strength, moisture resistance, and corona endurance, are required in varying degrees in different applications for the successful use of insulating materials.

5—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.67 insulation:** A material that has electrical insulating properties and is used to separate parts that have different voltages. Typical materials are gases such as air, liquids and solid dielectrics.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.68 insulator unit:** An insulator that is assembled with metal parts or other means so that it can be attached to other insulating units or to the parts of the device that may have different voltages or a ground potential.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.69 $I^2t$:** The integral of the square of the current during a given time interval in ampere-squared-seconds, as show in the following equation:

$$I^2t = \int_{t_0}^{t_1} i^2 dt \text{(ampere-squared-seconds)}$$

where

the melting $I^2t$ is equal to the integral of the square of the current during the melting time of the fuse;

the clearing $I^2t$ is equal to the integral of the square of the current during the clearing time of the fuse, the clearing time is equal to the sum of the melting time and arcing time;

the $I^2t$ (ampere-squared-seconds) multiplied by the resistance (ohms) through which the current flows is equal to the energy (joules) that will be produced in the resistance.

**4.1.70 latch:** An attachment used to hold a fuse or switch in the closed position.

**4.1.71 lifting eye (of a fuseholder, fuse unit, or disconnecting blade):** An eye provided for receiving the hook of a switch stick. This eye is used to insert the fuse or disconnecting blade into, and/or remove it from, the device’s support.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.72 link-break cutout:** A load-break fuse cutout that is operated by breaking the fusible portion of the fuse link to initiate a normal cutout interrupting operation. *See also:* **expulsion fuse.**

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.73 liquid-filled fuse unit**: A fuse unit in which the arc is drawn through a liquid.

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**4.1.74 liquid immersible current-limiting fuse/fuse unit:** A current-limiting fuse or fuse unit suitable for applications that requires total or partial immersion in oil or other dielectric liquid. The fuse is normally immersed in a liquid filled enclosure, the liquid of a transformer, or an enclosure containing switchgear.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.75 liquid submerged expulsion fuse/fuse unit:** An expulsion fuse intended for use totally immersed in oil or other dielectric liquid. The liquid plays a significant role in the expulsion action and subsequent recovery voltage withstand of the fuse.

**4.1.76 live parts:** Those parts that are designed to operate at a voltage different from that of the ground.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.77 load-break cutout**: A cutout with means for interrupting load currents.

NOTE—This definition only applies to devices that have the necessary parts so that breaking the link or opening the device causes the load current to be interrupted in an arc chute or another type of permanently attached device. It does not apply to devices that can be operated with a portable load-break device.

**4.1.78 mechanical interchangeability (of fuse links):** The mechanical characteristics that allow fuse links of various manufacturers to be interchanged physically so that they fit into and withstand the tensile stresses imposed by various types of prescribed cutouts made by different manufacturers. The characteristics that allow this interchangeability are specified in ANSI C37.42-1996.

NOTES

1—Fuse links that have mechanical interchangeability may not have electrical interchangeability. Care should be exercised with fuse links that have similar melting characteristics because the interrupting characteristics may be different. Protective performance provided by the combination of a selected fuse link and a selected fuseholder can only be assured by a performance test conducted on the specific combination.

2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.79 melting speed ratio:** A ratio that is obtained by dividing the 0.1 second minimum melting current by the 300 or 600 second, whichever is specified, minimum melting current. This number provides the relative speed of the fuse link. Fast speed fuse links have numbers that are between 6.0 and 8.1, and slow speed fuse links have numbers that are between 10.0 and 13.1.

NOTES

1—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

2—[speed ratio] See 1.2.

**4.1.80 melting time (of a fuse):** The time that elapses from the initiation of a current that will melt the fusible element to the initiation of arcing.

NOTES

1—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

2—[pre-arcing time (of a fuse)] See 1.2.

**4.1.81 minimum clearance between poles (phases):** The shortest distance between any live parts of adjacent poles.

NOTE—Caution should be used in the use of this term since clearance is not the same as phase spacing or center-to-center spacing. Clearances are normally smaller than the other two distances.

**4.1.82 minimum clearance to ground:** The shortest distance between any live part and adjacent grounded parts.


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**4.1.83 minimum melting current:** The lowest current that will melt the fuse's fusible element at a specified time and under specified conditions.

NOTES

1—The minimum melting time-current-characteristic curve for a fuse is generally derived with the fuse at an ambient temperature of 20 °C to 30 °C. An exception to this may be for fuses used where very high ambient temperatures exist.

2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.84 mounting position (of a switch or fuse):** A position determined by, and corresponding to, the approximate position of the switch blades, fuseholder, or fuse unit of the device relative to the surface of the earth.

NOTES

1—The usual positions are:

a) Vertical
b) Horizontal upright (when the switch blade, fuseholder, or fuse unit is mounted above the supporting insulators)
c) Horizontal underhung (when the switch blade, fuseholder, or fuse unit is mounted below the supporting insulators)
d) Angle (from vertical) (common angles for these devices range from 15° to 30° from the vertical)

2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.85 multipole fuse:** An assembly of two or more single-pole fuses.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.86 nondisconnecting fuse:** An assembly consisting of a fuse support with contact clips for directly receiving a fuse unit or fuseholder. The fuse unit or fuseholder must be inserted or extracted from the contact clips with a device that can grab hold of it. It does not have an opening eye and therefore cannot be operated with a switch stick as a disconnecting device.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.87 nonrenewable fuse; nonrenewable fuse unit:** A fuse or fuse unit that requires complete replacement after it has operated. That is, it cannot be restored for normal operation by only replacing the current-responsive element.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.88 nonvented fuse; nonvented fuse unit**: A fuse or fuse unit that does not allow any arc products or any other materials to escape from the fuse into the atmosphere at any time. All arc products or other materials are contained completely within the body of the fuse.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.89 oil-immersible current-limiting fuse/fuse unit:** *See:* **fuse, fuse unit; liquid immersible current-limiting fuse/fuse unit.**

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.90 open cutout**: A cutout where the live parts of the fuseholder, fuse unit, disconnecting blade, contacts and contact clips, and other live parts are exposed.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.91 opening eye (of devices covered by this standard, IEEE Std C37.40-2003):** An eye provided for receiving the hook portion of a switch stick that is used for opening and closing the device.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

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**4.1.92 open-link cutout:** A cutout designed specifically for use with open-link fuse links. It does not use a fuseholder since the fuse link performs the circuit interruption function. The contact clips of the fuse support are made so they tightly grip the leader of the fuse link.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.93 open-link fuse link:** A replaceable assembly that consists of a current-responsive fusible element, a fuse link tube, and the parts, such as the leader cable(s), necessary to connect it into the contact clips of the open-link fuse support. When the fusible element melts, the interaction of the arc and materials included in the fuse link tube produce a gas to facilitate current interruption. The expulsion effect and other properties of this gas either alone or aided by other mechanisms results in current interruption of the current in the circuit very near the normal current zero of the circuit and subsequent withstanding of the circuit's recovery voltage. Open-link fuse links have a rated maximum interrupting current and are used only in open-link fuse cutouts; also, refer to ANSI C37.42-1996 for construction details.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.94 open-link fuse support:** An assembly that consists of a base or mounting hardware, insulator(s) or insulator unit(s) and fuse contact clips that are designed so that they tightly grip the leader of the open-link fuse link. It also includes the parts and terminals required to connect the device into the circuit.

NOTES

1—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

2—[open-link mounting] See 1.2.

**4.1.95 outdoor (when used as an adjective to define or describe electrical equipment covered by this standard, IEEE Std C37.40-2003):** A general term used to indicate that the equipment being defined or described is suitable for use in an outdoor environment.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.96 peak let-through current (of a current-limiting fuse):** The highest instantaneous current passed by the fuse during its circuit-interrupting process.

NOTES

1—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

2—[cutoff current (of a current-limiting fuse)] See 1.2.

**4.1.97 peak let-through current characteristic curve (of a current-limiting fuse):** A curve showing the relationship between the maximum peak current passed by a fuse and the rms prospective current of the circuit under specified circuit conditions.

NOTES

1—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

2—[cutoff current characteristic curve (of a current-limiting fuse)] See 1.2.

**4.1.98 peak overvoltage (for current-limiting fuses):** The highest instantaneous peak value of the voltage that can exist across a current-limiting fuse during its arcing time.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.99 performance characteristic (of a device):** An operating characteristic for a device. The limit or limits for these characteristics are specified in the specification standard for the device. Typical characteristics are dry, dew, or wet power-frequency withstand voltage, impulse voltage, temperature-rise limit, radio-influence level, melting and clearing time-current-characteristics, maximum peak overvoltage, and peak let-through current.

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NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.100 phase spacing:** The distance between the centerlines of adjacent devices with different phase voltages.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.101 power; power class (when used as an adjective to define or describe electrical equipment covered by this standard, IEEE Std C37.40-2003):** A general term used by reason of specific physical or electrical characteristics to denote application, and/or restriction, of the modified term to generating stations, switching stations, substations, or other circuit locations with similar characteristics. Such locations typically have service requirements which are more severe than distribution applications. A power device is identified by the following characteristics:

a) Operating voltage limits corresponding to power system voltages

b) Rated lightning impulse withstand voltage [Basic impulse insulation level (BIL)] corresponding to power system levels

c) Primary applications in stations or substations

d) For many of the devices, a mechanical construction basically adaptable for mounting in stations or substations

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.102 power (when used as an adjective to define or describe electrical voltages used in this standard, IEEE Std 37.40-2004):** A general term used by reason of specific electrical characteristics to denote restriction of the modified term to voltages used to distribute electrical energy. Most power-frequency voltages used for distributing energy today are either 50 Hz or 60 Hz.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.103 power class current-limiting fuse:** *See:* **current-limiting fuse; power**.

**4.1.104 power class expulsion fuse:** *See:* **expulsion fuse; power**.

**4.1.105 power frequency:** *See:* **power**.

**4.1.106 power-frequency dew withstand voltage:** The rms voltage that can be applied to an insulator or a device, completely covered with condensed moisture, under specified conditions for a specified time without causing flashover or puncture of any solid dielectric material.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.107 power-frequency dry withstand voltage:** The rms voltage that can be applied to a dry insulator or device under specified conditions for a specified time without causing flashover or puncture of any solid dielectric material.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.108 power-frequency recovery voltage:** The power-frequency rms voltage that occurs across the terminals of a pole of an alternating current circuit-interrupting device after the interruption of the current and after the high-frequency transients have subsided.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

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**4.1.109 power-frequency wet withstand voltage:** The rms voltage that can be applied to a wetted insulator or device under specified conditions for a specified time without causing flashover or puncture of any solid dielectric material.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.110 power fuse:** A term used to describe a fuse that is generally used in stations or substations. It is an assembly that consists of a fuse support and either a fuseholder or a fuse unit and its required accessories. If the device uses a replaceable fuse link or a refill unit, they are not a part of the device but are required to make it a current-carrying device. *See also:* **power.**

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.111 pre-arcing time (of a fuse):** *See:* **melting time (of a fuse)**.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.112 prospective short-circuit current (at the point of test):** The maximum short-circuit current for any given setting of a test circuit that the test power source can deliver at the point of test, when the device to be tested is replaced or bypassed with a conductor of negligible impedance.

NOTES

1—This value is specified preferably in rms symmetrical amperes; however, for special conditions it may be specified as asymmetrical or as peak amperes.

2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

3—[available short-circuit current (at the point of test)] See 1.2.

**4.1.113 quick-break switch:** A switch that has a device that provides a high speed opening of auxiliary contacts for the purpose of interruption of load circuits. These devices have specific interrupting abilities and their ratings should not be exceeded without consulting the manufacturer.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.114 recovery voltage:** The voltage that occurs across the terminals of a pole of a circuit-interrupting device after the interruption of the current. A recovery voltage usually consists of a power-frequency recovery voltage that is sometimes modified by high-frequency transient voltages.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.115 refill unit (of a fuseholder):** An assembly comprised of the current-responsive element, the items that facilitate current interruption, and the remaining parts requiring replacement after each fuse circuit-interrupting operation, so that the fuseholder is restored to its original operating condition. A refill unit is different from a fuse unit in that it requires the use of a fuseholder. *See also:* **fuse; fuse unit**.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.116 slant-voltage rated distribution cutout:** A distribution cutout intended primarily for application on three-phase solidly grounded neutral (multi-grounded) systems where prescribed conditions exist. *See:* **slant-voltage rating (of a distribution cutout).**

NOTE—[multiple-voltage rated distribution cutout] See 1.2.

**4.1.117 solid-material fuse; fuse unit:** A fuse or fuse unit where the arc is drawn through a hole in a solid material. The solid material contains the ingredients that facilitate current interruption.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.


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**4.1.118 strain element (of a fuse):** In order to relieve the current-responsive element of the tensile strain that can be imposed on it, some fuses use a high-resistance wire or other part in parallel with it. During the interrupting process the fusible portion of the current-responsive fusible element melts first, the strain element melts next and then arcing commences. This parallel strain element may be a factor in the total melting characteristics of the fuse. This effect is more predominant in the smaller ratings of these types of fuses.

NOTES

1—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

2—[strain wire (of a fuse)] See 1.2.

**4.1.119 striker (of a current-limiting fuse):** A device that is a part of some current-limiting fuses, fuse units or refill units that operates when the fuse is clearing the circuit. This device releases a stored energy that can be used to cause operation of other apparatus, provide an interlock to other apparatus, and/or provide other means to indicate that this particular current-limiting fuse has operated.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.1.120 switch:** A device that is designed with a switch blade that is used for closing, opening, or changing the connections in a circuit or system. It may also be used for isolation purposes.

NOTES

1—A switch is required to carry load current continuously and also abnormal or short-circuit currents for short intervals as specified. These devices have no load-break ability if they are not equipped with a load-breaking means.

2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.121 switch stick:** An electrically insulating stick or pole with a head or hook, as described in ANSI C37.42-1996. Its primary functions are opening or closing fuses and switches or inserting and removing the fuseholder, fuse unit, and disconnecting blade from the device's support. This stick is generally used for distribution equipment that has a means for utilizing this device.

NOTES

1—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

2—[fuse hook; hot stick; switch hook] See 1.2.

**4.1.122 terminal:** A device used for attaching an electrical conductor to apparatus in order to connect the apparatus into the electrical system. The electrical conductor is typically a wire or other similar conducting material.

NOTES

1—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

2—[connector] See 1.2.

**4.1.123 terminal pad:** A flat conducting terminal part of a device that can be used to connect the electrical apparatus into the electrical system. It typically has holes in it so that a connector can be bolted to it. The connector may be crimped or attached by other means to the conductor or it may be a connector that can accept the conductor and have means for attaching it to the pad.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.124 transient recovery voltage (TRV):** The voltage transient that occurs across the terminals of a circuit-interrupting device after interruption of the current has occurred.

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NOTES

1—The voltage magnitude is the voltage as compared to ground. The term may be used for describing the transient recovery voltage as an inherent circuit TRV, a modified circuit inherent TRV, or an actual TRV. The inherent circuit TRV is the transient that would occur at that point in the circuit if a perfect interrupter were interrupting the circuit at that point. Low arc voltage interrupters such as vacuum devices are very close to perfect interrupters. For test purposes, a special device is used to determine inherent circuit TRV. Many devices will modify the voltage magnitude, the frequency, or both so that a modified circuit inherent TRV occurs. An actual TRV is the transient that is measured when a specific interrupting device operates and clears the circuit.

2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.125 universal fuse links:** Fuse links that for each rating provide mechanical interchangeability and, for some types of fuse links, time-current-characteristic interchangeability over the specified time-current range. Interrupting characteristics may or may not be the same for various manufacturer's units since device construction and application factors may be involved. Interchangeability requirements are specified in ANSI C37.42-1996.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.126 vent (of a fuse):** The means provided for the escape of the gases or other arc products developed during circuit interruption.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.1.127 vented fuse; vented fuse unit:** A fuse with provision for the escape of arc gases, or solid particles, or other arc products to the surrounding atmosphere during circuit interruption.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

## 4.2 Ratings

**4.2.1 intermediate current ratings (of distribution class fuse links):** A series of distribution class fuse link ratings chosen from a series of preferred numbers that are spaced between the preferred current ratings. Coordination is generally achieved between adjacent preferred current ratings or between adjacent intermediate current ratings. Coordination is generally not achieved between adjacent preferred and intermediate ratings. See ANSI C37.42-1996, 4.2.1.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.2.2 preferred current ratings (of distribution class fuse links):** A series of distribution class fuse link ratings so chosen from a series of preferred numbers that a specified degree of coordination is achieved between adjacent preferred current ratings. See ANSI C37.42-1996, 4.2.1.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.2.3 rated continuous current (of distribution class and power class fuse supports, distribution class and power class fuseholders that use replaceable fuse links or refill units, capacitor line fuse supports and their fuseholders that use replaceable fuse links or refill units, capacitor unit fuses that use replaceable fuse links, disconnecting switches, enclosed single-pole air switches, and other assemblies that do not contain a fusible element):** The rated continuous current is the designated value of rms current, in amperes, at rated frequency, assigned to these devices by the manufacturer. When tested as specified, the device shall be capable of carrying this rated continuous current without exceeding the allowable temperature rise and total temperature specified in Table 1.

2—The test used to validate the temperature rise and total temperature is specified in IEEE Std C37.41-2000.

3—Devices that use replaceable fuse links, fuse units, or refill units shall be capable of meeting these requirements with any size and type replaceable portion recommended by the manufacturer.


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4—The rated continuous current assigned to these devices is the maximum current that should be applied to these devices without consulting the manufacturer. When a switch blade is available for use in any of these devices, it modifies the current rating of the fuse support. Information regarding this modification is normally available in the manufacturer's literature.

**4.2.4 rated continuous current (of replaceable fuse links, fuses that include the fusible element, fuse units, refill units, and other assemblies that include a fusible element):** The rated continuous current is the designated value of rms current, in amperes, at rated frequency, assigned to these devices by the manufacturer.

NOTES

1—When tested as specified, the device shall be capable of carrying this rated continuous current without exceeding the allowable temperature rise and total temperature specified in Table 1 when it is in the normal service position.

2—The test used to validate the temperature rise and total temperature is specified in IEEE Std C37.41-2000.

3—The maximum value of current that the above devices will carry without the device exceeding one or both of the above temperatures may be higher or lower than the assigned rated continuous current. This new current rating is defined as the allowable continuous current, and it is associated with a specific ambient temperature. Higher values of allowable continuous current are normally associated with certain types of distribution fuse links and are allowed for specific application conditions. Lower values of allowable continuous current are normally associated with elevated ambient temperatures and specific application conditions.

**4.2.5 rated 15-cycle withstand current:** The designated maximum value in rms amperes that is assigned to a device regarding its ability to withstand the electromagnetic forces and the heat that is generated during short-circuit conditions. When tested as specified, the device shall be capable of successfully withstanding its assigned rating. These ratings are normally provided in rms symmetrical amperes and have specified circuit conditions.

NOTES

1—This value is the maximum value of current that the device is capable of withstanding for the specified duration and should not be exceeded without consulting the manufacturer.

2—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

3—[15-cycle current rating] See 1.2.

**4.2.6 rated lightning impulse withstand voltage:** The designated maximum crest withstand-voltage value, of a lightning impulse voltage wave, that is assigned to the device regarding its ability to withstand a lightning impulse voltage without causing flashover or puncture of any solid dielectric material. *See also:* **impulse withstand voltage.**

NOTE—[basic impulse insulation level (BIL)] See 1.2.

**4.2.7 rated maximum application temperature:** The maximum ambient temperature at which a device is suitable for use. An interrupting device shall be capable of withstanding this temperature without any deterioration that would inhibit its ability to interrupt the circuit.

NOTES

1—A fuse may not be suitable for normal continuous operation at its rated maximum application temperature as this surrounding temperature in some applications may only exist under abnormal conditions such as overload or equipment failure conditions. For these applications the fuse would not be assigned an allowable continuous current at its rated maximum application temperature. It would be assigned this current rating at a lower temperature where the fuse would be expected to operate continuously. Manufacturers should ensure that the users of fuses that cannot operate continuously at their rated maximum applications temperature are provided with the proper information that indicates the conditions under which the fuse may be used continuously.

2—Fuses that are applied at temperatures that exceed their rated maximum application temperature may not interrupt the circuit when called upon to perform that function.

3—[rated maximum reference ambient temperature] See 1.2.

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**4.2.8 rated maximum interrupting current:** The designated maximum value in rms amperes that is assigned to a device regarding its interrupting ability. When tested as specified, the device shall be capable of successfully interrupting a power system circuit that can produce this current. These ratings are normally provided in rms symmetrical amperes and specified circuit conditions.

NOTES

1—This value is the maximum value of current that the device is capable of interrupting and should not be exceeded without consulting the manufacturer.

2—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

3—[breaking capacity; breaking current; rated interrupting capacity] See 1.2.

**4.2.9 rated maximum load-break current (of a device equipped with a load-breaking mechanism):** The designated maximum value in rms amperes that is assigned to the device regarding its ability to interrupt load currents. When tested as specified, the device shall be capable of successfully interrupting the load current of the power system circuit. These ratings are normally provided in rms symmetrical amperes and have specified circuit conditions.

NOTES

1—This is the maximum value of current that the device is capable of interrupting and should not be exceeded without consulting the manufacturer.

2—Devices have no load-breaking capability if they are not equipped with a load-breaking mechanism.

3—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

4—[load-break current rating (of a device equipped with a load-breaking mechanism)] See 1.2.

**4.2.10 rated maximum voltage:** The designated maximum value in rms volts that is assigned to the device regarding its ability to operate continuously at this assigned voltage. This voltage is used in many of the tests required for the device.

NOTES

1—This value is the maximum value of voltage for which the device is capable of being applied and should not be exceeded without consulting the manufacturer.

2—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

3—[maximum voltage rating] See 1.2.

**4.2.11 rated minimum interrupting current:** The designated minimum value in rms amperes that is assigned to the device regarding its low current-interrupting capability. When tested as specified, the device shall be capable of successfully interrupting a power system circuit that can produce this current level. These ratings are normally provided in rms symmetrical amperes and specified circuit conditions.

NOTES

1—This value is the minimum value of current that the device is capable of interrupting and the device should not be applied where the available current could be lower without consulting the manufacturer.

2—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.2.12 rated momentary withstand current:** The designated maximum value in rms amperes that is assigned to the device regarding its ability to withstand the electromagnetic forces that occur under maximum short-circuit conditions. When tested as specified, the device shall be capable of successfully withstanding its assigned rating. These ratings are normally provided in rms asymmetrical amperes and specified circuit conditions.


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NOTES

1—This value is the maximum value of current that the device is capable of withstanding for the specified duration and should not be exceeded without consulting the manufacturer.

2—The rated momentary current value for any device is normally based on the device's 15-cycle rated short-time current multiplied by the appropriate asymmetry factor associated with the specified X/R. The assigned value includes the direct current component that occurs in the first maximum offset current loop of the specified design test.

3—To ensure that the device is tested with the proper severity, the first and second major current peaks shall be equal to or greater than those specified in IEEE Std C37.41-2000.

4—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

5—[momentary current rating] See 1.2.

**4.2.13 rated power frequency:** The frequency of the power system at which the device has been designed to operate during its normal operation.

NOTES

1—Devices designed for a particular frequency should not be used at other frequencies without consulting the manufacturer.

2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

3—[rated frequency] See 1.2.

**4.2.14 rated short-time withstand current:** The designated maximum value in rms amperes that is assigned to a device regarding its ability to withstand the electromagnetic forces and/or heat that is generated during short-circuit conditions. When tested as specified, the device shall be capable of successfully withstanding its assigned ratings. These ratings are normally provided in rms symmetrical amperes for 15-cycle and 3-second short-time tests and in rms asymmetrical amperes for momentary short-time tests and under specified circuit conditions.

NOTES

1—These values are the maximum value of current that the device is capable of withstanding for the specified duration and should not be exceeded without consulting the manufacturer.

2—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

3—[short-time current rating] See 1.2.

**4.2.15 rated 3-second withstand current:** The designated maximum value in rms amperes that is assigned to a device regarding its ability to withstand the heat that is generated during long time short-circuit conditions. When tested as specified, the device shall be capable of successfully withstanding its assigned rating. These ratings are normally provided in rms symmetrical amperes and have specified circuit conditions.

NOTES

1—This value is the maximum value of current that the device is capable of withstanding and should not be exceeded without consulting the manufacturer.

2—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

3—[3-second current rating] See 1.2.

**4.2.16 rating; rated:** A qualifying term that when applied to an operating characteristic indicates the designated limit(s) of the characteristic for application under specific conditions.

NOTES

1—Typical uses are for characteristics such as maximum voltage, continuous current, maximum and minimum interrupting current, frequency, and other operating characteristics.

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2—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.2.17 slant-voltage rating (of a distribution cutout):** A pair of maximum voltage ratings assigned to a distribution cutout intended primarily for application on three-phase solidly grounded neutral (multigrounded) systems where construction conditions are such that two cutouts will normally operate in series to clear phase-to-phase faults. In applying these cutouts, the system line-to-line voltage must be equal to or less than the maximum voltage rating to the right of the slant (/), and the system line-to-ground voltage must be equal to or less than the maximum voltage rating to the left of the slant (/). For application in other systems, and for more complete application guidance, refer to IEEE Std C37.48-1997.

NOTES

1—Slant-voltage rated cutouts may be used in single-phase applications where the power-frequency recovery voltage across the cutout does not exceed the maximum voltage rating to the left of the slant (/).

2—[multiple-voltage rating (of a distribution cutout)] See 1.2.

## 4.3 Tests

**4.3.1 conformance tests:** Those tests that are specifically made to demonstrate the conformity of switchgear or its component parts with applicable standards.

NOTE—While this term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

**4.3.2 design tests:** Those tests made to determine the adequacy of a particular type, style, or model of equipment with its component parts to meet its assigned ratings and to operate satisfactorily under normal service conditions or under special conditions if specified.

NOTE—Design tests are made only on representative apparatus to substantiate the ratings assigned to all other apparatus of basically the same design. These tests are not intended to be used as a part of normal production. The applicable portion (part) of these design tests may also be used to evaluate modifications of a previous design and to assure that performance has not been adversely affected. Test data from previous similar designs may be used for current designs, where appropriate.

**4.3.3 dielectric withstand-voltage tests:** Tests made to determine the ability of insulating materials and spacings to withstand specified overvoltages for a specified time without flashover or puncture.

**4.3.4 interrupting tests:** Tests that are made to determine or check the current-interrupting performance of a device.

**4.3.5 load-break tests:** Tests that consist of manual or remote-control opening of a device, which is provided with a means for breaking load, while the device is carrying a prescribed current under specified conditions. *Syn:* **load-interrupting tests.**

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.3.6 making-current tests:** Tests that consist of manual or remote-control closing of the device against a prescribed current.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.3.7 radio-influence tests:** Tests that consist of the application of voltage and the measurement of the corresponding radio-influence voltage produced by the device being tested.

**4.3.8 routine tests:** Those tests made to check the quality and uniformity of the workmanship and materials used in the manufacture of switchgear or its components. *Syn:* **production tests.**


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**4.3.9 short-time current tests:** Tests that consist of the application of a current higher than the rated continuous current for specified short periods to determine the adequacy of the device to withstand short-circuit currents for the specified short time.

NOTE—At the time this standard, IEEE Std C37.40-2003, was approved, there was no corresponding definition in IEEE Std C37.100-1992.

**4.3.10 temperature-rise tests:** Tests to determine the temperature rise, above ambient, of various parts of the tested device when subjected to specified test quantities.

NOTES

1—The test quantities may be rated continuous current, allowable continuous current, etc.

2—Values for various types of devices are shown in Table 1.

**4.3.11 time-current tests:** Tests that consist of the application of current to determine the relation between the rms alternating current and the time for the fuse to perform the whole or some specified part of its interrupting function.

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# Annex A

(informative)

## Altitude correction factors (historical)

Altitude corrections factors have been removed from this standard due to the current controversy regarding their use, particularly in the range of sea level to 1000 m. This standard will adopt the recommendations of the Common Clause Working Group when the recommendations become an IEEE standard (see Annex B for the present Working Group Draft Recommendations). This standard contains no ambient temperature recommendations, such as have been used historically for fuse products. The following paragraphs and table present the altitude correction factor information from IEEE Std C37.40-1993 [B3].

Correction factors for dielectric strength and rated continuous current are given in columns 1 and 2 of Table A.1.

Equipment designed for standard temperature use may be used at its normal rated continuous current without exceeding ultimate standard temperature limits provided that the ambient temperature does not exceed the maximum ambient temperature assigned to the device, in accordance with 3.1, multiplied by the appropriate factor specified in column 3 of Table A.1.

**Table A.1—Altitude correction**

| Altitude above sea level | | Altitude correction factor to be applied to | | |
|---|---|---|---|---|
| | | Dielectric strength | Rated continuous current | Ambient temperature |
| Meters | Feet | 1 | 2 | 3 |
| 1000 | 3300 | 1.00 | 1.00 | 1.00 |
| 1200 | 4000 | 0.98 | 0.99 | 0.992 |
| 1500 | 5000 | 0.95 | 0.99 | 0.980 |
| 1800 | 6000 | 0.92 | 0.98 | 0.968 |
| 2100 | 7000 | 0.89 | 0.98 | 0.956 |
| 2400 | 8000 | 0.86 | 0.97 | 0.944 |
| 2700 | 9000 | 0.83 | 0.96 | 0.932 |
| 3000 | 10 000 | 0.80 | 0.96 | 0.920 |
| 3600 | 12 000 | 0.75 | 0.95 | 0.896 |
| 4300 | 14 000 | 0.70 | 0.93 | 0.872 |
| 4900 | 16 000 | 0.65 | 0.92 | 0.848 |
| 5500 | 18 000 | 0.61 | 0.91 | 0.824 |
| 6100 | 20 000 | 0.56 | 0.90 | 0.800 |

NOTE—Use one correction factor from columns 2 or 3, but not both, for any one application. If the derating, as determined from the table, is significant, equipment of suitable higher rating should be chosen to meet requirements after the correction factor has been applied.


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# Annex B

(informative)

# Altitude correction factors (from proposed common specifications standard)

## B.1 Introduction

Altitude corrections factors have been removed from this standard due to the current controversy regarding their use, particularly in the range of sea level to 1000 m. Altitude correction factors are being studied by the Switchgear Committee and will be adopted by issuance of a supplement or revision to this standard when they are approved. At that time, this informative annex will be removed. The following information presents the altitude correction factor proposal from the initial draft of IEEE PC37.100.1 [B1]. The information is provided for reference only.

## B.2 Altitude correction factors

Most switchgear is tested with reference to normal temperature and pressure at sea level (NTP) (25 °C, 298 °K, and 101.3 kPa, 1013 mbar). An added safety factor allows normal use at altitudes up to 1000 m. For installation of switchgear, rated for up to 1000 m, at altitudes above 1000 m, the insulation level of external insulation under the standardized reference atmospheric conditions shall be determined by multiplying the insulation withstand voltages by a factor K.

There is no requirement to confirm the test at the required altitude.

— The factor K for the required increase in insulation withstand rating for equipment already rated for up to 1000 m is $K = e^{(M(H-1000)/8150)}$

— The factor K for the required decrease in insulation withstand rating for equipment already rated for up to 1000 m is $K = (1/K_{1000\ m})$ in accordance with Figure B.1 and Table B.2.

NOTES

1—Switchgear rated for up to 1000 m will also be capable of higher withstand voltage when used at less than 1000 m.

2—For insulation not exposed to ambient atmospheric pressure, the dielectric characteristics are identical at any altitude and no special precautions need to be taken.

3—For low-voltage auxiliary and control equipment, no special precautions need to be taken if the altitude is 2000 m or less. For higher altitude, see IEEE Std C37.20.1™-2002 [B2].

4—Figure B.1 is based on M = 1 for power frequency, lighting impulse, and phase-to-phase switching impulse voltages. Similar figures can be produced for

M = 0.9 for longitudinal switching impulse voltage

M = 0.75 for phase-to-ground switching impulse voltage

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**Table B.1—Correction factors**

| For correction factor starting at 1000 m | For correction factor starting at sea level |
|---|---|
| $k = e^{M(H-1000)/8150}$ | $k = e^{M(H)/8150}$ |
| H = altitude (meters)<br>M = 1 for power frequency, lightning impulse, and phase-to-phase switching impulse voltages<br>M = 0.9 for longitudinal switching impulse voltage<br>M = 0.75 for phase-to-ground switching impulse voltage | |

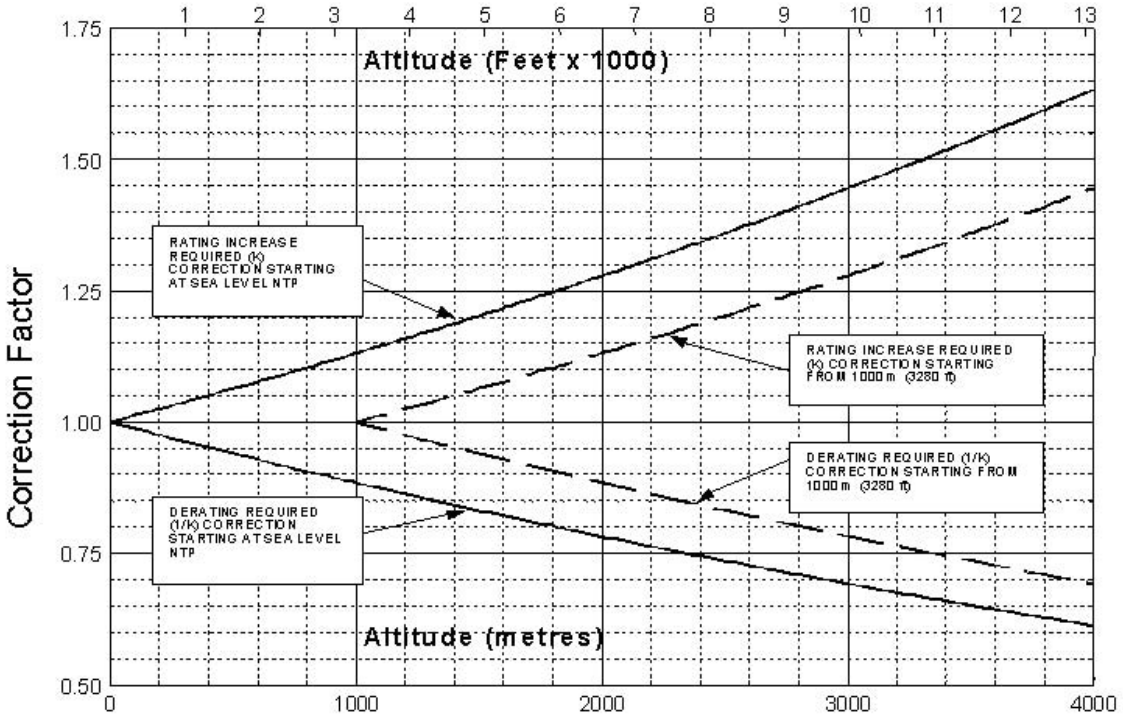


**Figure B.1—Altitude correction factors**

## B.3 Examples for switchgear with 110 kV/BIL already rated for 1000 m

*Example 1:* The required increase in voltage withstand for installation at 2000 m is shown in Equation (B.1) and Equation (B.2).

$$K_{1000\,m} = e^{M(H-1000)/8150} \tag{B.1}$$

where

e = 2.7183,
M = 1,
H = 2000.


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$$K_{1000m} = 2.7183^{1(2000-1000)/8150} = 1.131 \text{ correction factor} \quad \text{(B.2)}$$

$1.131 \times 110$ kV = 124.4 kV BIL, indicating 125 kV BIL equipment should be chosen for the required 110 kV BIL equivalent at 2000 m.

*Example 2:* The decrease in voltage withstand when installed at 2000 m for equipment rated 110 kV BIL at 1000 m is show in Equation (B.3).

$$1/K_{1000m} = (1/1.131 = 0.884) \text{ correction factor} \quad \text{(B.3)}$$

$0.884 \times 110$ kV BIL = 97.3 kV (an 11.6% reduction of safety factor)

## B.4 Examples for switchgear ratings based on 110 kV BIL withstand tests referred to sea level NTP without adjustment for 1000 meters

*Example 3:* The required increase in voltage withstand for installations at 2000 m is shown in Equation (B.4).

$$K_{NTP} = e^{M(H)/8150} \quad \text{(B.4)}$$

$$K_{NTP} = 2.7183^{1(2000)/8150}$$

$K_{NTP}$ = 1.278 correction factor; required equivalent increase

$1.278 \times 110$ kV = 140.6 kV BIL required equivalent for 2000 m when tested at sea level NTP without 1000 m safety factor.

*Example 4:* The decrease in voltage withstand at 2000 m for 110 kV BIL equipment tested at sea level is shown in Equation (B.5).

$$1/K_{NTP} = 1/1.278 = 0.782 \text{ correction factor} \quad \text{(B.5)}$$

$0.782 \times 110$ kV = 86.1 kV BIL (a reduction of 21.8% safety factor from sea level)

**Table B.2—Altitude correction factors**

| Altitude in meters (ft) | Rating increase required starting from 1000 meters (M = 1) | Derating required starting from 1000 meters (M = I) | Rating increase required starting from sea level (M = 1) | Derating required starting from sea level (M = I) |
|---|---|---|---|---|
| 0 | | | 1.000 | 1.000 |
| 500 (1641) | | | 1.063 | 0.940 |
| 1000 (3281) | 1.000 | 1.000 | 1.131 | 0.885 |
| 1500 (4923) | 1.063 | 0.940 | 1.202 | 0.832 |
| 2000 (6562) | 1.131 | 0.885 | 1.278 | 0.782 |

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**Table B.2—Altitude correction factors *(continued)***

| Altitude in meters (ft) | Rating increase required starting from 1000 meters (M = 1) | Derating required starting from 1000 meters (M = I) | Rating increase required starting from sea level (M = 1) | Derating required starting from sea level (M = I) |
|---|---|---|---|---|
| 2500 (8203) | 1.202 | 0.832 | 1.359 | 0.736 |
| 3000 (9843) | 1.278 | 0.782 | 1.445 | 0.692 |
| 3500 (11,484) | 1.359 | 0.736 | 1.536 | 0.651 |
| 4000 (13,124) | 1.445 | 0.692 | 1.634 | 0.612 |

NOTES

1—At a 1000 m application altitude, if not already rated for 1000 m, there is a 13.1% increase in withstand requirement or an 11.5% decrease in withstand capability from sea level NTP rating.

2—For normal variations in barometric pressure and temperature due to weather change, the above formulas can be averaged. Where extreme weather and barometric pressure changes occur, the altitude correction factor may need to be adjusted.


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# Annex C

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# Bibliography

[B1] IEEE PC37.100.1/D1.2, Draft Standard Common Specifications for Switchgear.[7]

[B2] IEEE Std C37.20.1-2002, IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

[B3] IEEE Std 37.40-1993, IEEE Standard Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.

[7]This IEEE standards project was not approved by the IEEE-SA Standards Board at the time this publication went to press. For information about obtaining a draft, contact the IEEE.

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