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# ANSI C37.47-2000
## (Revision of ANSI C37.47-1981 (R1992)

# American National Standard

## For High Voltage Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches

**ANSI C37.47-2000**
Revision of
ANSI C37.47-1981 (R1992)

American National Standard

# For High Voltage Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches

Secretariat:
**Institute of Electrical and Electronics Engineers**
**National Electrical Manufacturers Association**

Approved May 3, 2000
**American National Standards Institute, Inc.**

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# Contents



 

**Tables**

## **Foreword** (This Foreword is not part of American National Standard C37.47-2000)

This standard is a revision of American National Standard Specifications for Distribution Fuse Disconnecting Switches, Fuse Supports, and Current-Limiting Fuses, ANSI C37.47-1981, to bring it up to date and in line with present day requirements for high-voltage current-limiting type distribution class fuses, and fuse disconnecting switches.

This standard was prepared by the NEMA High Voltage Fuse Technical Committee with cooperation from the IEEE Subcommittee on High Voltage Fuses. Liaison was maintained with Edison Electric Institute (EEI) and International Electrotechnical Commission (IEC) during the development of the revisions in order to incorporate the latest thinking up to the time of publication.

This standard 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, ANSI/IEEE C37.40-1993, IEEE ANSI/IEEE C37.41-2000, plus the additional standard covering that device, constitute a complete standard for the device. In addition, ANSI/IEEE C37.48-1997 is an application, operation, and maintenance guide for all the devices.

The following standards make up this series:

ANSI/IEEE C37.40-1993, Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

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

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

ANSI C37.45-2000, Specifications for High Voltage Distribution Class Enclosed Single-Pole Air Switches

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

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

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

Suggestions for improvement of this standard will be welcome. They should be sent to the National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee on Power Switchgear, C37. Committee approval of the standard does not necessarily imply that all the committee members voted for its approval. At the time it approved this standard, the C37 Committee had the following members:

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|---|---|
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# For High Voltage Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches

## 1 General Scope

This standard establishes specifications for high voltage (above 1000 volts) distribution class current limiting type fuses and associated accessories. All of these devices are intended for use on alternating current systems. These specifications apply to the following specific types of equipment:

a) Distribution class current limiting type fuses and fuse units.

b) Distribution class current-limiting fuse disconnecting switches.

c) Items (a) thru (b) used in fuse enclosure packages (FEP) (see types listed in Clause 1.1 below)

d) Fuse supports, fuse units, refill units and fuse mountings of the type used exclusively with distribution class current limiting type fuses, and fuse disconnecting switches.

e) Removable switch blades of the type used exclusively with distribution class current limiting type fuses, and fuse disconnecting switches.

Note: Some of the distribution class current-limiting type fuses listed above are similar to those now covered in IEC Standard 60282-1. This ANSI standard contains specific requirements for more types of current-limiting fuses than IEC 60282-1. Use caution if devices specified and tested per ANSI/IEEE standards are compared to those specified and tested per IEC standards as they may or may not be the same.

In the headings and the text of this document there will be some areas where information is included in brackets []. The information in the brackets is a term used in IEC standards that may be similar to the term we are using, a term that is common in some parts of the world, or is a term that has been used previously in ANSI and IEEE standards. Caution is again advised when making comparisons.

### 1.1 Description of Fuse Enclosure Packages Using Current-Limiting Type Indoor Distribution Class Fuses

Type 1C A fuse mounted in an enclosure with relatively free air circulation within the enclosure. (Examples - A current-limiting type fuse mounted in a live front pad mounted transformer or in a vault.)

Type 2C A fuse mounted in a container with restricted air flow surrounding the fuse, but relatively free air circulation within the enclosure on the outside surfaces of the container. (Example - a current-limiting type fuse inside a canister in a vault.)

Type 3C A fuse mounted in a container with restricted air flow surrounding the fuse, but relatively free liquid circulation within the enclosure on the outside surfaces of the container. (Example - a current-limiting type fuse inside a canister immersed in transformer oil.)

 

Type 4C A combination of types 2 and 3, where the container is partially in air and partially in liquid. (Example - a current-limiting type fuse inside a transformer bushing.)

Type 5C A fuse mounted in an enclosure, directly immersed in liquid, with relatively free liquid circulation around the fuse. (Example - an oil immersible current-limiting type fuse in a transformer or switchgear enclosure.)

# 2 Referenced and Related Standards

## 2.1 Referenced American National Standards

This standard is intended to be used in conjunction with the following American National Standards. When these referenced standards are superseded by a revision approved by the American National Standards Institute, Inc., the revision may not apply:

ANSI/IEEE C37.40-1993, Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.

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

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

## 2.2 Other Referenced Standards

IEC 60282-1-1994, High Voltage Fuse - Part 1, Current-Limiting Fuses

# 3 General Rating Information

## 3.1 Ratings of Distribution Class Current-Limiting Type Fuse Supports and Fuse Disconnecting Switches

The ratings of distribution class current-limiting type fuse supports and fuse disconnecting switches shall be determined with tests performed using the usual service conditions defined in clause 2 of ANSI/IEEE C37.40, except where other conditions are specified, and shall include:

a) Rated maximum voltage, determined by the rating of the fuse unit or insulator(s) employed therewith (whichever is lower) and dielectric design tests specified in 4.1.

b) Rated continuous current, determined by temperature-rise design tests at rated continuous current as specified in clause 4.4.

c) Basic impulse insulation level (BIL) determined by the impulse withstand tests specified in 4.1.

## 3.2 Ratings of Fuse Units and Refill Units for Distribution Class Current-Limiting Type Fuses

The ratings of fuse units and refill units for distribution class current-limiting type fuses shall be determined with tests performed using the usual service conditions defined in clause 2 of ANSI/IEEE C37.40, except where other conditions are specified, and shall include:

 

a) Rated maximum voltages, as specified in clause 3.3.1, and determined by the current interrupting design tests specified in clause 4.2.

b) Rated continuous current, determined by the temperature-rise design tests specified in 4.4 and if applicable in accordance with the preferred ratings listed in clause 3.3.3 and the time-current-characteristics specified in clauses 5.1 and 5.2.

c) Rated frequency, as specified in clause 3.3.4.

d) Rated (maximum) interrupting current and rated minimum interrupting current as follows:

(1) Rated maximum interrupting current for fuse units and refill units as specified in clause 3.3.5 and as determined by the current interrupting design tests specified in clause 4.2.

(2) Rated minimum interrupting current, for backup current-limiting distribution fuses, as specified in clause 3.3.6 and as determined by the current interrupting tests specified in clause 4.2.

Distribution class current-limiting fuses have three different sub-classes that depend on the fuse's low current interrupting capability. The three sub-classes are backup current-limiting fuses, general-purpose current-limiting fuses and full-range current-limiting fuses. Only backup current-limiting fuses have a rated minimum interrupting current. The other two types have low current capabilities as described in their definitions. Refer to ANSI/IEEE C37.40 for the definitions of these devices.

## 3.3 Preferred Ratings and Performance Requirements For Distribution Class Current-Limiting Type Fuses and Fuse Disconnecting Switches

### 3.3.1 Rated Maximum Voltage

The preferred rated maximum voltages for future designs of fuse supports, fuse disconnecting switches, fuse units, and refill units shall be 2.8, 5.5, 8.3, 15.5, 17.2, 23.0, 27.0, 38.0 kV. Presently, there are also ratings of 21 and 22 kV being manufactured and used.

The rated voltage of a fuse support and a fuse disconnecting switch shall correspond to the rated voltage of either the fuse unit or the supporting insulator unit, whichever is lower.

### 3.3.2 Rated Continuous Current For Distribution Class Fuse Supports and Fuse Disconnecting Switches

The preferred Rated continuous current for fuse supports and fuse disconnecting switches shall be 50, 100 or 200 amperes.

### 3.3.3 Rated Continuous Current For Distribution Class Fuse Units and Refill Units

The preferred rated continuous current for fuse units and refill units shall be 6, 8, 10, 12, 15, 18, 20, 25, 30, 40, 50, 65, 80, 100, 125, 150, and 200 amperes.

### 3.3.4 Rated Frequency

The preferred rated frequency for these devices shall be 50 Hz, 60 Hz, or both.

### 3.3.5 Rated Interrupting [Breaking] Current

The preferred rated maximum symmetrical interrupting currents of fuses in rms kiloamperes shall be 12.5, 16, 20, 25, 31.5, 40, 50, 63, 80, 100, and 125.

Rated interrupting currents are selected from the R10 series of preferred numbers. The R10 series is comprised of the numbers 1, 1.25, 1.60, 2.00, 2.50, 3.15, 4.00, 5.00, 6.30, 8.00, and their multiples of 10.

#### 3.3.6 Rated Minimum Interrupting [Breaking] Current for Backup Current-Limiting Fuses

The rated minimum interrupting current for back up current-limiting type distribution class fuses shall be designated by the manufacturer.

#### 3.3.7 Rated Maximum Application Temperature [Rated Maximum Reference Ambient Temperature]

The rated maximum application temperature [rated maximum reference ambient temperature] is the maximum ambient temperature at which the device is suitable for use. The device must be capable of withstanding this temperature without any deterioration that would inhibit its ability to properly interrupt the circuit. The minimum rating allowable is 40°C. The rated maximum application temperature of the device in degrees C shall be preferably selected from the R20 series of preferred numbers (typically 40, 45, 50, 56, 63, 71 etc.). The R20 series is comprised of the numbers 1, 1.12, 1.25, 1.40, 1.60, 1.80, 2.00, 2.24, 2.50, 2.80, 3.15, 3.55, 4.00, 4.50, 5.00, 5.60, 6.3, 7.10, 8.00, 9.00, and their multiples of 10.

#### 3.3.8 Basic Impulse Insulation Level (BIL)

The preferred basic impulse insulation level of fuse supports and fuse disconnecting switches shall be as specified in Table 1.

#### 3.3.9 Performance Requirements.

##### 3.3.9.1 Performance Requirements of Distribution Class Current-Limiting Type Fuse Supports and Fuse Disconnecting Switches

The preferred performance requirements of fuse supports and fuse disconnecting switches shall include:

a) Power-frequency dry-withstand voltages for outdoor and indoor devices as specified in clause 4.1.

b) Power-frequency wet-withstand voltages for outdoor devices as specified in clause 4.1.

c) Power-frequency dew-withstand voltages for indoor devices used in fuse enclosure packages (FEP) as specified in clause 4.1.

d) Impulse withstand voltages for outdoor and indoor devices as specified in clause 4.1

e) Temperature rise as specified in clause 4.4.

f) Radio-influence voltage, as specified in 4.3.

##### 3.3.9.2 Performance Requirements of Fuse Units, Refill Units, and Fuse Links For Distribution Class Current-Limiting Type Fuses

The preferred performance requirements of fuse units and refill units for fuses shall include:

a) Melting [pre-arcing] time-current-characteristic requirements specified in clause 5 and determined as specified in clause 4.5.

b) Total clearing-time-current characteristics, determined as specified in clause 4.5.

c) Maximum peak overvoltages for current limiting fuses determined as specified in clause 4.2.2.

 

d) Peak let-through [cut-off] current characteristics, for current-limiting fuses, determined as specified in clause 4.2.3.

### 3.3.10 Ratings and Performance Requirements Other Than Preferred

Special circuit or environmental conditions may require devices with ratings or performance requirements that are different from the preferred values specified above. For these devices the ratings and the performance requirements shall be agreed upon by the user and the manufacturer.

# 4 Design Test Requirements

## 4.1 Dielectric Tests

### 4.1.1 Outdoor Distribution Class Current-Limiting Type Fuse Supports and Fuse Disconnecting Switches

Outdoor devices shall be capable of withstanding the test voltages specified in Table 2 when tested as specified in clause 5 of ANSI/IEEE C37.41.

### 4.1.2 Indoor Distribution Class Current-Limiting Type Fuse Supports and Fuse Disconnecting Switches Used In Fuse Enclosure Packages (FEP)

Indoor devices used in fuse enclosure packages shall be capable of withstanding the test voltages specified in Table 3 when tested as specified in clause 5 of ANSI/IEEE C37.41.

## 4.2 Interrupting [Breaking] Test

Distribution class current-limiting type fuses when tested as specified in clause 6 of ANSI/IEEE C37.41 shall be capable of interrupting all currents from low current up to and including the rated interrupting current of the device, with any degree of asymmetry associated with the specified X/R ratio. For current-limiting general-purpose fuses, the low current is the current that causes the fuse to melt in not less than one hour. For full-range current-limiting fuses it is the minimum test current determined for the series 3 tests and for back up fuses it is the minimum interrupting rating [minimum breaking current] assigned by the manufacturer.

### 4.2.1 Test Requirements and Test Circuit Parameters

The tests required and the test circuit parameters are as listed below:

| Device | ANSI/IEEE C37.41 | |
|---|---|---|
| | Test Clause | Tables |
| Current-limiting type distribution class fuses | 6.6 | 12 & 10 |
| Current-limiting type distribution class fuses used in air insulated, liquid filled or combination enclosure packages | 6.7 | — |
| Current-limiting type distribution class fuses used for the protection of shunt capacitors (a) | 6.10<br>(6.10.2, 6.12.3, & 6.10.4) | 10,14,15 & 16 |

(a) If these devices are used in enclosures the additional testing required for devices used in enclosures may be required.

 

### 4.2.2 Peak Overvoltage For Current-Limiting Type Distribution Class Fuses

Peak overvoltages for current-limiting type distribution class fuses, as determined in accordance with clause 6 of ANSI/IEEE C37.41, shall not exceed the values specified in Table 4.

### 4.2.3 Peak Let-Through [Cut-off] Current

Peak let-through [cut-off] current for current-limiting type distribution class fuses shall be determined as specified in clause 6 of ANSI/IEEE C37.41.

### 4.3 Radio-Influence Tests

Distribution class current-limiting type fuses, fuse supports and fuse disconnecting switches when new and clean and when tested at the point of manufacture as specified in clause 9 of ANSI/IEEE C37.41 shall be capable of meeting the limits of radio-influence voltage at the test voltage specified in Table 5.

### 4.4 Temperature Rise Tests

Current-limiting type distribution class fuses and disconnecting switches, when tested as specified in clause 11 of ANSI/IEEE C37.41, shall not exceed the temperature rise and total temperature values specified in Table 2 of ANSI/IEEE C37.40 when the device is carrying rated continuous current and the tests ambient temperature is within the allowable range specified. Fuse devices being tested shall be fused with the maximum rated fuse unit or refill unit that is used in the device being tested. Disconnecting switches shall be equipped with a disconnecting blade designed for the device or a blade recommended by the manufacturer.

NOTE: Clause 11 of ANSI/IEEE C37.41 covers testing of devices used at ambient temperatures of 40°C and below. If the fuse application involves containers, enclosures or an ambient temperature of greater than 40°C the fuse manufacturer should be consulted.

### 4.5 Time-Current Tests

The minimum melting and total clearing time-current curves for fuse units and refill units shall be determined as specified in clause 12 of ANSI/IEEE C37.41. A sufficient number of tests shall be made to ensure that all fuse units and refill units meet the melting current tolerance specified in clause 5.4.

### 4.6 Liquid Tightness Tests For Liquid Immersed Current-Limiting Type Distribution Class Fuses

Current-limiting type distribution class fuses immersed in a liquid in an enclosure shall be capable of withstanding the liquid tightness tests specified in Clause of ANSI/IEEE C37.41. Devices requiring this test are listed as type 5C in paragraph 1.1.

NOTE: If a current-limiting fuse is used in a fuse enclosure package (FEP) such as those listed in clause 1.1 types 3C and 4C, it is recommended that appropriate tests be performed to ensure that the fuse being used will not be inadvertently subjected to submersion in the liquid that surrounds the container during the containers service lifetime.

## 5 Time-Current-Characteristic Requirements For Distribution Class Current-Limiting Type Fuse Refill Units and Fuse Units

To comply with this standard, fuse refill units and fuse units are not required to meet any particular time-current characteristic. Some fuse refill units or fuse units have been designed to comply with the melting characteristics that have been designated as “C” rated. A “C” rating, specifies a range of currents that an individual fuse must melt at for one particular time. The assignment of “C” rating to a fuse does not make any particular “C” fuse interchangeable with any other particular fuse having this rating since the shape of the curves may be significantly different. The slope and shape of the melting curve is determined by the design of the current responsive element and is a distinctive feature of each manufacturer.

### 5.1 Minimum Melting and Total Clearing Time-Current Characteristics For Refill Units and Fuse Units Not Assigned a Specific Letter Designation

Refill units and fuse units are available that meet and comply with this standard except that the melting time-current-characteristics differ from the “C” types listed below, or the rated continuous current differs from that specified in clause 3.3.3 or both. The ratings and/or the time-current-characteristics for these devices provide desirable properties for many applications.

Since the current responsive element is a distinctive feature of each manufacturer, the minimum melting times and the total clearing times for these fuses shall be shown on each manufacturers published time-current-characteristic curves.

### 5.2 Melting [Pre-arcing] Time-Current-Characteristics for C-Rated Fuses

The melting-time-current-characteristics of fuse units and refill units for distribution fuses designated as C rated shall be as follows:

a) The current-responsive element shall melt in 1000 seconds at an rms current within the range of 170% to 240% of the continuous current rating of the device.

b) The minimum melting-time-current characteristics of a C rated current limiting distribution fuse at any current higher than the value of 1000 seconds shall be shown by each manufacturer's published time-current curves, since the current-responsive element is a distinctive feature of each manufacturer.

### 5.3 Identification For “C” Rated Fuse Units, Refill Units or Fuse Links

Fuse units and refill units that are identified by the letter “C shall have melting-time-current characteristics that conform to the requirements specified in clause 5.2.

### 5.4 Melting Current Tolerance

For all types of fuse units or refill units the maximum melting current shall not exceed the minimum melting current by more than 20% for any given melting time.

## 6 Conformance Tests

For all distribution class current-limiting type fuses, the conformance tests, as defined in clause 3 of ANSI/IEEE C37.40, shall consist of a power-frequency dry-withstand voltage test on the fuse support. The test shall be conducted as specified in clause 5 of ANSI/IEEE C37.41.

## 7 Nameplate Marking

### 7.1 Fuse Supports or Fuse Disconnecting Switches

The following minimum information shall be placed on the fuse supports or fuse disconnecting switches:

a) Manufacturer's name or trademark (or monogram).

b) Manufacturer's type or other product identification.

c) Rated continuous current (maximum or, if limited, minimum sizes of fuse units or refill units to be used).

d) Rated maximum voltage.

e) Basic impulse insulation level (BIL).

### 7.2 Fuse Units or Refill Units

The following minimum information shall be placed on the fuse units, refill units, or on the shipping containers. The minimum information that shall appear on the fuse units and refill units is indicated by an asterisk (*).

a) Manufacturer's name or trademark (or monogram). (*)

b) Manufacturer's type or other product identification of the fuses, fuse supports or disconnecting switches for which the fuse units or refill units are designed.

c) Manufacturer's type or identification letter for the fuse unit, refill unit or fuse link. This identification shall follow the rated continuous current marking (C, where applicable). (*)

d) Rated continuous current. (*)

e) Rated maximum voltage. (*)

f) Rated (maximum) interrupting current. (*)

g) Rated minimum interrupting current (for backup current-limiting type distribution class fuses only)

h) Rated frequency.

## 8 Application Requirements

See ANSI/IEEE C37.48 and ANSI/IEEE C37.48.1 for general application guidelines.

### 8.1 Effects of Ambient Temperature on a Fuse

#### 8.1.1 Rated Maximum Application Temperature

Fuses which are designed for outdoor use and tested to IEEE Standard C37.41, and this standard, are suitable for continuous use in an ambient temperature of up to 40°C. However, the standards also include fuses for use in enclosures, some of which subject the fuse to higher temperatures or other conditions which require additional testing. Fuses designed and tested for use in enclosures are assigned a Rated Maximum Application Temperature (RMAT) [maximum reference ambient temperature], which must be at least 40°C. A current-limiting fuse in a fuse enclosure package (FEP) has to demonstrate successful current interruption at the RMAT assigned by the FEP manufacturer. In-air expulsion fuses used in enclosures are also required to demonstrate successful interruption in such enclosures. The tests are performed at normal test ambient temperature (between 10°C and 40°C) if the assigned RMAT is 55°C or less, and at the RMAT if it is higher than 55°C. The rated maximum application temperature is thus the highest ambient temperature of the fluid in contact with the fuse or FEP for which the manufacturer rates the device as being suitable for interrupting current. The elevated ambient temperature may be caused by factors, or a combination of factors, such as solar heating, heat from the fuse and/or other equipment in the enclosure, or restriction of cooling fluid by the enclosure. It is important to note that if a fuse is used in an ambient temperature higher than its RMAT, it may not interrupt the current when its element(s) melt.

### 8.1.2 Rated Continuous Current and Allowable Continuous Current

Fuses designed and tested to current standards are required to carry a current at least equal to their rated continuous current in an ambient temperature of up to 40°C without exceeding the maximum temperatures specified in Table 2 of ANSI/IEEE C37.40. It should be noted, however, that some older designs of expulsion fuses use an ambient temperature of 30°C as a basis for their rated continuous current. Fuses may not be able to carry this current (nameplate rating or rating marked on the fuse) if they are used in some form of enclosure, or if the ambient temperature is over 40°C (30°C for some older designs). The current a fuse can carry continuously under these different circumstances, without exceeding the specified temperatures, is defined as its allowable continuous current. This current is linked to a specific ambient temperature. Such a rating, when the fuse is a part of an FEP, should be available from the FEP manufacturer, or often the fuse manufacturer. It would normally be in the form of de-rating (re-rating) factors applied to the fuse's rated continuous current, and will allow for the effect of enclosure and/or ambient temperature. Alternatively, a table of current ratings related to temperature may be supplied.

In some cases, the RMAT assigned to a fuse may be higher than the maximum temperatures permitted in Table 2 of ANSI/IEEE C37.40. This is because it may be anticipated that, in practice, the RMAT will occur in equipment experiencing severe overload or failure conditions. In this case, the fuse cannot be assigned an allowable continuous current at its RMAT, since the permitted temperatures would be exceeded even without taking into account any temperature rise caused by current in the fuse. It cannot, therefore, be assumed that a fuse will have an allowable continuous current at its RMAT. In some cases, fuses will only be assigned such a current rating at a lower temperature where they would be expected to operate continuously.

There are some circumstances under which a fuse may be required, and is able, to carry a particular continuous current at some ambient temperature, or in an enclosure, which produces temperatures in excess of those specified in Table 2 of ANSI/IEEE C37.40. In this case, the application should be by agreement between the manufacturer and user. It is worth noting that some of these temperatures are based on spring contact temperatures in air, while fuses in enclosures may use bolted contacts and/or contacts in fluid, which may allow for successful operation at higher temperatures.

### 8.1.3 Time Current Characteristics

The time current characteristic (TCC) curve of a fuse is determined at 25°C ± 5°C. Ambient temperatures that differ from this may cause a shift in the TCC, with higher temperatures causing the fuse to melt faster for a given current. Other factors that can affect the TCC include changes in heat transfer caused by an enclosure or container and the type of cooling medium (for example air or oil). The degree of change to a fuse's TCC is a function of the individual fuse design, and is different for different types of fuse. When the fuse is a part of an FEP, details of the resulting effect on the TCC should be available from the FEP manufacturer. It is normally in the form of multiplying factors applied to the fuse's TCC allowing for the effect of the enclosure and/or ambient temperature. The most significant area of concern is usually change to the long time melting characteristics of fuses, since this may change the way a fuse is affected by an overload. This is usually of significance to general-purpose and full-range current-limiting fuses, while the change in TCC is usually much less significant for backup fuses.

### 8.1.4 Fuse Selection

The effects of ambient temperatures less than 25°C generally do not have to be considered, as these temperatures produce longer melting times than those shown on the minimum melting TCC curves, and the operating temperatures are less than those obtained during the temperature rise tests. In most applications between 25°C and 40°C, the effects of ambient temperature do not have to be considered since the decrease in melting current is generally less than 5% and most coordinating margins are greater than this. However, if a fuse is to be used at an ambient temperature over 40°C, or in an FEP, it is important to assess the effect of the environment on the fuse. The actual maximum application temperature should be compared to the fuse's RMAT and the effect on current rating and TCC are also relevant. It is important that conditions are not such as to cause deterioration of the fuse and associated components; an example of such a condition would be overloading backup and general-purpose current limiting fuses, and some types of expulsion fuse. It is also very important to ensure that changes in the fuse's TCC do not result in a fuse being called upon to interrupt a current for which it is not designed and tested. Attention should, therefore, be given to fuse coordination under all anticipated ambient temperature conditions. In ANSI/IEEE C37.48 there is some discussion concerning the use of de-rating factors for a current-limiting fuse's TCC when the fuse is used in a container or enclosure.

 

## 8.2 Paralleling of Fuses

Distribution class current-limiting fuses should not be paralleled unless they have been tested in parallel. Parallel fuses should be considered a separate design and tested accordingly. Consult the manufacturer for this application.

**Table 1 – Basic impulse insulation level for distribution class current-limiting type fuse supports and fuse disconnecting switches**

| Rated Maximum Voltage (kV, rms) (b) | Basic Impulse Insulation Level (BIL) (a) (kV, crest) | |
|---|---|---|
| 2.8 | 60 | 45 |
| 5.5 | 75 | 60 |
| 8.3 | 95 | 75 |
| 15.5 - 17.2 | 110 | 95 |
| 23.0 (21-22) | 150 | 125 |
| 27.0 | 150 | 125 |
| 38.0 | 200 | - |

NOTES – (a) Two standard values have been established for each voltage rating.
(b) See clause 3.3.1.

**Table 2 – Minimum dielectric withstand test voltage for outdoor distribution class current-limiting type fuse supports for fuse disconnecting switches (a)**

| BIL | Terminal-to-Ground Withstand Voltage | | | Terminal-to-Terminal Withstand Voltage | |
|---|---|---|---|---|---|
| | Normal-Frequency Dry Test, 1 min (kV, rms) | Normal-Frequency Wet Test, 10 seconds* (kV, rms) | Impulse Test, 1.2 x 50 microseconds (kV, crest) | Normal-Frequency Dry Test, 1 min (kV, rms) | Impulse Test, 1.2 x 50 microseconds (kV, crest) |
| 45 | 15 | 13 | 45 | 15 | 45 |
| 60 | 21 | 20 | 60 | 21 | 60 |
| 75 | 27 | 24 | 75 | 27 | 75 |
| 95 | 35 | 30 | 95 | 35 | 95 |
| 110 | 50 | 45 | 110 | 50 | 110 |
| 125 | 42 | 36 | 125 | 42 | 125 |
| 150 | 70 | 60 | 150 | 70 | 150 |
| 200 | 95 | 80 | 200 | 95 | 200 |

NOTE – (a) Normal-Frequency wet-withstand voltages on the insulators, which meet these values, will be satisfactory in lieu of this test, provided the design of the complete device does not decrease the normal frequency withstand test voltages of the insulators.

**Table 3 – Minimum dielectric withstand test voltage for indoor distribution class current-limiting type fuse supports and fuse disconnecting switches (a)**

| | Terminal-to-Ground Withstand Voltage | | | Terminal-to-Terminal Withstand Voltage | |
|---|---|---|---|---|---|
| BIL | Normal-Frequency Dry Test, 1 min (kV, rms) | Normal-Frequency Dew Test, 10 seconds* (kV, rms) | Impulse Test, 1.2 x 50 microseconds (kV, crest) | Normal-Frequency Dry Test, 1 min (kV, rms) | Impulse Test, 1.2 x 50 microseconds (kV, crest) |
| 45 | 15 | 10 | 45 | 15 | 45 |
| 60 | 19 | 15 | 60 | 19 | 60 |
| 75 | 26 | 24 | 75 | 26 | 75 |
| 95 | 35 | 26 | 95 | 35 | 95 |
| 110 | 50 | 30 | 110 | 50 | 110 |
| 125 | 42 | 28 | 125 | 42 | 125 |
| 150 | 60 | 40 | 150 | 60 | 150 |
| 200 | 95 | 80 | 200 | 95 | 200 |

NOTE – (a) Normal-Frequency dew-withstand voltages on the insulators, which meet these values, will be satisfactory in lieu of this test, provided the design of the complete device does not decrease the normal frequency withstand test voltages of the insulators

**Table 4 – Maximum Permissible Overvoltages for Current-Limiting Type Distribution Class Fuses**

| | Maximum Peak Overvoltage (kV, crest) | |
|---|---|---|
| Rated Maximum Voltage (kV, rms) (a) | Through 12 Amperes | Over 12 Amperes |
| 2.8 | 13 | 9 |
| 5.5 | 25 | 18 |
| 8.3 | 38 | 26 |
| 15.5 - 17.2 | 70 | 49 |
| 23.0 (21-22) | 105 | 72 |
| 27.0 | 123 | 84 |
| 38.0 | 173 | 119 |

NOTE – (a) See clause 3.3.1.

**Table 5 – Radio-Influence Voltage**

| Rated Maximum Voltage (a) (kV, rms) | Test Voltage (b) (volts) | Limit of Radio - Influence Voltage (µV at 1 MHz) |
|---|---|---|
| 2.8 | 3 000 | 250 |
| 5.5 | 5 800 | 250 |
| 8.3 | 8 700 | 250 |
| 15.5 – 17.2 | 16 300 | 250 |
| 23.0 (21-22) | 24 000 | 250 |
| 27.0 | 23 000 | 250 |
| 38.0 | 23 000 | 250 |

NOTES –

(a) See clause 3.3.1.

(b) For rated maximum voltages of 2.6 kV through 23.0 kV, the test voltages are based on the possibility of line to ground application at the devices rated maximum voltage. For rated maximum voltages of 27.0 kV through 38.0 kV, the test voltages are based on line-to-line applications with voltages equal to or less than the devices rated maximum voltage. If these devices are applied line-to-ground, the system voltage should be less than 23.0 kV. If the device is designed to be applied in line-to-ground applications at its rated maximum voltage, the test voltage shall be 1.05 times the rated maximum voltage.