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IEEE Std C37.48b-1997, IEEE Std C37.48c-1991,  
and C37.48d-1997)

# IEEE Guide for the Application, Operation, and Maintenance of High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

Sponsor  
**Switchgear Committee  
of the  
IEEE Power Engineering Society**

Co-Secretariats

**The Institute of Electrical and Electronics Engineers, Inc.  
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**Abstract:** Information on the application, operation, and maintenance of high-voltage fuses (above 1000 V), distribution enclosed single-pole air switches, fuse disconnecting switches, and accessories for use on ac distribution systems is provided. This guide is one of a series of complementary standards covering various types of high-voltage fuses and switches, so arranged that two of the standards apply to all devices while each of the other standards provides additional specifications for a particular device. For each device, IEEE Std C37.40-1993, IEEE Std C37.41-1994, plus the standard covering that device, constitute a complete set of standards for each device. In addition, IEEE Std C37.48-1997 is an application, operation, and maintenance guide for all the devices.

**Keywords:** current-limiting fuses, distribution class fuses, expulsion type fuses, fuse enclosure packages, fuses, power class fuses

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## Introduction

(This introduction is not part of IEEE Std C37.48-1997, IEEE Guide for the Application, Operation, and Maintenance of High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.)

This guide is a revision of ANSI/IEEE Std C37.48-1987 to bring it up to date and in line with present day requirements for high-voltage fuses and switches. The addition of guidelines for full-range current-limiting fuses, expulsion fuses in enclosures, and external fuses for shunt capacitors broadens its applicability. Information formerly included on the testing of current-limiting fuses in enclosures now appears in IEEE Std C37.41-1994.

This guide was prepared by the IEEE Subcommittee on High-Voltage Fuses with cooperation from the National Electrical Manufacturers Association (NEMA). Liaison was maintained with the Edison Electric Institute (EEI) and the International Electrotechnical Commission (IEC) during the development in order to incorporate the latest thinking up to the time of publication.

This guide is one of a series of complementary standards covering various types of high-voltage fuses and switches, so arranged that two of the standards apply to all devices while each of the other standards provides additional specifications for a particular device. For each device, IEEE Std C37.40-1993, IEEE Std C37.41-1994, plus the standard covering that device, constitute a complete set of standards for each device. In addition, IEEE Std C37.48-1997 is an application, operation, and maintenance guide for all the devices.

The following standards comprise this series:

ANSI C37.42-1995, American National Standard Specifications for Distribution Cutouts and Fuse Links.

ANSI C37.44-1981 (R1992), American National Standard Specifications for Distribution Oil Cutouts and Fuse Links.

ANSI C37.45-1981 (R1992), American National Standard Specifications for Distribution Enclosed Single-Pole Air Switches.

ANSI C37.46-1981 (R1992), American National Standard Specifications for Power Fuses and Fuse Disconnecting Switches.

ANSI C37.47-1981 (R1992), American National Standard Specifications for Distribution Fuse Disconnecting Switches, Fuse Supports, and Current-Limiting Fuses.

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

IEEE Std C37.41-1994, IEEE Standard Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories (ANSI).

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

Work on the added material on external capacitor fuses began in 1981 to fill a void in fuse standards and is being published for the first time in this revision of IEEE Std C37.48.

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| CLAUSE                                                                                                                                        | PAGE |
|-----------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1. Overview .....                                                                                                                             | 1    |
| 1.1 Scope.....                                                                                                                                | 1    |
| 1.2 Description of fuse-enclosure packages (FEPs) using expulsion type indoor power class fuses .....                                         | 2    |
| 1.3 Description of FEPs using current-limiting type indoor distribution and power class fuses.....                                            | 2    |
| 2. References.....                                                                                                                            | 2    |
| 2.1 American National Standards .....                                                                                                         | 2    |
| 2.2 Other standards .....                                                                                                                     | 3    |
| 3. General application guidelines for all fuse types .....                                                                                    | 3    |
| 3.1 Introduction.....                                                                                                                         | 3    |
| 3.2 Service conditions .....                                                                                                                  | 4    |
| 3.3 Selection of class and type of fuse .....                                                                                                 | 4    |
| 3.4 Clearances and spacing .....                                                                                                              | 5    |
| 3.5 Fuse position .....                                                                                                                       | 6    |
| 3.6 Noise level.....                                                                                                                          | 6    |
| 3.7 Selection of fuse voltage rating (see 4.4.2.2 and 4.4.3.2 for specific guidelines for voltage rating selection for capacitor fuses) ..... | 6    |
| 3.8 Selection of continuous-current rating (all applications except capacitor fuses and fuses used in enclosures—see 4.2, 4.3 and 4.4) .....  | 8    |
| 3.9 Selection of interrupting rating .....                                                                                                    | 9    |
| 3.10 Fuse coordination procedure.....                                                                                                         | 10   |
| 3.11 Coordination for motor starter fuses (motor protection).....                                                                             | 10   |
| 4. Additional application guidelines for specific devices .....                                                                               | 11   |
| 4.1 Current-limiting fuses .....                                                                                                              | 11   |
| 4.2 Current-limiting fuses used in FEPs .....                                                                                                 | 15   |
| 4.3 Expulsion fuses in enclosures .....                                                                                                       | 16   |
| 4.4 External fuses for shunt capacitors .....                                                                                                 | 17   |
| 5. Operation guidelines for various fuse types.....                                                                                           | 30   |
| 5.1 Use of nonexpendable cap on expendable-cap cutouts.....                                                                                   | 30   |
| 5.2 Operating speed.....                                                                                                                      | 30   |
| 5.3 Locking or latching of fuses, blades, or links in closed position .....                                                                   | 30   |
| 5.4 Fuseholder position .....                                                                                                                 | 30   |
| 5.5 Voltage withstand of blown fuses .....                                                                                                    | 30   |
| 5.6 Replacement and handling of fuses .....                                                                                                   | 30   |
| 5.7 Replacement of exhaust control device .....                                                                                               | 31   |
| 5.8 Operation of energized fuses.....                                                                                                         | 31   |
| 5.9 Storing spare fuse units and replaceable parts .....                                                                                      | 32   |
| 6. Additional operation guidelines for specific devices.....                                                                                  | 32   |
| 6.1 Capacitor fuses.....                                                                                                                      | 32   |
| 6.2 Liquid-submerged expulsion fuses in enclosures .....                                                                                      | 32   |

| CLAUSE                                                         | PAGE |
|----------------------------------------------------------------|------|
| 7. Maintenance for all fuse types .....                        | 33   |
| 7.1 Safety precautions .....                                   | 33   |
| 7.2 Frequency of maintenance .....                             | 33   |
| 7.3 Inspection of fuse or switching device.....                | 33   |
| 7.4 Inspection of fuse links in distribution cutouts .....     | 34   |
| 8. Additional maintenance guidelines for specific devices..... | 34   |
| 8.1 Capacitor fuses .....                                      | 34   |
| 8.2 Liquid-submerged expulsion fuses in enclosures .....       | 34   |
| 8.3 Distribution oil cutouts (inspection) .....                | 35   |



# IEEE Guide for the Application, Operation, and Maintenance of High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

## 1. Overview

This guide presents information on the application, operation, and maintenance of high-voltage fuses (above 1000 V), distribution enclosed single-pole air switches, fuse disconnecting switches, and accessories for use on ac distribution systems.

### 1.1 Scope

These guidelines apply to the following specific types of equipment:

- a) Distribution and power class expulsion type fuses;
- b) Distribution and power class current-limiting type fuses;
- c) Distribution and power class fuse disconnecting switches;
- d) Items a) through c) used in fuse-enclosure packages (see types listed in 1.2 and 1.3);
- e) Fuse supports, fuse mountings, and fuse hooks, of the type intended for use with distribution and power class fuses, and fuse disconnecting switches;
- f) Removable switch blades of the type used exclusively with distribution class oil cutouts, power class fuses, and distribution class fuse disconnecting switches;
- g) Fuse links of the type used exclusively with distribution class oil cutouts, power class fuses, and distribution class fuse disconnecting switches;
- h) Distribution class oil cutouts;
- i) Distribution class enclosed single-pole air switches; and
- j) Distribution and power classes of expulsion, current-limiting and combination external capacitor fuses used with a capacitor unit, groups of units, or capacitor banks.

NOTE — The distribution and power class expulsion type fuses listed above are the same as those covered in IEC 60282-2<sup>1</sup>. The distribution class fuses are the same as class “A” fuses in that document and the power class fuses are the same as the class “B” fuses. At present IEEE standards do not cover the class “C” fuses. Some of the power and distribution class current-limiting fuses listed above are the same as those covered in IEC 60282-1.

## 1.2 Description of fuse-enclosure packages (FEPs) using expulsion type indoor power class fuses

- *Type 1E*: A fuse mounted in an enclosure with relatively free air circulation within the enclosure (for example, an expulsion fuse mounted in an enclosure or in a vault)
- *Type 2E*: A fuse mounted in a container with restricted air flow surrounding the fuse, but relatively free air circulation within the enclosure on the outside of the container (for example, an expulsion fuse in an enclosure with insulating barriers that form a container that restricts the airflow)
- *Type 3E*: A fuse mounted in an enclosure, directly immersed in liquid, with relatively free liquid circulating around the fuse (for example, an expulsion fuse in a switchgear enclosure)

## 1.3 Description of FEPs using current-limiting type indoor distribution and power class fuses

- *Type 1C*: A fuse mounted in an enclosure with relatively free air circulation within the enclosure (for example, a 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 with relatively free air circulation within the enclosure on the outside surfaces of the container (for example, a 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 circulating within the enclosure on the outside surfaces of the container (for example, a fuse inside a canister immersed in transformer oil)
- *Type 4C*: A combination of types 2C and 3C, where the container is partially in air and partially in liquid (for example, a 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 (for example, an oil immersed fuse in a transformer or switchgear enclosure)

## 2. References

### 2.1 American National Standards

When the following standards are superseded by an approved revision, the revision may not apply.

ANSI C37.42-1995, American National Standard Specifications for Distribution Cutouts and Fuse Links.<sup>2</sup>

ANSI C37.44-1981 (R1992), American National Standard Specifications for Distribution Oil Cutouts and Fuse Links.

ANSI C37.45-1981 (R1992), American National Standard Specifications for Distribution Enclosed Single-Pole Air Switches.

ANSI C37.46-1981 (R1992), American National Standard Specifications for Power Fuses and Fuse Disconnecting Switches.

<sup>1</sup>For information on references, see Clause 2.

<sup>2</sup>ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

ANSI C37.47-1981 (R1992), American National Standard Specifications for Distribution Fuse Disconnecting Switches, Fuse Supports, and Current-Limiting Fuses.

IEEE Std 18-1992, IEEE Standard for Shunt Power Capacitors.<sup>3</sup>

IEEE Std 1036-1992, IEEE Guide for Application of Shunt Power Capacitors (ANSI).

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

IEEE Std C37.41-1994, IEEE Standard Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories (ANSI).

IEEE Std C37.99-1990 (Reaff 1994), IEEE Guide for the Protection of Shunt Capacitor Banks (ANSI).

IEEE Std C37.100-1992, IEEE Standard Definitions for Power Switchgear (ANSI).

NEMA CP1-1988 (R1992), Shunt Capacitors.<sup>4</sup>

## 2.2 Other standards

IEC 60282-1 (1994-12), High-voltage fuses—Part 1: Current-limiting fuses.<sup>5</sup>

IEC 60282-2 (1995-09), High-voltage fuses—Part 2: Expulsion fuses.

## 3. General application guidelines for all fuse types

### 3.1 Introduction

The application, operation, and maintenance of equipment covered by this guide is the responsibility of the user, who is expected to take into account his or her own particular requirements. As an aid in obtaining satisfactory performance of equipment, this guide provides information on some of the more important features of the above functions for normal conditions of service; unusual conditions may require special measures.

Although fuses are single-phase devices, they can be applied with single- or three-phase equipment or lines, or a combination of these. However, characteristics of the power system should be considered when selecting all fuses.

A fuse, when applied in an electric circuit within the limits of its ratings, protects the circuit. Its primary function is to isolate faulty equipment from the system. When applied with other equipment in a coordinated overcurrent protection scheme, it may also limit service interruptions to only a predetermined section of a power system. In many applications it is possible that the equipment connected to the system can be protected from excessive damage. In this latter application, the primary function is to remove the faulted equipment from the system, and the secondary function is to minimize the damage to the connected equipment as much as possible, considering the varying fault or overload circumstances that can occur.

<sup>3</sup>IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

<sup>4</sup>A 1995 revision of CP1 has been published and may be referred to for general information. The 1988 edition is used for normative references in this guide. NEMA publications are available from the National Electrical Manufacturers Association, 1300 N. 17th St., Ste. 1847, Rosslyn, VA 22209, USA.

<sup>5</sup>IEC publications are available from IEC Sales Department, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse. IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

Fuse performance depends upon the integrity with which the fuse was manufactured, the correctness of its application, and the attention it receives after it is installed. If not properly applied and maintained, it might not perform properly when required, which might result in considerable damage to costly equipment or extensive interruptions in service.

*It cannot be stressed too strongly that prescribed safety rules and manufacturers' recommendations and instructions should be adhered to at all times when operating or maintaining these devices near energized equipment or conductors. This is especially true for devices where air-insulated blades, insulating barriers or liners, or fuses are removed or replaced while mating contacts are energized.*

## 3.2 Service conditions

### 3.2.1 Usual

Usual service conditions conforming to this guide are defined in IEEE Std C37.40-1993, subclause 2.1. These conditions specify limits in altitude and ambient temperature.

### 3.2.2 Unusual

Unusual service conditions are defined in IEEE Std C37.40-1993, subclause 2.2, which gives examples of such conditions. IEEE Std C37.40-1993, Table 1, lists altitude correction factors for dielectric strength, and rated continuous current, or ambient temperature for altitudes above 1000 m (3300 ft).

If, during service, the fuse will be subjected to mechanical vibratory stress that may damage the fuse element, the manufacturer should be consulted to verify that it can withstand these conditions.

## 3.3 Selection of class and type of fuse

There are no generalizations that can be made about selecting the class and type of fuse to use at a particular location. In selection of the class of fuse, factors such as power being supplied, dielectric properties of the equipment being protected, X/R ratios, fault currents available, and transient recovery voltage (TRV) severity require consideration. The major classes of fuses are power class and distribution class.

### 3.3.1 Fuse class

#### 3.3.1.1 Power class fuses

Power class fuses are

- a) Generally used in three-phase applications.
- b) Generally used in substations, cabinets, or vaults where a large amount of electrical power is being supplied to a distribution system or some facility that requires large quantities of energy.
- c) Generally used in that part of a system where high dielectric properties are required for all equipment.
- d) Normally placed in a position on the system where fault currents are high, X/R ratios are high, and TRV characteristics are more severe than those found in the applications where distribution fuses are used.
- e) Used in single-phase applications where severe faults, high X/R, or severe TRV is anticipated in an area where distribution fuses would normally be used.

#### 3.3.1.2 Distribution class fuses

Distribution class fuses are

- a) Generally used in single-phase applications.