

IEEE Standard Requirements for Pad-Mounted Fused Switchgear

Sponsor

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Abstract: Requirements for assemblies of single-phase and three-phase, dead-front and live-front, pad-mounted, load-interrupter switches with expulsion, current-limiting, and other types of fuses in enclosures up to 38 kV rated maximum voltage are given. Definitions are given, and service conditions and ratings are discussed. Design tests, production tests, and construction requirements are included.

Keywords: fused-loadbreak way, fused-switched way, fused way, pad-mounted fused switchgear, switched way

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Introduction

(This introduction is not part of IEEE Std C37.73-1998, IEEE Standard Requirements for Pad-Mounted Fused Switchgear.)

This standard is part of a series for submersible and pad-mounted switchgear covered in IEEE Std C37.71-1984 and ANSI C37.72-1987, and it draws heavily from these. Substantial changes and improvements have been made, and it is expected that these improvements will be incorporated in IEEE Std C37.71 and ANSI C37.72 at their next revision, or the scope of this standard will be broadened to cover these other standards.

This standard covers pad-mounted switchgear, using air or other insulating media, and includes switches, fuses, and loadbreak devices. Live-front and dead-front equipment with all types of connectors are covered.

This standard assigns an overall rating to the switchgear for the common ratings of dielectric withstand, momentary current, and short-time current ratings. The ratings for the switchgear are based on the minimum ratings of the components or ways. In addition, each way is assigned specific ratings reflecting its continuous current, and its specific load or fault interrupting current, depending upon the components used in that way.

This standard also recognizes designs for equipment specifically intended for grounded-wye system applications, utilizing phase-to-ground rated devices for those applications.

There are substantial improvements and detailed test requirements for switching tests for interrupter switches, and for loadbreak devices that are operated by opening and closing the fuse assemblies. This standard also includes testing to verify proper operation of the fuse within the enclosed equipment.

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IEEE Standard Requirements for Pad-Mounted Fused Switchgear

1. Scope

This standard applies to assemblies of single-phase and three-phase, dead-front and live-front, pad-mounted, load-interrupter switches with expulsion, current-limiting, and other types of fuses in enclosures up to 38 kV rated maximum voltage.

2. References

This standard shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply.

AEIC CS5-1994, Specifications for Cross-Linked Polyethylene Insulated Shielded Power Cables Rated 5 Through 46 kV.¹

AEIC CS6-1987, Specification for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV.

ANSI C37.46-1981 (Reaff 1992), American National Standard Specifications for Power Fuses and Fuse Disconnecting Switches.²

ANSI C37.47-1981 (Reaff 1992), American National Standard Specification for Distribution Fuse Disconnecting Switches, Fuse Supports, and Current-Limiting Fuses.³

ANSI C37.85-1989 (Reaff 1995), American National Standard for Switchgear—Alternating-Current High-Voltage Power Vacuum Interrupters—Safety Requirements for X-Radiation Limits.⁴

¹AEIC publications are available from the Association of Edison Illuminating Companies, 600 N. 18th Street, P. O. Box 2641, Birmingham, AL 35291-0992, USA.

²This publication is available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

³See Footnote 2.

⁴See Footnote 2.

ANSI C57.12.28-1996, American National Standard for Switchgear and Transformers—Pad-Mounted Equipment—Enclosure Integrity.⁵

IEEE Std 4-1995, IEEE Standard Techniques for High-Voltage Testing.⁶

IEEE Std 386-1995, IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V.

IEEE Std 1291-1993, IEEE Guide for Partial Discharge Measurement in Power Switchgear.

IEEE Std C37.09-1979 (Reaff 1989), IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (DoD).

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.

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

IEEE Std C37.48-1998, IEEE Guide for Application, Operation, and Maintenance of High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.

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

3. Definitions

The definitions of terms contained in this standard, or in other standards referred to in this document, are not intended to embrace all the legitimate meanings of the terms. They are applicable only to the subject treated in this standard. For additional definitions, see IEEE Std C37.100-1992.

3.1 fused-loadbreak way: A fused way incorporating an integral switching device operated by opening and closing a fuse assembly. (See Figure 1.)

3.2 fused-switched way: A way connected to the bus through a three-phase group-operated switch or single-phase switch in series with high-voltage fuses.

3.3 fused way: A way connected to the bus through a high-voltage fuse.

3.4 pad-mounted fused switchgear (PMFSG): Load-interrupter switch and fuse assemblies in which all energized parts are insulated and completely enclosed within an enclosure when the doors and covers are securely closed. The overall enclosure is of suitable environmental and tamper-resistant construction for outdoor, above-ground installation.

3.5 switched way: A way connected to the bus through a three-phase group-operated switch or single-phase switch.

3.6 way: A three-phase or single-phase circuit section containing a switch, fuse, combination switch and fuse, or bus.

⁵ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

⁶IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

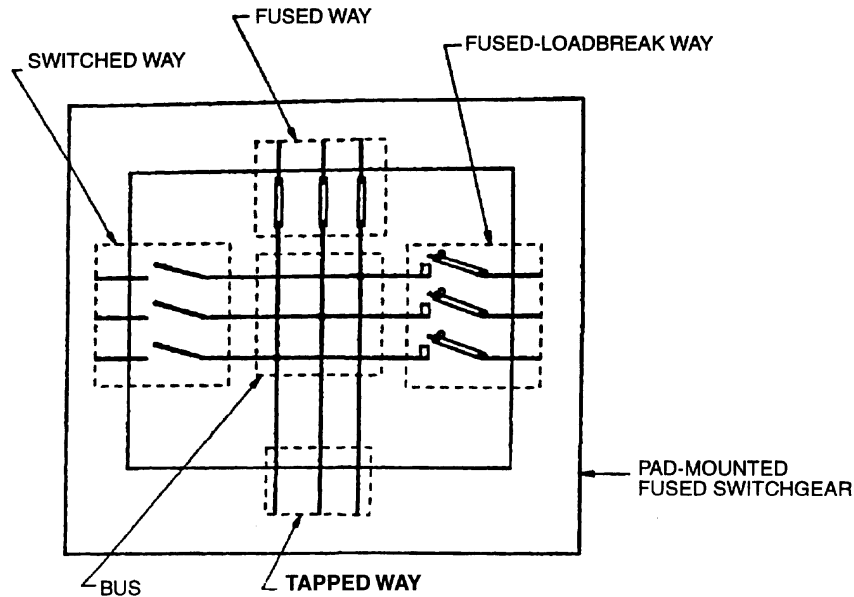


**Figure 1—Example using definitions from Clause 3
(4-way pad-mounted switchgear shown)**

4. Service conditions

4.1 Usual service conditions

Apparatus conforming to this standard shall be suitable for operation at nameplate rating when

- a) The ambient air temperature is not above 40 °C or below –30 °C;
- b) The altitude does not exceed 1000 m (3300 ft).

NOTE—Fuse time current characteristics and continuous-current ratings are affected by temperature (see IEEE Std C37.48-1987).

4.2 Unusual service conditions

4.2.1 Abnormal ambient temperature

The pad-mounted fused switchgear (PMFSG) may be applied at higher or lower ambient temperatures than specified, but performance may be affected and special consideration shall be given to these applications.

4.2.2 Altitudes above 1000 m (3300 ft)

This subclause is currently under review. The results will be incorporated in the next revision of this standard.

4.2.3 Other service conditions that may affect design and application

Where other unusual conditions exist, they should be brought to the attention of the manufacturer. An unusual condition is considered to be any installation, application, or operation outside the requirements defined in this standard.

Among such unusual conditions are

- a) Exposure to damaging fumes or vapors, excessive dust, explosive mixtures of dust or gases, and steam or excessive moisture;
- b) Exposure to abnormal vibrations, shocks, and tilting;
- c) Flooding;
- d) Unusual frequency of operation;
- e) High harmonic content currents and voltages.

5. Ratings and test requirements

5.1 General

The ratings designated in this standard are preferred and are not considered restrictive. Non-preferred ratings based on performance are acceptable under provisions of this standard when accepted by the equipment user. The ratings of the PMFSG are designations of operating limits under specified conditions of ambient temperature, temperature rise, etc., and include ratings indicated in 5.2.

5.2 Rating information

The ratings shall include overall ratings of the PMFSG and ratings of individual ways.

5.2.1 Overall ratings

The overall ratings of PMFSG shall include the following:

- a) Rated power frequency;
- b) Rated maximum voltage;
- c) Rated lightning-impulse withstand voltage;
- d) Rated power-frequency withstand voltage;
- e) Rated short-circuit current.

5.2.1.1 Rated power frequency

The rated power frequency shall be the frequency at which the PMFSG and its components are designed to operate. The preferred rated power frequency is 50 Hz or 60 Hz.

5.2.1.2 Rated maximum voltage

The rated maximum voltage of PMFSG shall be that of the way with the lowest rating. A three-phase PMFSG containing one or more ways with components, such as fuses, single-phase switches, or fused-load-break devices rated for phase-to-ground voltage (maximum voltage divided by 1.732), shall have the designation "Grd-Y" (grounded-wye) added to the rated maximum voltage. The application of Grd-Y rated PMFSG should be limited to those three-phase applications where the recovery voltage, during switching or fault clearing across any Grd-Y rated way, does not exceed the phase-to-ground rating of components, and the three-phase system voltage does not exceed the rated maximum voltage of the PMFSG.

5.2.1.3 Rated lightning-impulse withstand voltage

The rated lightning-impulse withstand voltage shall be that of the way with the lowest rating.

5.2.1.4 Rated power-frequency withstand voltage

The rated power-frequency withstand voltage shall be that of the way with the lowest rating.

5.2.1.5 Rated short-circuit current

The rated short-circuit current shall be the lowest of the following ratings of any of the ways, and shall be expressed in both symmetrical (sym) and asymmetrical (asym) rms amperes (peak amperes may also be included or substituted for asymmetrical amperes):

- a) The rated interrupting current of the fuses, if applicable (see IEEE Std C37.41-1994);
- b) The rated momentary and short-time current of the switches, loadbreak devices (if applicable), and bus;
- c) The rated fault-closing current of the switches and loadbreak devices.

NOTES

1—A PMFSG consisting of only a single switched way and ways containing fuses may have a rated short-circuit current equal to that of the fuses, if it can be demonstrated that the switch can withstand the fault-closing and momentary duty, as limited by the fuses.

2—Bushings, separable connectors, terminators, or cables may not have short-circuit capabilities as high as the rating of the gear, and could limit the application.

5.2.2 Individual way ratings

The ratings of individual ways shall be assigned as shown in Table 1.

Table 1—Ratings of individual ways

Rating	Switched way	Fused-switched way	Fused-loadbreak way	Fused way	Tapped way
1. Rated maximum voltage ^a	X	X	X	X	X
2. Rated continuous current	X	X	X	X	X
3. Rated load switching current	X	X	X		
4. Rated loop switching current	X	X	X		
5. Rated cable-charging switching current	X	X	X		
6. Rated transformer-magnetizing switching current	X	X	X		
7. Rated momentary current ^a	X	X ^b	X ^b	X ^b	X
8. Rated short-time current and duration ^a	X	X ^b	X ^b	X ^b	X
9. Rated fault-closing current ^a	X	X	X		
10. Rated interrupting current ^a		X	X	X	
NOTE—Lines 7 through 10 shall be expressed as sym/asym or sym/peak ampere ratings.					

^aThese ratings are optional as they are covered by the overall rating of the PMFSG and equal or exceed those ratings of 5.2.1.

^bThese ratings are only applicable with fuse shorting bars.

5.3 Preferred voltage ratings and related test requirements

See Table 2 for preferred rated values.

Table 2—Preferred voltage ratings and related test requirements

Line no.	Related test requirements							
	Rated maximum voltage (kV)			Rated lightning-impulse withstand voltage (kV)	Rated power-frequency withstand voltage (kV)	Power-frequency withstand production test voltage (kV)	DC withstand (15 min) (kV) ^a	Minimum partial discharge (corona) extinction voltage (kV) ^b
	Three-phase PMFSG		Single-phase PMFSG					
	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
1	15.5	15.5 Grd-Y	8.9	95	35	34	53	—
2	27	27 Grd-Y	15.5	125	60	40	78	—
3	38	38 Grd-Y	21.9	150	70	50	103	—
NOTE—When performing tests involving open contacts in a vacuum, the tests should be performed in accordance with ANSI C37.85-1989.								

^aDC withstand values are design test values; they are not field test values.

^bValues for partial discharge extinction voltage are under consideration by the working group.

5.4 Continuous-current ratings and related test requirements

See Tables 3 and 4 for preferred ratings.

5.4.1 Conditions of continuous-current rating

The rated continuous current is applicable under the usual service conditions defined in 4.1. Current ratings shall be based on the total temperature limits of the materials used for such parts. A temperature rise reference is given to permit testing at reduced ambient. PMFSGs shall have their ratings based on a 40 °C ambient air temperature outside the enclosure, with a 15 °C solar radiation factor added. The “effective” ambient is therefore 55 °C.

5.4.2 Limits of observable temperature rise

At rated current, the observable hottest temperature rise above ambient and the total temperature of each of the various parts shall not exceed the values listed in Table 5.

5.4.3 Application of fuses

Application of fuses may require derating of the allowable continuous current due to time-current characteristics (TCC) shift, reduction in the current required to produce element melting, or excessive total temperature of contacts, conducting joints, bushing terminals, insulation, etc. This is particularly true of current-limiting fuses subject to, or producing, high ambient temperatures. (See IEEE Std C37.48-1987.)