

C37.74™

IEEE Standard Requirements for Subsurface, Vault, and Pad-Mounted Load-Interrupter Switchgear and Fused Load-Interrupter Switchgear for Alternating Current Systems Up to 38 kV

IEEE Power Engineering Society

Sponsored by the
Switchgear Committee



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IEEE Power Engineering Society

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Abstract: Required definitions, ratings, procedures for performing design tests and production tests, and construction requirements for subsurface, vault, and pad-mounted load-interrupter switchgear and fused load-interrupter switchgear for ac systems up to 38 kV are specified.

Keywords: fused, load-interrupter, pad-mounted, subsurface, switchgear, vault, way

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Introduction

(This introduction is not part of IEEE Std C37.74-2003, IEEE Standard Requirements for Subsurface, Vault, and Pad-Mounted Load-Interrupter Switchgear and Fused Load-Interrupter Switchgear for Alternating Current Systems up to 38 kV.)

This standard is a consolidation of a series of standards for submersible and pad-mounted switchgear previously covered in IEEE Std C37.71™-2001 [B4]^a, ANSI C37.72-1987 [B1], and IEEE Std C37.73™-1998 [B5]. Substantial changes and improvements were made to IEEE Std C37.71-2001 [B4] and ANSI C37.72-1987 [B1] for testing requirements as was previously done for IEEE Std C37.73-1998 [B5]. The consolidation of the standards is based on commonality of the applications of the equipment that lead to a commonality of the testing and ratings. In one notable example, the higher cable-charging switching current ratings of IEEE Std C37.71-2001 [B4] were used. These standards were essentially similar, with primary differences relating to mounting configurations. This standard covers subsurface, vault, and pad-mounted switchgear and includes switches, fault interrupters, fuses, loadbreak devices, and ground switches. Live-front and dead-front equipment are covered, including all types of connectors and insulating media.

This standard assigns an overall rating to the switchgear for the common ratings of dielectric withstand, peak withstand current, short-time withstand current, and fault-making current. 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 specific applications.

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

Altitude correction factors have been removed. Refer to the following paragraph and Annex B.

Although this standard may be published before the work on IEEE PC37.100.1 [B6] is finished, it is the intention of the Pad-Mount Working Group to adopt or reference common clauses as they become available, specifically, on the treatment of

- Altitude correction factors
- Total temperature limits for contacts, connectors, and insulation
- Common test methods and procedures

^aThe numbers in brackets correspond to the numbers of the bibliography in Annex C.

Participants

The Accredited Standards Committee on Power Switchgear, C37, which reviewed and approved this standard, had the following members at the time of approval:

T. W. Olsen, *Acting Chair*
A. K. McCabe, *Vice Chair, HV Standards*
J. C. Scott, *Vice Chair, LV Standards*
D. L. Swindler, *Vice Chair, IEC Activities*
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Electric Light & Power Group/Edison Electric Institute	E. M. Worland D. E. Galicia J. L. Koepfinger G. J. Martuscello Y. J. Musa
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National Electrical Manufacturers Association	G. Sakats G. T. Jones R. W. Long T. W. Olsen D. T. Stone
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International Electrical Testing Association (NETA)	A. Peterson
U.S. Department of Agriculture	H. Bowles
U.S. Department of the Army—Office of the Chief of Engineers	J. A. Gilson
U. S. Department of the Navy—Naval Construction Battalion Center	D. Mills
Western Area Power Administration	(vacant)
National Electric Contractors Association	D. Harwood
Technical Liaison (nonvoting)	W. E. Laubach C. L. Wagner

At the time this standard was completed, the Recloser Working Group of the Recloser and Other Distribution Equipment (RODE) Subcommittee of the IEEE Switchgear Committee had the following members:

David T. Stone, *Chair*

Don Akers
Charles Ball
Harvey L. Bowles
Raymond L. Capra

Marcel Fortin
Edward M. Jankowich
Larry McCall
Steven Meiners

Donald R. Martin
Jim Ransom
John G. Wood
Janusz Zawadzki

The following members of the balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

Charles Ball
Edward Bertolini
Glenn Borchardt
Harvey L. Bowles
Lyne Brisson
Robert Brown
Raymond L. Capra
James Christensen
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IEEE Standard Requirements for Subsurface, Vault, and Pad-Mounted Load-Interrupter Switchgear and Fused Load-Interrupter Switchgear for Alternating Current Systems up to 38 kV

1. Scope

This standard applies to enclosed assemblies of single-phase and three-phase, dead-front and live-front, subsurface, vault, and pad-mounted load-interrupter switches with or without protective devices, such as fuses or fault interrupters, up to 38 kV rated maximum voltage.

2. References

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

AEIC CS8-2000, Specification For Extruded Dielectric, Shielded Power Cables Rated 5 Through 46 kV.¹

ANSI C37.46-2000, American National Standard for High Voltage Expulsion and Current-Limiting Type Power Class Fuses and Fuse Disconnecting Switches.²

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

ANSI C37.85-2002, American National Standard for Switchgear—Alternating-Current High-Voltage Power Vacuum Interrupters—Safety Requirements for X-Radiation Limits.

¹AEIC publications are available from the Association of Edison Illuminating Companies, 600 N. 18th Street, P.O. Box 2641, Birmingham, AL 35291-0992, USA (<http://www.aeic.org>). AEIC publications are also available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112-5704, USA (<http://www.global.ihs.com/>).

²ANSI 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/>).

ANSI C57.12.26-1993, American National Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors (34 500 Grd Y/19 920 V and Below; 2500 kVA and Smaller).

ANSI C57.12.28-1999, American National Standard for Pad-Mounted Equipment—Enclosure Integrity.

ANSI C57.12.29-1991, American National Standard for Switchgear and Transformers—Pad-Mounted Equipment—Enclosure Integrity for Coastal Environments.

IEC 60060-1:1989-11, High-Voltage Test Techniques—Part 1: General Definitions and Test Requirements.³

IEC 60270:2000-12, High-Voltage Test Techniques—Partial Discharge Measurements.

IEC 60694:2002-01, Common Specifications for High-Voltage Switchgear and Controlgear Standards.

IEEE Std 4™-1995, IEEE Standard Techniques for High-Voltage Testing.^{4, 5}

IEEE Std 4a™-2001, Amendment to IEEE Standard Techniques for High-Voltage Testing.

IEEE Std 386™-1995 (Reaff 2001), IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V.

IEEE Std 1247™-1998, IEEE Standard for Interrupter Switches for Alternating Current, Rated Above 1000 Volts.

IEEE Std 1291™-1993 (Reaff 1998), IEEE Guide for Partial Discharge Measurement in Power Switchgear.

IEEE Std C37.09™-1999, IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.

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 C37.40b™-1996, IEEE Standard Service Conditions and Definitions for External Fuses for Shunt Capacitors.

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 C37.60™-2003, IEEE Standard for Overhead, Pad-Mounted, Dry Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for Alternating Current Systems Up to 38 kV.

³IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembe, 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, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org>).

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IEEE Std C37.100™-1992 (Reaff 2001), IEEE Standard Definitions for Power Switchgear.

IEEE Std C57.12.32™-2002, IEEE Standard for Submersible Equipment—Enclosure Integrity.

3. Definitions

The definitions of terms contained in this standard, or in other standards referenced 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 C37.100-1992.⁶

A dagger (†) following a definition indicates that while the term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

An asterisk (*) indicates that at the time this standard was approved, there were no corresponding definitions in 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.

3.2 fused-switch 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 pad-mounted switchgear, subsurface switchgear, vault-fused switchgear, vault switchgear†: Refer to IEEE Std C37.100-1992. In IEEE Std C37.74-2003, pad-mounted switchgear, subsurface switchgear, vault switchgear, with or without protective devices, shall be designated simply as distribution switchgear (DSG).

3.4 protected way*: A way connected to the bus through a protective device.

3.5 subsurface switchgear: A submersible switching assembly suitable for application in a below-grade enclosure normally surface operable.

3.6 surface operable: A term indicating that the switch and its accessories are operable from above grade.

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

3.8 tapped way: A way solidly connected to the bus.

3.9 vault switchgear: A term indicating that the switch and its accessories are operable from inside a vault.

3.10 way†: A three-phase or single-phase circuit connection to the bus, which may contain combinations of switches and protective devices or may be a solid bus.

NOTE—See Figure 1 for an illustration of the definitions in Clause 3.

⁶Information on references can be found in Clause 2.

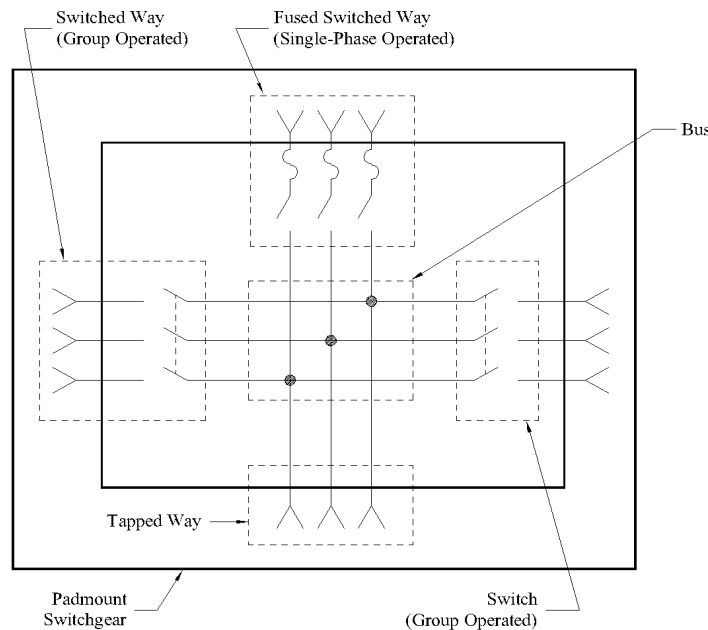


**Figure 1—Example using the definitions from Clause 3
(four-way pad-mounted switchgear shown)**

4. Service conditions

4.1 Usual service conditions

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

- The ambient air temperature is not above 40 °C or below –30 °C.
- The altitude does not exceed 1000 m.
- The subsurface or vault switchgear that is installed in a below-grade enclosure is subject to occasional flooding to a depth not exceeding 3 m above the top of the switchgear.

NOTE—Fuse time-current characteristics and continuous current ratings are affected by temperature; see IEEE Std C37.48-1997.

4.2 Unusual service conditions

Unusual service conditions shall include, but are not limited to, service conditions that exceed the conditions defined in 4.1 or extremes in

- Duty cycle or unusual frequency of operation
- System conditions including high harmonic content currents and voltages
- Site conditions
- Shock, vibration, or tilting
- Damaging fumes, vapors, or corrosive liquids
- Excessive or abrasive dust
- Explosive mixtures of dust or gases

- h) Salt air or extreme humidity
- i) Flooding, including long-term flooding of submersible equipment, or flooding to a level that exceeds 3 m above the top of the submersible switchgear

Unusual service conditions should be brought to the attention of the equipment manufacturer to define or prevent loss of performance or service life, if any, from specified values. Applicable standards such as standards for altitude correction should be used when available.

4.2.1 Abnormal ambient temperatures

Distribution switchgear (DSG) may be applied at higher or lower ambient temperatures than specified. However, performance may be affected, and special consideration shall be given to these applications.

4.2.2 Altitudes above 1000 m

DSG may be applied at altitudes higher than 1000 m; however, the basic impulse insulation level, rated maximum voltage, and rated continuous current may be reduced. The rated interrupting current, related required capabilities, and rated interrupting time are not affected by altitude. Altitude correction factors are being studied by the Switchgear Committee. In the meantime, users should consult the manufacturer for appropriate derating when the equipment is applied above 1000 m. Refer also to Annex B.

5. Ratings, required related capabilities, and test requirements

5.1 General

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

5.2 Rating information

The ratings shall include overall ratings of the DSG and ratings of individual ways. See Table 1 for preferred rated values.

5.2.1 Overall ratings

The overall ratings of DSG 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 is the frequency at which the DSG and its components are designed to operate. The preferred rated power-frequencies are 50 Hz or 60 Hz.

Table 1—Preferred voltage ratings and related test requirements

Line no.	Rated maximum voltage (kV)		Related test requirements ^a				
	Three-phase DSG		Single-phase DSG	Rated lightning impulse withstand voltage (kV)	Rated power-frequency withstand voltage (kV) ^b	Power-frequency withstand production test voltage (kV) ^c	DC withstand (5 min) (kV) ^d
	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
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

WARNING

When performing tests involving open contacts in vacuum, adequate precautions such as shielding or distance should be used to protect test personnel against the possibility of higher X-radiation occurrences due, for example, to incorrect contact spacing or to the application of voltages in excess of the specified voltages. For example, maintaining a distance of 2 m to 3 m between the DSG and all test personnel is a typical basic precaution to reduce the risk of excess X-radiation exposure. Further discussion of shielding, adequate distances, and personnel exposure limits are found in ANSI C37.85-2002.

^aPartial discharge is another related test requirement as specified in 6.7.7

^bRated lightning impulse withstand voltages in Column 4 and rated power-frequency withstand voltages in Column 5 are design test requirements.

^cPower-frequency withstand production test voltages in Column 6 are production test requirements that may be limited by terminations.

^dDC withstand values in Column 7 are design test values; they are not field test values.

5.2.1.2 Rated maximum voltage

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

The preferred values of rated maximum voltage are shown in Column 1, Column 2, and Column 3 of Table 1.

5.2.1.3 Rated lightning impulse withstand voltage

The rated lightning impulse withstand voltage shall be the voltage of the way with the lowest rating. The preferred values of rated lightning impulse withstand voltage are shown in Column 4 of Table 1.

5.2.1.4 Rated power-frequency withstand voltage

The rated power-frequency withstand voltage shall be the voltage of the way with the lowest rating. The preferred values of rated power-frequency withstand voltage are shown in Column 5 of Table 1.

5.2.1.5 Rated short-circuit withstand current and duration

The rated short-circuit withstand current shall be the lowest of the following ratings of any of the ways and shall be expressed in both short-time withstand and peak withstand current:

- a) The rated interrupting current of the protective devices (if applicable)
- b) The rated peak withstand and short-time current of the switches, loadbreak devices (if applicable), grounding switches (if applicable), and buses
- c) The rated fault-making current of the switches, loadbreak devices, protective devices, and grounding switches (if applicable)

The relationship between the peak withstand current and short-time withstand current shall be based on a minimum peak current to root-mean-square (rms) symmetrical current ratio of 2.6 for 60 Hz and 2.5 for 50 Hz,⁷ which equates to an approximate X/R of 17 for 60 Hz systems and 14 for 50 Hz systems. These figures are based on a decay time constant of 45 ms. The rated short time withstand current duration is 1 s.

NOTES

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

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

5.2.1.6 DC withstand voltage (required related capability)

The assembly shall pass a dc withstand voltage test in accordance with 6.7.8, with test values based on rated maximum voltage values in Table 1.

5.2.2 Individual way ratings

The ratings of individual ways shall be assigned as shown in Table 2.

⁷It is accepted practice in ANSI and IEC HVCB standards to use the 2.5 figure for peak current to rms symmetrical current ratio. Annex A provides actual value of 2.55.