IEEE Std C37.04-1999
(Revision of
IEEE Std C37.04-1979)

IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers

Sponsor

Switchgear Committee of the
IEEE Power Engineering Society

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Abstract: This standard covers the rating structure for all high-voltage circuit breakers, which include all voltage ratings above 1000 V ac and comprise both indoor and outdoor types having the preferred ratings as listed in ANSI C37.06-1997. Typical circuit breakers covered by these standards have maximum voltage ratings ranging from 4.76 kV through 800 kV, and continuous current ratings of 600 A, 1200 A, 2000 A, and 3000 A associated with the various maximum voltage ratings. The rating structure establishes the basis for all assigned ratings, including continuous current, dielectric withstand voltages, short-circuit current, transient recovery voltage, and capacitor switching, plus associated capabilities such as mechanical endurance, load current, and out-of-phase switching. This standard does not cover generator circuit breakers, which are covered in IEEE Std C37.013-1997.

Keywords: capacitance current switching, dielectric withstand, fast transient recovery voltage, indoor, initial interrupting time, mechanical endurance, operating duty, outdoor, power frequency, ratings, related capabilities, short-circuit current, shortline fault, voltage distribution

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Introduction

(This introduction is not part of IEEE Std C37.04-1999, IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers.)

In 1964, consolidated standards for circuit breakers rated on a symmetrical current basis were published to take the place of standards established on the total current basis of rating. This 1999 revision was undertaken to update the standard to reflect today's circuit breaker technology and application on modern power systems. The revision also continues harmonization with IEC 60056 Ed. 4.0b: 1987, a process that first began in 1951.

This document makes significant changes in the rating structure for circuit breakers, such as the change of the voltage range factor, K, and the standard duty cycle. With these changes, information needed to properly apply circuit breakers rated in accordance with the 1979 or 1964 editions of IEEE Std C37.04 are eliminated from this new edition. Accordingly, users must refer to the prior editions of the relevant standards (including IEEE Std C37.04-1999, ANSI C37.06, IEEE Std C37.09-1999, etc.) in order to properly select and apply circuit breakers rated in accordance with the older standards.

NOTE—These older standards are part of the IEEE archives. Contact the IEEE Standards Association for ordering information.

The changes in this standard are explained in the following clause-by-clause summary:

1. Scope—The scope was expanded to clarify the type of circuit breakers specifically covered by this standard.
2. References—A complete updated listing of references is supplied.
3. Definitions—No substantial changes.
4. Service conditions—The usual and unusual service conditions are given. Information given on how to deal with unusual service conditions has been moved to IEEE Std C37.010-1999.
5. Ratings—The rated voltage range factor, K, defined in earlier versions of IEEE Std C37.04 is commonly recognized as being equal to 1.0 for modern interrupting technologies; consequently, the rating structure has been simplified, because the use of a K factor of 1.0 has effectively eliminated K from the rating structure. The rated permissible tripping delay, Y, has been incorporated in the rated closing, latching, and short-time current carrying capability (5.8.2.3).
   - 5.1 Rated maximum voltage—No major changes.
   - 5.2 Rated power frequency—No major changes.
   - 5.3 Rated continuous current—Changes were made to Table 1 (Limits of temperature and temperature rise for various parts and materials of circuit breakers). This table has been brought into better harmony with IEC.
   - 5.4 Rated dielectric withstand capability—Changes clarify basic dielectric requirements.
   - 5.5 Rated standard operating duty (standard duty cycle)—Changed and expanded to include circuit breakers for rapid reclosing and to coordinate with IEC.
   - 5.6 Rated interrupting time—The definition was clarified and updated for modern circuit breaker performance.
   - 5.7 Contact parting time—This definition was modified to alert users of high-voltage circuit breakers that it may be necessary to add external delay to account for fault deionization times on power systems.
   - 5.8 Rated short-circuit current and related required capabilities
     - 5.8.1 Rated short-circuit current—No major changes.
     - 5.8.2 Related required capabilities—The required asymmetrical interrupting capability for three-phase faults (5.8.2.2) defines the percent dc component based on the standard time constant of 45 ms (corresponding to an X/R of 17 for 60 Hz or 14 for 50 Hz). This

replaces the "S-factor" concept used in earlier versions of IEEE Std C37.04.
The rated closing, latching, and short-time current carrying capability (5.8.2.3) incorporates the permissible tripping delay and short-time current into values that coordinate with IEC. The required reclosing capability is referenced to IEEE Std C37.010-1999.

5.9 Rated transient recovery voltage (TRV)—This subclause of the standard was expanded to provide a detailed explanation of how TRV values are calculated. The first pole-to-clear factor and transient amplitude factors have been harmonized with IEC in preparation for future harmonization of waveshapes for testing. The shortline fault surge impedance and amplitude constant were harmonized to a single value. The initial TRV was incorporated from IEEE Std C37.04i-1991.

5.10 Rated operating endurance capabilities—This subclause replaced "Required load current switching capability and life."

5.11 Rated capacitance current switching—This subclause was not changed. Requirements for capacitance switching are currently under review by a joint IEEE/IEC working group.

5.12 Out-of-phase switching current capability—No major changes.

5.13 Shunt reactor current switching capability—References are made to IEEE Std C37.015-1993.

5.14 Rated line closing switching surge factor—No changes.

5.15 Rated control voltage—IEC definitions are incorporated.

5.16 Rated operating pressure for insulation and/or interruption (P_{re})—IEC definitions are incorporated.

5.17 Rated operating pressure for mechanical operation (P_{rm})—IEC definitions are incorporated.

6. Construction

6.1 Outdoor apparatus bushings—References have been updated.

6.2 Creepage distance—References ANSI C37.06-1997 requirements.

6.3 Mechanical loading—This subclause has been updated to reflect individual mechanical loads per IEC.

6.4 Pressurized components—Requirements for non-ceramic pressurized vessels have been added.

6.5 Pressurized systems—No major changes.

6.6 Gas and vacuum tightness—Requirements have been added that correlate to IEC.

6.7 Functional components—Basic requirements for circuit breakers have been defined.

6.8 Stored energy requirements for operating mechanisms—Basic requirements for stored energy are established based upon the time to replenish the stored energy after operation.

6.9 Operating mechanism requirements—Establishes trip-free and anti-pump requirements.

6.10 Electromagnetic compatibility (EMC)—Establishes withstand of secondary systems.

6.11 Requirements for simultaneity of poles—Establishes mechanical requirements in correlation with IEC.

7. Nameplate markings—No major changes.

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IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers

1. Scope

This standard establishes a symmetrical current rating structure and construction requirements for all indoor and outdoor types of ac high-voltage circuit breakers rated above 1000 V. It is only applicable to three-pole circuit breakers used in three-phase systems and single-pole circuit breakers used in single-phase systems. This standard does not cover circuit breakers used at frequencies other than 50 Hz or 60 Hz, or generator circuit breakers that are covered in IEEE Std C37.013-1997.

2. References

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

ANSI C37.06-1997, American National Standard for Switchgear—AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis—Preferred Ratings and Related Required Capabilities.[1]

ANSI C37.06.1-1997, American National Standard Trial-Use Guide for High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis—Designated "Definite Purpose for Fast Transient Recovery Voltage Rise Times."

ANSI C37.54-1996, American National Standard for Switchgear—Indoor Alternating-Current High-Voltage Circuit Breakers Applied as Removable Elements in Metal-Enclosed Switchgear Assemblies—Conformance Test.

ANSI C84.1-1989, American National Standard for Voltage Ratings for Electric Power Systems and Equipment (60 Hz).[2]

ASME 1998 Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels.[3]

[1]ANSI C37 standards are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://www.standards.ieee.org/).

[2]ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (http://www.ansi.org/).

[3]ASME publications are available from the American Society of Mechanical Engineers, 3 Park Avenue, New York, NY 10016-5990, USA (http://www.asme.org/).