ANSI C37.12-1991
(Revision of ANSI C37.12-1981)

American National Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis—Specifications Guide

Secretariat

Institute of Electrical and Electronics Engineers
National Electrical Manufacturers Association

Approved May 22, 1991

American National Standards Institute, Inc.

American National Standard

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Published by
American National Standards Institute
11 West 42nd Street, New York, New York 10036

Printed in the United States of America

Foreword

(This foreword is not part of American National Standard C37.12-1991.)

This publication represents standard practices in the United States relating to ac high-voltage circuit breakers and is one of a series of American National Standards on this subject. It was first published as an American National Standard in 1952.

The Committee on Electric Power Apparatus of the Association of Edison Illuminating Companies (AEIC), which originated these specifications prior to their adoption in 1952, initiated a review in 1983 for the purpose of establishing a suitable and up-to-date guide for construction and performance of alternating-current power circuit breakers. This work, which was carried out by a Subject Committee on Specifications, included such general requirements as are ordinarily fixed in uniform, supplementing rating standards, and contained applicable specific requirements of the purchasers. ANSI C37.12 is issued as a guide and as such is advisory in nature. This edition includes revisions and additions to the previous edition in the following areas:

- performance;
- insulation structure;
- operating mechanism;
- structural features;
- incorporated secondary and control devices;
- purchaser's detailed requirements;
- information to be furnished by manufacturer or vendor with bid.

This standard applies to circuit breakers covered by the symmetrical current basis or rating. Related standards include the following:

Symmetrical current basis of rating

ANSI C37.06-1987, *Switchgear - AC high-voltage circuit breakers - rated on a symmetrical current basis - Preferred ratings and related required capabilities*

ANSI/IEEE C37.04-1979 (R1989), *Rating structure for AC high-voltage circuit breakers rated on a symmetrical current basis*

ANSI/IEEE C37.09-1979 (R1989), *Test procedure for high-voltage circuit breakers rated on a symmetrical current basis*

ANSI/IEEE C37.010-1979 (R1989), *Application guide for AC high-voltage circuit breakers rated on a symmetrical current basis*

ANSI/IEEE C37.011-1979 (R1989), *Application guide for transient recovery voltage for AC high-voltage circuit breakers rated on a symmetrical current basis*

ANSI/IEEE C37.012-1979 (R1989), *Application guide for capacitance current switching of AC high-voltage circuit breakers rated on a symmetrical current basis*

ANSI/IEEE C37.11-1979, *Requirements for electrical control for AC high-voltage circuit breakers rated on a symmetrical current basis and total current basis*[1]

There is one annex in this standard. Annex A is informative and is not considered part of this standard.

[1]This standard has been withdrawn and is listed for historical purposes only. It is currently under revision. Contact the secretariat for more information.

Suggestions for improvement of this standard will be welcome. They should be sent to the National Electrical Manufacturers Association, 2101 L Street NW, Suite 300, Washington, DC 20037.

This standard was processed and approved for submittal to ANSI by American National Standards Committee on Power Switchgear, C37. Committee approval of the standard does not necessarily imply that all committee members voted for its approval.

At the time it approved this standard, the C37 Committee had the following members:

T. C. Burtnett *(Chairman)*
A. K. McCabe *(Executive Vice-Chairman, HV Standards)*
S. H. Telander *(Executive Vice-Chairman, LV Standards)*
D. L. Swindler *(Executive Vice-Chairman, IEC Activities)*
C. H. White, *Secretary*
M. B. Williams *(Program Administrator)*

Organization Represented	***Name of Representative***
Association of Iron and Steel Engineers	J.M. Tillman
Electric Light and Power Group	R. L. Capra K. D. Hendrix D.T. Weston J. H. Provanzana M. C. Mingoia G. R. Brandenberger (Alt.) T. E. Bruck (Alt.)
Institute of Electrical and Electronics Engineers	W. F. Hoenigmann D. M. Larson W. E. Laubach E. W. Schmunk C. A. Schwable S. C. Atkinson (Alt.) D. G. Kumbera (Alt.)
National Electrical Manufacturers Association	T.C. Burnett R.A. McMaster R. H. Miller R. O. D. Whitt H. L. Miller (Alt.)
Tennessee Valley Authority	R. B. Rotton
Testing Laboratory Group	L. Frier W. T. O'Grady R. W. Seelbach (Alt.)
U. S. Department of the Army	W. M. Jones
U. S. Department of the Interior, Bureau of Reclamation	J. W. Reif
U. S. Department of the Navy, Naval Construction Battalion Center	R. L. Clark
U.S. Department of Agriculture - REA	H. L. Bowles
Western Area Power Administration	G. D. Birney

A subcommittee of the AEIC Committee on Electric Power Apparatus worked on this revision to coordinate with the applicable standards on high-voltage circuit breakers rated on both the symmetrical current basis and the total current basis. During the tenure of the subcommittee many members and operating companies contributed to the task of revising this standard. Representatives of several switchgear manufacturers served as advisers. This subcommittee had the following members:

D. O. Craghead
J. H. Provanzana
L. S. Heins
L. J. Savio

The Subcommittee on High-Voltage Circuit Breakers of the ANSI C37 Committee, which developed this standard, had the following members:

G. N. Lester, Chairman
J. H. Brunks
C. J. Dvorak
R. D. Garzon
G. Hanks
R. L. Mattingly (Alt.)
R. H. Mlller
H. M. Smith
D. L. Swindler
L. H. Schmidt (Alt.)
G. A. Wilson

CLAUSE PAGE

CLAUSE PAGE

American National Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis—Specifications Guide

1. Scope

These specifications apply to all indoor and outdoor types of ac high-voltage circuit breakers rated above 1000 volts.

This document is issued only as a guide for use in compiling specifications for ac high-voltage circuit breakers. The imperative mode of the language is illustrative of that used in specifications. It does not imply that this document is anything other than advisory in its scope.

2. Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI C37.06-1987, *Switchgear - AC high-voltage circuit breakers rated on a symmetrical current-basis - Preferred ratings and related required capabilities*

ANSI/IEEE 24-1984, *Performance characteristics and dimensions for outdoor apparatus bushings*

ANSI/IEEE C37.04-1979 (R1989), *Rating structure for AC high voltage circuit breakers rated on a symmetrical current basis*

ANSI/IEEE C37.09-1979 (R1989), *Test procedure for AC high-voltage circuit breakers rated on a symmetrical current basis*

ANSI/IEEE C37.010-1979 (R1989), *Application guide for AC high-voltage circuit breakers rated on a symmetrical current basis*

ANSI/IEEE C57.13-1978 (R1987), *Requirements for instrument transformers*

3. General requirements

All ac high-voltage circuit breakers to be supplied shall conform to

- the general requirements specified in clause 3 through 9;
- the applicable detailed requirements of the purchaser in clause 10.

The manufacturer or vendor shall furnish with his bid the applicable information covered in clause 11. The successful bidder shall furnish the applicable information covered in clause 12 prior to or at the time of delivery.

4. Application of other standards

Unless otherwise specified, all equipment covered by these specifications shall conform to the latest applicable approved American National Standards.

NOTE — These standards are subject to periodic review. Users are cautioned to secure the latest applicable edition.

5. Tests

5.1 Design tests

Tests shall be conducted on each design of circuit breaker and on each significant design change in accordance with ANSI/IEEE C37.09.

5.2 Production tests

All applicable production tests included in ANSI/IEEE C37.09 shall be made on each circuit breaker.

6. Performance

The circuit breaker shall meet all its ratings as defined in ANIS/EEE C37.04, and as listed in ANSI C37.06.

7. Insulation structure

7.1

The circuit breaker shall be capable of withstanding an out-of-phase voltage across the terminals with the phase angle between the two voltages continuously varying.

This requirement is to assure that the circuit breaker in the open position is capable of withstanding voltages to which it can be subjected under such conditions as systems being out of phase.

7.2

All parts of the insulation structure including that between phases to ground and across the open contacts shall be of an inherently stable nature such that, when subjected to dielectric stresses corresponding to the circuit breaker's rating, no tracking occurs.

7.3

Materials used in the insulation structure of oilless breakers shall, wherever practicable, be of a type that would not support combustion, produce toxic gases, or absorb moisture. When subjected to an electric arc, the emission of conducting materials from the insulation structure shall be so limited that it will not interfere with the required performance of the circuit breaker.

7.4

For circuit breaker insulation structures, no material shall be used whose deterioration is significantly accelerated while in the interrupting or insulating media (i.e., oil, SF6, air) or that causes significant deterioration of the media.

7.5

The mechanical strength and physical characteristics of the insulation structure shall be such that the structure will withstand the shocks of circuit breaker operations within ratings, reasonable strains of connecting conductors, and usual service conditions as specified by ANSI/IEEE C37.04, subclause 4.1, or as specified by the user. Where fibrous insulation is used, means such as heaters may be provided to minimize condensation.

NOTE — ANSI/IEEE C37.04 outlines requirements for pressurized components of ac high-voltage circuit breakers rated on a symmetrical current basis.

7.6

Provisions shall be made to keep the insulation structures, not normally exposed to the weather, dry during shipment. Breaker enclosures and Bus that operate under SF_6 pressure shall be shipped under positive dry air, dry nitrogen, or SF_6 pressure.

7.7

All paper-oil condenser bushings for circuit breakers shall be provided with facilities for making power factor tests when applicable. The potential tap shall be in accordance with ANSI/IEEE C57.13.

7.8

Circuit breaker appurtenances such as current transformers and potential devices shall not reduce the circuit breaker insulation level below the specified value.

8. Operating mechanism

8.1 General

8.1.1

The design of the operating mechanism shall be tested with the circuit breaker design to ensure positive opening of the circuit breaker and circuit interruption, whether the tripping impulse is received in the fully closed or any partially closed position. Closing the circuit breaker into a standing trip signal or opening the circuit breaker into a standing close signal shall not cause damage to the circuit breaker. If the release or tripping circuit is completed through an auxiliary switch, electrical release or tripping will not take place until such auxiliary switch is closed. The operating mechanism and appurtenances shall conform to ANSI C37.11. The mechanism shall be suitable for one of the control voltages listed in table 9 of ANSI C37.06.

8.1.2

For purposes of inspection and adjustment, means shall be provided to permit local operation of the circuit breaker. The mechanism and the maintenance operating means,for all circuit breaker types where it is feasible, shall be designed so a person can slowly operate the contacts so that the breaker may be adjusted when it is not in service.

8.1.3

Each circuit breaker shall be equipped with an operation counter. If the poles of a circuit breaker can be operated independently, each pole shall be equipped with an operation counter. Preferably, this device should operate only during the opening cycle of the circuit breaker operation.

8.1.4

For circuit breaker designs adaptable to the application of a time travel device, provisions shall be made for such a device and, when requested, mounting facilities shall be furnished in an easily accessible viewing area.

For circuit breaker designs not adaptable to the application of a time travel device, instructions for timing of the circuit breaker shall be furnished, and, when requested, any required devices on the circuit breaker for such timing shall also be furnished.

8.2 Closing

The operating mechanism, when used with automatic reclosing devices, shall be capable of reclosing the circuit breaker in accordance with the requirements in ANSI C37.06.

8.3 Opening

8.3.1

A shunt trip coil, when used, shall be capable of tripping the circuit breaker when any voltage throughout the control voltage range is applied, even if the plunger of the shunt trip coil is raised so that it is in contact with the trigger.

8.3.2

Transformer tripping solenoids and the tripping mechanism shall be capable of successfully withstanding, without failure, any duty cycle covered by these standards. When operated by multi-ratio current transformers that are standard equipment for the breaker, any tap may be used; if operation is by separate current transformers, the accuracy class of such transformers need not exceed C200.

8.3.3

Multiple-pole or single-pole tripping devices, when furnished, shall be protected against accidental operation and conveniently located for manual tripping.

8.3.4

Mechanical hand trip device shall be furnished as a standard item.

8.4 Energy storage system for individual circuit breakers

8.4.1

The capacity of energy storage facilities that are an integral part of a compressed air or other gas breaker shall be of sufficient size to permit at least two complete closing-opening operations, starting at normal working pressure and without replenishing the store of energy, at rated short-circuit current or at related required capabilities.

8.4.2

The capacity of energy storage facilities that are an integral part of a pneumatically or hydraulically operated circuit breaker other than the gas-blast type shall be of sufficient size to permit at least five complete closing-opening operations at rated short-circuit current or at related required capabilities, starting at normal working pressure and without replenishing the store of energy.

8.4.3

The energy storage of a motor-compressed spring-operated circuit breaker shall be sufficient for an opening-closing operation at rated short-circuit current or at related required capabilities, after which the spring-compressing motor shall not require more than 10 seconds, or as agreed between the purchaser and manufacturer, to compress the closing spring. The spring-operating mechanism shall have provisions for manually charging the closing springs.

8.4.4

Pressure tanks and other pressurized components shall conform to the requirements in ANSI/IEEE C37.04 and to applicable state and local regulations as specified by the user. An ASME standard certificate of inspections shall be furnished.

8.4.5

Welding and cleaning of pressure tanks shall be done in such a manner as to remove all scale and to permit good adherence of coatings to surfaces. The exterior and interior of the tank shall be treated to inhibit rust, scaling, and flaking.

8.4.6

Operating systems for the various types of circuit breakers shall include the devices listed in table 1 and they shall perform as indicated in this table.

Table 1— Devices included in operating systems for circuit breaders

Devices	Compressed air or other gas system	Pneumatically operated	Hydraulically operated	Spring-charged stored energy
Pressure gauges connected to read tank pressure at each storage level.	X	X	X	-
Pressure control switch for compressor motors.	X	X	X	-
Safety valves or other relief devices at each storage level.	X	X	X	-
Manually operated drain valves at each storage level as applicable.	X	X	X	-
Supply check valve as applicable.	X	X	X	-
Supply shutoff valves at each storage level as applicable.	X	X	-	-
Alarm pressure switch set to close its contacts at approximately 110% of minimum operating pressure.	X	X	X	-
Minimum-closing-pressure switch, which shall prevent the electrical control system from attempting to close the breaker, when the pressure of the interrupting medium is below the minimum value required to complete a close-open operation at rated short-circuit current or at related required capabilities.	X	-	-	-
Lockout pressure switch to prevent the mechanism from attempting to close (or open) the breaker when the pressure of the mechanism is too low to obtain proper contact velocities.	-	X	X	-
Minimum opening-pressure switch, which shall prevent the electrical control system from attempting to open the breaker when the pressure of the interrupting medium is below the minimum value required to complete an opening operation at rated short-circuit current or at related required capabilities. As an alternative, this switch may be specified to cause the breaker to be opened automatically or prevent the breakers from closing or reclosing when the pressure drops to this minimum value.	X	See note	See note	-
Means to prevent overcharging of spring(s).	-	-	-	X
Means to prevent insufficiently charged spring(s) from attempting a close operation.	-	-	-	X
Mechanical indication that spring(s) is charged, not fully charged, or discharged if applicable.	-	-	-	X

NOTE - If applicable.

9. Structural features

9.1 General

9.1.1

The completely assembled circuit breaker, including linkages and all other parts, shall have ample mechanical strength to withstand without damage all stresses incident to multiple operation within the rated short-circuit current or the related required capabilities of the circuit breaker as well as stresses resulting from mounting, moving (if feasible), or maintaining the circuit breaker in a proper manner.

9.1.2

No part shall unduly change its characteristics due to aging, temperature variations, moisture, corrosion, or wear; loosen excessively with operation; require delicate or frequent adjustments; or require frequent periodic lubrication.

9.1.3

All pressure gauges, counters, fluid level indicators and running time meters shall be readable from ground level without the use of ladders or portable stands.

9.1.4

The circuit breaker shall be designed for convenient installation and to permit reasonable access to all parts for inspection, maintenance, and adjustments.

9.1.5

The circuit breaker shall consist of a minimum number of assemblies except for interrupters and other parts subject to deterioration. Such parts shall be easily removable in small assemblies.

9.1.6

Original and renewal parts shall be so manufactured that they can be assembled in the field without undue fitting.

9.1.7

All nuts and studs shall be securely locked in place to prevent loosening during operation.

9.1.8

Removable bolts or nuts shall be adequately protected from corrosion and shall be easily accessible with the proper tool.

9.1.9

All moving parts shall be made free from objectionable friction due to corrosion or galling of pins, shafts, bushings, etc., by the use of material in the proper corrosion-resistant and nongalling combinations, properly protected.

Corrosion-resistant cotter pins, fasteners, and washers shall be used throughout. All clevises and hangers shall be designed to allow rotating pins to move without excessive wear of cotter pins and other fasteners. Where lubricant is

required, the manufacturer shall recommend a noncorrosive and noncongealing lubricant and convenient means shall be provided for its application.

9.1.10

On outdoor circuit breakers, the housing containing the operating mechanism shall have an insect screen, be weatherproof, and be mounted so that any equipment inside the housing subject to water damage will be located not less than 18 inches above the circuit breaker foundation.

9.1.11

A reliable, easily readable mechanical position indicator shall be furnished to indicate the open and closed positions of the circuit breaker. The word “open” or “O,” in white letters, shall be displayed on a green background and the word “closed” or “C”, in white letters, shall be displayed on a red background. On spring-charged mechanisms, the mechanism indicator shall display the word “charged,” in black letters on a yellow background and the word “discharged,” in black letters, on a white background. If more than one mechanism is utilized, each shall be equipped with the above operation indicators.

9.1.12

Each circuit breaker shall be provided with facilities for making a ground connection capable of carrying fault currents equal to rated short-circuit currents and related required capabilities. Frame and common base-mounted circuit breakers shall have two such facilities, located at the base below Terminals 1 and 6. Ground connectors shall not depend on any structural frame bolted joint; therefore, additional ground pads shall be furnished or frames can be welded.

Separately mounted tanks shall have two such facilities per phase, one below each terminal.

9.1.13

The design of gasket seals shall be such that the gasket will not be displaced by pressure caused by circuit breaker operation at rated short-circuit current and at related required capabilities.

9.1.14

Coil springs, when used, should not carry current and should preferably be used in compression only.

9.1.15

All conduit and conduit fittings on the circuit breaker shall be of adequate size toprevent jamming of wires and, where exposed to possible use for climbing, shall be of adequate size and mounting strength to support readily the weight of a person.

9.1.16

Provisions shall be made to protect all control wires from rough and sharp edges, and be routed so as to minimize the effects of magnetic impulses.

9.1.17

All surfaces of outdoor breaker frames, tanks, operating mechanisms, and other parts exposed to possible corrosion shall be weatherproofed and designed to prevent accumulation of moisture. Those surfaces that require painting shall be shotblasted, sandblasted, or chemically cleaned and given at least two coats of rust-inhibitive paint at least three mils total thickness by the manufacturer. A salt spray test meeting ASTM B117 requirements may be specified.

9.1.18

The circuit breaker shall be suitable for application in a location subject to seismic disturbances, when specified. The user shall specify the seismic conditions and acceptable response when the requirement is specified.

9.2 Air magnetic circuit breakers

9.2.1

In air magnetic circuit breakers, the arc-enclosing structure shall be designed to permit ready access to the contacts for inspection and maintenance.

9.2.2

In air magnetic circuit breakers, barriers or other effective means shall be provided to prevent ionized gases from transversing between poles or to other adjacent equipment.

9.3 Oil circuit breakers

9.3.1

In oil circuit breakers, the main operating shaft, the control conduits, and other connecting members shall be designed to prevent the transfer of gas from any tank to the operating mechanism housing.

9.3.2

Oil circuit breaker tanks shall be oil-tight except for the relief port and shall be designed to prevent the entrance of water into the tank. All other parts subject to water damage shall be protected by a waterproof housing. In oil circuit breakers having a rated short-circuit current of 7 kA or higher, each tank shall have a reliable, easily readable oil level indicator, located where it can be plainly seen, and of ample range for all service conditions listed in ANSI/IEEE C37.04.

9.3.3

Frame-mounted oil circuit breakers shall be designed so that the tanks may be readily lowered and removed.

9.3.4

Floor-mounted and common base-mounted oil circuit breakers shall be provided with manholes located so that, with all contacts and mechanisms in place, a person can easily enter the tank. If the manholes are located in the side of the tank, the manhole covers shall be hinged. The manholes shall be large enough to permit the removal of all internally mounted parts from the tank. Means shall be provided on the sloping bottom of the tank to ensure safe footing and shall be designed so that sediment or liquids will not be trapped. Two or more openings shall be provided in the sides of the tank support, below the bottom, sufficiently large to permit easy access for painting and inspection of the tank bottom.

9.3.5

The tanks of dead-tank oil circuit breakers having a rated short-circuit current of 7 kA or higher shall be equipped with an oil drain connection at the lowest part of the tank and an oil filling connection located in the upper part of each tank. Drain connections shall be equipped with a valve whose drain end is closed with a substantial pipe plug. The drain valve shall be located outside the lower rim of the tank. When the oil sampling valves are used, they shall be connected to the drain side of the main drain valve so that they can be maintained without having to empty the tank.

9.4 Vacuum circuit breakers

9.4.1

Vacuum circuit breakers shall be provided with a means for determining contact wear.

9.4.2

Vacuum circuit breakers shall be designed with the capability for the customer to replace the vacuum interrupters.

9.4.3

In some applications, for example, motor switching, surge protection may be required.

9.5 Compressed air or other gas circuit breakers

9.5.1

The external current carrying parts shall be of such a capacity so as not to increase the temperature of interrupters or interrupter housings.

9.5.2

Provisions shall be provided for the withdrawal of gas from circuit breaker gas systems, for measuring the moisture content, dielectric strength, and other characteristics of the gas. When practical, these measurements should be possible without removing the circuit breakers from service.

9.5.3

Each gas system on a circuit breaker shall have an ASME-approved safety of relief valve.[1]

9.5.4

Each circuit breaker shall be furnished with a support frame or frames which will elevate the breaker to the required height.

10. Incorporated secondary and control devices

10.1

All control devices, including current transformers and secondary connections, shall be designed to withstand without injury the mechanical shocks incident to handling and operations at rated short-circuit current, and at related required capabilities of the circuit breakers stipulated in ANSI C37.06.

[1] Some designs incorporate an intrinsic pressure relief system, such as a portion of the enclosure designed and tested to rupture in a controlled fashion. Such designs shall be considered acceptable if agreeable between the user and manufacturer.

10.2

Current transformers and control and instrument transformer secondary wiring, if a part of the breaker or its assembly, shall be located or protected by metallic coverings so as to provide adequate shielding from voltages induced by switching surges, from arcing in or around the circuit breakers, and to minimize the possibility of insulation failure introducing line potential on this wiring.

10.3

The insulation class of all control and instrument transformer secondary wiring shall be coordinated with the voltage conditions it may be expected to encounter, and shall in no case be less than 600 volts.

10.4

The control and instrument transformer secondary wiring shall be oil-, water-, and flame-resistant, and shall be provided with oil stops where the wiring enters a chamber and is exposed to oil vapor. Polarity, phase, and tap identification shall be provided. High-temperature insulated wire shall be used for connections to heaters.

10.5

Closing and trip coil leads, instrument transformer secondary leads, solenoid valve leads, and similar wiring shall be securely anchored to the coil.

10.6

Wire sizes for control wiring and instrument transformer secondary leads shall be coordinated with the inherent current requirements and voltage drop limitations of the breaker. Wire shall be stranded copper and in no case shall be smaller than No. 14 AWG. The wire ends shall be permanently fitted with pressure-type connectors before attachment to terminal studs. Splices shall be avoided wherever practicable, but, if required, for control wiring they shall be brazed or made by permanently fitted pressure-type connectors. No splices shall be allowed in current transformer secondary leads.

10.7

Dependable, weatherproof, and adequately sealed terminal facilities shall be provided for current transformers, linear couplers and bushing potential devices, when designed for outdoor service.

10.8

All terminal blocks for instrument transformer and linear coupler secondary leads, where those devices are a part of the outdoor breaker assembly, shall be located in the operating mechanism housing or in other suitable housings conveniently located near the breaker. Terminal blocks, including those for external wiring connections, shall be molded heavy-duty compound of sufficient size to easily accommodate terminals for No. 8 AWG and smaller stranded copper wire and shall meet the withstand voltages of ANSI/IEEE C37.09.

10.9

All terminals and control circuit wiring shall be capable of withstanding 1500 volts, 60 Hz or one minute in accordance with ANSI/IEEE C37.09. The duration of the test may be one second if a voltage of 1800 volts is applied.

10.10

Provision shall be made at terminal blocks for convenient and adequate grounding of instrument transformer secondary circuits.

10.11

The metallic parts of terminals for control and instrument transformer wiring shall be nonferrous and corrosion-resistant.

10.12

All component wiring shall be terminated on terminal blocks.

10.13

All terminals of control wires and instrument transformer circuits shall be identified in a substantial manner. This identification shall be the same as that shown on the breaker elementary and wiring drawings. Physical arrangement of all wiring terminals shall be identical on all similar circuit breakers.

10.14

Auxiliary switch contacts and bearings shall be made of corrosion-resistant materials, and the other parts shall be treated to resist corrosion.

10.15

Auxiliary compartments shall be provided with heaters to minimize condensation. For personal safety, heaters in areas subject to accidental contact shall be equipped with barriers.

11. Purchaser’s detailed requirements

11.1 General

When requesting proposals for ac high-voltage circuit breakers, the purchaser shall furnish to the manufacturer or vendor as much as is necessary of the information outlined in 11.2 through 11.14 to describe completely the requirements.

11.2 Purchaser’s specification number and date

11.3 Number of circuit breakers required and delivery requirements

11.4 System characteristics

— Line-to-line voltage (normal and maximum);
— Number of phases;

- Frequency;
- System grounded or ungrounded;
- Method of grounding;
- Minimum phase spacing;
- Minimum reclosing time.

11.5 Application

11.5.1 Type of circuit

- Line (overhead or underground);
- Generator;
- Transformer;
- Motor;
- Capacitor (kvar and how switched);
  - Nominal capacitor bank voltage;
  - Connection - wye or delta, grounded or ungrounded;
  - Single-bank or back-to-back switching;
  - Impedance between banks.
- Shunt reactor (kvar and how switched).

11.5.2 Special system requirements

- Synchronizing service;
- Out-of-phase switching;
- Greater than twice the line-to-neutral value of the rated maximum voltage across open contacts;
- Frequency of operation;
- High rate of rise of recovery voltage;
- High surge voltage;
- Individual pole operation (close and open);
- Independent pole tripping;
- Special loading capability;
- General or definite-purpose breaker (detailed system characteristics are required where definite-purpose breaker is specified).

11.5.3 Unusual physical conditions

- Corrosive atmosphere;
- Exposure to floods;
- Ambient temperatures;
- High altitude;
- Sound level prescribed;
- Seismic limits.

11.5.4 Nuclear power plant application requirements

- Humidity;
- Pressure;
- Radiation;
- Seismic;
- Safety class.

11.6 Circuit breaker electrical characteristics

— Rated maximum voltage (kV);
— Insulation level, low-frequency and full-wave impulse withstand test (kV);
— Rated continuous current;
— Overload capability (define,percent,and time);
— Rated short-circuit current;
— Rated interrupting time;
— Reclosing time;
— Reclosing duty cycle;
— Rated system frequency;
— Closing time;
— Resistor data (closing surge suppression), resistance value hot and cold, duty cycle or thermal limit and insertion time with tolerances;
— Maximum permissible tripping current (*E/Z* and cutoff current);
— Minimum dead time (cycles) to ensure that reclosing time is not too short;
— Circuit *X/R* if higher than that defined in ANSI/IEEE C37.010.

11.7 Circuit breaker physical characteristics

11.7.1 General

— Indoor;
— Outdoor;
— Number of poles;
— Single tank;
— Multi-tank;
— Phase spacing (on multi-tank breakers).

11.7.2 Method of Interrupting

— Compressed air;
— Air magnetic;
— Oil;
— Vacuum;
— SF_6 gas;
— Other.

11.7.3 Type of mounting

— Floor, with common base;
— Floor, with individual bases;
— Frame;
— Cell;
— Station-type cubicle switchgear;
— Metal-clad switchgear;
— Gas insulated substation.

11.8 Bushing characteristics

— Voltage class, if different from breaker;
— Extra creepage of high altitude, if required;

- Type and size of terminal connectors;
- Required cantilever loading in excess of ANSI/IEEE 24.

11.9 Operating mechanism and auxiliaries

11.9.1 Closing mechanism

- Voltage;
- Type:
  - Solenoid;
  - Motor;
  - Hydraulic;
  - Pneumatic;
  - Motor-charged spring;
  - Manual-charged spring;
  - Manual.

11.9.2 Tripping mechanism

- Voltage;
- Type:
  - DC shunt trip;
  - AC capacitor or reactor trip;
  - Undervoltage trip;
  - Time delay trip unit, if required;
  - Transformer tripping solenoid.

11.9.3 Compressed air or other gas circuit breakers

On decrease of gas pressure below minimum value, the circuit breaker shall be as follows:

- Tripping
  - Prevented from tripping; or
  - Tripped automatically.
- Closing:
  - Prevented from closing; or
  - Closed automatically.

11.9.4 Auxiliary switches and control wiring

Refer to ANSI C37.11 and indicate the following:

- Selected operating connection;
- Number of auxiliary switches in addition to those normally required for circuit breaker operation.

11.9.5 Characteristics of purchaser’s auxiliary power supply

- Voltage, including ac and dc range;
- Frequency;
- Number of phases;
- Number of wires (three, four, etc.);
- Required interrupting capacity;
- Type of grounding.

11.9.6 Relays, meters, and other equipment

— Number and characteristics of relays, meters, reclosing, and other equipment that are to be furnished;
— Location of this equipment.

11.10 Current and potential devices

11.10.1 Current transformers

— Number;
— Ratios;
— Relaying or metering accuracy class;
— Locations;
— Voltage class, when other than bushing-type transformers are used.
— Rating and/or thermal factor if greater than 1.0.

NOTE — If free standing current transformers are specified, they shall meet all electrical and mechanical requirements of the breaker.

11.10.2 Linear coupler transformers

— Number;
— Locations.

11.10.3 Bushing potential devices

— Number;
— Ratings;
— Locations.

11.11 Miscellaneous

11.11.1 Maximum dimensions permitted by space and handling limitations

— Height;
— Depth;
— Width.

11.11.2 Requirements for Interlocks and key coordinations or for Improper operation alarms

11.11.3 Mounting facilities for time travel device

11.11.4 Number and type of maintenance closing devices

11.11.5 Number and type of tank litters or handling devices

11.11.6 Number of sets of special assembly or maintenance tools

11.11.7 Color of paint

11.12 Tests required of manufacturer

11.12.1 Standard tests

Refer to ANSI/IEEE C37.09.

11.12.2 Additional tests

- Nature of tests to be made;
- Circuit breakers for which certified test data are to be furnished are as follows:
  - Number of circuit breakers covered by these specifications that are to be tested;
  - An identical circuit breaker previously fabricated.
- Field tests.

11.13 Drawings and data

11.13.1

Purchasers drawings and data comprise a part of these specifications.

11.13.2

Drawings and data to be furnished by the successful bidder are as follows:

- Number and type of drawings to be submitted for purchaser’s review prior to manufacture, and the time allowed for their return to meet the promised shipping date;
- Number of copies of instruction books;
- All documentation to be in English.

11.14 Shipping instructions

- Destination;
- Degree of assembly;
- Impact recorder requirements, if any;
- Desiccant requirements, if any.

12. Information to be furnished by manufacturer or vendor with bid

12.1 General considerations

When submitting proposals for ac high-voltage circuit breakers, the manufacturer or vendor shall furnish to the purchaser as much of the information listed in 12.2 through 12.20 as is necessary to completely describe the equipment intended to be supplied in accordance with the purchaser's detailed requirements.

12.2 Manufacturer's statement

A statement from the manufacturer that the proposal is in accordance with the purchaser's specification or, if not, a listing of all exceptions.

12.3 Circuit breaker type and designation number

12.4 Dimensional data

Outline drawings, photographs, or descriptive sheets and sketches to describe clearly the construction and operation of the equipment covered by the proposal. The data should include a listing of guide values for static and dynamic forces that influence the foundation loading requirements.

12.5 Circuit breaker ratings and related required capabilities

12.5.1 Voltage ratings

— Rated maximum voltage (kV) rms;
— Rated voltage range factor (*K*).

12.5.2 Insulation level withstand tests

— Rated low-frequency withstand voltage (rms kV);
— Rated full-wave impulse withstand voltage (crest kV);
— Maximum out-of-phase voltage the open breaker can tolerate.

12.5.3 Current ratings in amperes

— Continuous;
— Closing and latching capability;
— Short-time carrying capability.

12.5.4 Interrupting ratings in amperes

— Rated short-circuit current;
— Maximum symmetrical interrupting capability;
— Maximum asymmetrical interrupting capability;
— Percent of rating for specified reclosing duty cycle.

12.6 Copies of certified breaker design test data when required by customer

12.7 Time characteristics at rated control voltage and operating pressure

- Opening time (from energization of trip coil to contact parting);
- Closing time;
- Minimum reclosing time;
- Maximum interrupting time:
  - For 25% to 100% of the required asymmetrical interrupting capability;
  - For less than 25% of the required asymmetrical interrupting capability.
- Additional time for interrupting of resistor current.

12.8 Breaker electrical data, actual representative values

- Phase spacing;
- Typical measured external creepage distance, phase to ground;
- External striking distances:
  - Phase to ground;
  - Phase to phase.

12.9 Operating mechanism and auxiliaries data

- *E/Z* and cutoff current in closing circuit at rated voltage;
- *E/Z* and cutoff current required by shunt trip circuit for opening and closing-opening at rated voltage;
- Voltage and wattage requirements of heater elements used in housing of operating mechanism or circuit breaker.

12.10 Compressed air or other dual-pressure gas circuit breakers

12.10.1

Number of closing-opening circuit breaker operations that can be performed by the gas in the individual circuit breaker reservoir only, starting at the normal working pressure and without replenishing the supply.

12.10.2

Normal value of gas pressure in the individual circuit breaker reservoir and range of gas pressure within which circuit breaker will operate satisfactorily.

12.10.3

Number of cubic feet of free gas required for each closing-opening operation.

12.10.4

Description of gas system to be furnished with circuit breaker is as follows:

- Number of compressor units and a complete description of each unit, including number type, and rating of compressors, number and capacity of all storage tanks, and tank working pressures, and setting of safety valves and relief devices;
- Description of control circuit;

- Description of alarms;
- Description of reducing-valve operation and all automatic features;
- Description of facilities for elimination of moisture and dirt in the gas system;
- Power supply data:
  - AC voltage, phases and amperes;
  - Locked rotor and maximum running currents required by each motor at rated voltage;
  - DC voltage and amperes.

12.10.5

Recommendations covering gas supply piping and accessories.

12.10.6

Calculated values of the following when gas pressure is reduced to atmospheric pressure:

- Impulse withstand voltage;
- Low frequency (60 Hz) impulse withstand voltage:
  - Across the open contacts;
  - Phase to ground.
- Interrupting current limitations.

12.10.7

Minimum gas pressure at which the breaker can interrupt rated short circuit current.

12.10.8

Level of gas pressure at which the breaker must be isolated from the system to prevent failure.

12.11 Single pressure gas (SF_6) breakers

12.11.1

Normal value of gas pressure in the individual circuit breaker system and range of gas pressure within which circuit breaker will operate satisfactorily.

12.11.2

Number of pounds of gas required to fill the breaker.

12.11.3

Description of alarms.

12.11.4

Value of the following when gas pressure is reduced to atmospheric pressure:

- Impulse withstand voltage;
- Low frequency (60 Hz) impulse withstand voltage:
  - Across the open contacts;
  - Phase to ground.

12.11.5

Minimum gas pressure at which the breaker can interrupt rated short circuit current.

12.11.6

Level of gas pressure at which the breaker must be isolated from the system to prevent failure.

12.12 Pneumatically or hydraulically operated circuit breakers

12.12.1

Number of closing-opening operations that can be performed by the energy in the stored energy device on each circuit breaker, starting at the normal working pressure and without replenishing the energy.

12.12.2

Normal value of pressure and the range of pressure within which the circuit breaker will operate satisfactorily.

12.12.3

Description of stored energy system to be furnished with circuit breakers:

- Description of control circuit;
- Description of all automatic features;
- Description of facilities for elimination of moisture and dirt in the system;
- Power supply data:
  - AC voltage, phases and amperes;
  - Locked rotor and maximum running currents required by each motor at rated voltage;
  - DC voltages and amperes.
- Time required to pump from lockout pressure to normal pressure.

12.13 Spring-operated mechanism

- Number of close-open operations that can be performed by mechanism before having to recharge spring;
- Rated voltage, frequency, and current, and maximum starting current required to operate the spring-charging motor;
- Description of control circuit including limit switches, etc.;
- Time required to charge the spring-operated mechanism.

12.14 Bushing data

- Name of bushing manufacturer, type designation, and outline drawing;
- Voltage rating;
- Current rating;
- Wet withstand voltage test at operating frequency (for outdoor bushings only);
- Dry withstand voltage test at operating frequency;
- Full-wave impulse withstand voltage test;
- Permissible safe cantilever loading at external terminal of bushing as installed;
- Facilities provided for making power factor test;
- Brief description of bushing construction;
- lnterchangeability with purchaser’s other bushings when purchaser provides a list of such bushings stocked.

12.15 Current and potential devices

12.15.1 Current transformers

- Number furnished;
- Total number for which space is available;
- Type (multi or single ratio);
- Ratings;
- Relaying or metering accuracy class;
- Thermal factor;
- Ratio.

12.15.2 Linear coupler transformers and bushing potential devices

- Number;
- Type;
- Ratings;
- Mutual reactance.

12.16 General Information

12.16.1

Net weight of complete circuit breaker:

- With oil or gas;
- Without oil or gas.

12.16.2

Quantity of oil or gas per complete circuit breaker.

12.16.3

Facilities provided for filling and removing oil or gas from the circuit breakers.

12.16.4

Facilities provided for handling complete breaker or individual pole units.

12.16.5

Facilities provided for lifting and removing bushings and vertical clearance required for bushing removal.

12.16.6

Facilities provided for handling removable tanks.

12.16.7

Facilities provided for removing and replacing arc chutes and heavy interrupter assemblies.

12.16.8

Impact loading of circuit breaker during opening and closing operations.

12.17

Tests, and a statement of any price additions for tests requested in purchaser's specifications.

12.18

List of exceptions to specifications.

12.19 Storage requirements

Manufacturer's recommendations for storage and any required maintenance during storage.

12.20

Recommended frequency of manually initiated operations to insure proper automatic operation of breaker mechanism.

12.21

Value of grading capacitors and capacitance equivalent model of circuit breaker.

13. Information to be furnished by successful bidder only

The following information shall be furnished prior to or at the time of delivery in the quantities specified by the purchaser's detailed requirements at the time of the bid request:

- Instruction books specifically covering the equipment furnished, including part numbers of assemblies and components. Specific identification of replacement parts, components, and assemblies shall be included;
- Drawings, diagrams, and photographs;
- Certified test data when specified by purchaser;
- Actual contact opening time from energization of trip coil to contact parting;
- Travel record curve for circuit breaker designs adaptable to the application of a time travel device. Equivalent timing information should be furnished for circuit breaker designs not adaptable to the application of a time travel device;
- Maximum dc resistance of the power-carrying circuit from terminal to terminal of circuit breaker when new;
- Power factor of oil filled condenser bushings rated 25.8 kV or higher and when specified by the purchaser;
- Listing of recommended spare parts to be maintained as spares by the purchaser;
- Storage requirements.

Annex A Bibliography

(Informative)

ASTM B117-1990, *Test methods for salt spray (fog testing)* [2]

[2] Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.