

1 **PC37.30.3™/D2.10**
2 **Draft Standard for Requirements for**
3 **Interrupter Switches, Interrupters or**
4 **Interrupting Aids Used on or Attached**
5 **to Switches Rated for High-Voltage AC**
6 **Above 1000 Volts**

7 Sponsor

8

9 **High Voltage Switch**

10 of the

11 **IEEE Switchgear**

12

13

14 Approved <Date Approved>

15

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1 **Abstract:** This standard covers requirements for Interrupter Switches, Interrupters or Interrupting Aids
2 Used on or Attached to Switches Rated for High-Voltage AC Above 1000 Volts and used indoors,
3 outdoors, or in enclosures for non-fault current interrupting for which an interrupting duty is assigned. It
4 includes preferred ratings, construction application, loading, installation, operation and maintenance
5 guidelines. This standard does not apply to load-break separable insulated connectors, circuit-breakers,
6 circuit-switchers, metal enclosed switchgear, pad mounted switchgear, reclosers, sectionalizers or other
7 switching devices that are covered by other IEEE standards.

8
9
10 **Keywords:** Interrupting switches, high voltage switches, indoor switches, outdoor switches
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1 Introduction

2 This introduction is not part of PC37.30.3/D2.10, Draft Standard for Requirements for Interrupter Switches,
3 Interrupters or Interrupting Aids Used on or Attached to Switches Rated for High-Voltage AC Above 1000 Volts.

4 This standard provides the product code for switching (except capacitive current) and fault making tests for
5 switching devices for alternating current, rated above 1000 volts and used indoors, outdoors, or in
6 enclosures.

7

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1 Draft Standard for Requirements for 2 Interrupter Switches, Interrupters or 3 Interrupting Aids Used on or Attached 4 to Switches Rated for High-Voltage AC 5 Above 1000 Volts

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16 1. Overview

17 1.1 Scope

18 Standard Requirements for Interrupter Switches, Interrupters or Interrupting Aids Used on or Attached to
19 Switches Rated for High-Voltage AC Above 1000 Volts and used indoors, outdoors, or in enclosures for non-
20 fault current interrupting for which an interrupting duty is assigned. This standard covers preferred ratings,
21 construction application, loading, installation, operation, and maintenance guidelines. This standard does not
22 apply to load-break separable insulated connectors, circuit-breakers, circuit-switchers, metal enclosed
23 switchgear, pad mounted switchgear, reclosers, sectionalizers or other switching devices that are covered by
24 other IEEE standards.

25

1 1.2 Purpose

2 The purpose of this standard is to provide a basic standard Requirements for Interrupter Switches, Interrupters
3 or Interrupting Aids Used on or Attached to Switches Rated for High-Voltage AC Above 1000 Volts

4

5 2. Normative references

6 The following referenced documents are indispensable for the application of this document (i.e., they must be
7 understood and used, so each referenced document is cited in text and its relationship to this document is
8 explained). For dated references, only the edition cited applies. For undated references, the latest edition of the
9 referenced document (including any amendments or corrigenda) applies.

10 ANSI/IEEE Std C37.100-2007 IEEE Standard Definitions For Power Switchgear

11 IEEE Std C37.09-2007, IEEE Standard Test Procedure For AC High-Voltage Circuit Breakers Rated On A
12 Symmetrical Current Basis (ANSI)¹

13 IEEE Std C37.20.2-2005, IEEE Standard For Metal-Clad And Station-Type Cubicle Switchgear (ANSI)

14 IEEE Std C37.20.3-2013, IEEE Standard For Metal-Enclosed Interrupter Switchgear (ANSI)

15 IEEE Std C37.30.1-2011, Standard Requirements For High-Voltage Air Switches

16

17

18

19 3. Definitions

20 For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary*
21 *Online* should be consulted for terms not defined in this clause.²

22 **Allowable Continuous Current Class (ACCC) Designation (of an Air Switch):** A code that identifies the
23 composite curve relating the loadability factor (LF) of the switch to the ambient temperature θ_A as determined
24 by the limiting switch part class designations.

25 **Arc Reach:** The distance from a point midway between the arc extremities to the most remote point of the
26 arc at the time of its maximum length.

27 **Arcing Horn:** One of a pair of diverging electrodes on which an arc is extended to the point of extinction
28 after the main contacts of the switching device have parted.

29 **Distribution Class:** A descriptive term used to denote application, restriction, or both to that part of an
30 electric system between the substation and the customer.

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- 1 **Enclosed Switch:** Switches designated for operation within a housing restricting heat transfer to the external
2 medium.
- 3 **Horn-Gap Switch:** A switch provided with arcing horns.
- 4 **Indoor Switch:** Switches designated for operation inside buildings or weather-resistant enclosures which do
5 not restrict heat transfer to the ambient.
- 6 **Interrupter Switch:** A switching device, designed for making specified currents and breaking specified
7 steady state currents. (HVS, Swg)
- 8 **Interrupting Aids:** A current-interrupting device that can be attached to an air switch to improve its
9 interrupting capability. (eg Quick Break Arcing horns; Vacuum, SF6 and Expulsion interrupters)
- 10 **Lightning Impulse Dry Withstand Voltage:** The crest value of a voltage impulse with a front duration from
11 less than one to a few tens of microseconds that, under specified conditions, can be applied without causing
12 flashover or puncture.
- 13 **Loadability Factor:** The ratio of allowable continuous current at a given ambient temperature to rated
14 current.
- 15 **Loadability:** The ratio of allowable continuous current at 25° C ambient temperature to rated continuous
16 current.
- 17 **Observable Temperature Rise:** The observable temperature rise of any part of the switch is the steady-state
18 temperature rise above ambient temperature.
- 19 **Outdoor Switch:** Switches designated for operation outside buildings or enclosures. Outdoor switches may
20 be exposed to the weather. Outdoor switches experience no restriction of heat transfer to the ambient.
- 21 **Peak Withstand Current:** The maximum instantaneous current at the major peak of an offset power
22 frequency sinusoidal current that a switch is required to carry.
- 23 **Power Frequency:** The frequency at which a device or system is designed to operate.
- 24 **Quick break Arcing Horns:** commonly referred to also as a quick break whip – a conductive member
25 mounted such that as the main switch blade opens it remains in contact then releases and quickly creates a
26 large open gap for improved current interruption compared to arcing horns.
- 27 **Making Current:** The value of the available current at the time the device closes.
- 28 **Short-time (Symmetrical) Withstand Current Duration:** The maximum duration of short-time
29 (symmetrical) withstand current that a switch is required to carry.
- 30 **Short-time (Symmetrical) Withstand Current:** An abnormal power frequency current, the initial portion of
31 which may have a dc offset, expressed in rms symmetrical amperes that a switch is required to carry.
- 32 **Station Class:** A descriptive term used to denote application or restriction or both to generating stations,
33 switching stations, substations and transmission lines.
- 34 **Switch Part Class Designation:** A code that identifies the curve that relates the loadability factor (LF) of a
35 switch part material and function to the ambient temperature θ_A .
- 36 **Switch:** Within this document, the noun "switch" shall refer to switching devices, interrupters, current
37 interrupting devices, interrupting aids or interrupter switches.

1 **Switching Impulse Withstand Voltage:** The crest value of a voltage impulse with a front duration from tens
2 to thousands of microseconds that, under specified conditions, can be applied without causing flashover or
3 puncture.

4 **Visible Corona:** A luminous discharge due to ionization of the air surrounding a device, caused by a voltage
5 gradient exceeding a certain critical value.

6

7 **4. Normal (usual) and special (unusual) service conditions**

8 Clause 2 of IEEE C37.100.1-2007 applies with the additions and modification given in sub clauses 4.1, 4.2,
9 and 4.3.

10 **4.1 Normal (Usual) service conditions**

11 **4.1.1 Indoor switchgear**

12 Clause 2.1.1 of IEEE C37.100.1-2007 applies with the following modifications

13 The ambient temperature (temperature of the surrounding air) is within the range of -30°C to +40°C.

14 **4.1.2 Outdoor switchgear**

15 Clause 2.1.2 of IEEE C37.100.1-2007 applies with the following modifications

16 The wind velocity does not exceed 37 m/s (80 mi/h).

17 NOTE 1—The interrupting ability of some switches which rely on a rapidly increasing external air gap for circuit
18 interruption (such as quick break arcing horns) may be influenced by local wind velocity and direction.

19 **4.2 Special (Unusual) service conditions**

20 Clause 2.2 of IEEE C37.100.1-2007 applies with following additions.

21 Where other unusual conditions exist, they should be brought to the attention of those responsible for the
22 design and application of the equipment. Examples of such conditions are:

23 — Equipment that depends on air for its insulating and cooling medium will have a higher temperature
24 rise and a lower dielectric strength when operating at higher altitudes than when operating at lower
25 altitudes. For altitudes above 1000 m (3300 ft), correction factors should be applied to the switch
26 ratings. Altitude correction factors are specified in IEEE Std C37.100.1.

27 — Contamination, such as damaging fumes or vapors, excessive or abrasive dust, explosive mixtures of
28 dust or gases, steam, salt spray, excessive moistures or dripping water.

29 — Abnormal vibration, shocks, earthquakes, or tilting.

30 — Excessively high or low ambient temperatures.

- 1 — Unusual transportation or storage conditions.
- 2 — Unusual space limitations.
- 3 Unusual operating duty, frequency of operation, difficulty of maintenance, poor current wave
- 4 — form (high harmonic content), unbalanced voltage, special insulation requirements.
- 5 — The application of an outdoor switch, indoor switch, or an enclosed switch for other purposes which
- 6 may include concerns regarding weather exposure and restricted heat transfer, see Table 1

Table 1: Applications which may be Considered Unusual

Type of Switch	Switch Exposed to Weather	Installation with Restricted Heat Transfer
Outdoor Switch	Usual	Unusual
Indoor Switch	Unusual	Unusual
Enclosed Switch	Unusual	Usual

5. Ratings

The following table lists the required and optional ratings for each device.

Table 2: Switch Ratings

Switch rating	Interrupter Switch
Rated power frequency	REQUIRED
Rated maximum voltage	REQUIRED
Rated continuous current	REQUIRED
Rated dielectric withstand voltage	REQUIRED
Rated lightning-impulse withstand (BIL)	REQUIRED
Rated switching-impulse withstand (for rated maximum voltage of 362 kV and above)	REQUIRED
Rated power frequency dry withstand	REQUIRED
Rated power frequency wet withstand (outdoor)	REQUIRED
Rated dew power frequency withstand (indoor)	REQUIRED
Rated peak-withstand current	REQUIRED
Rated short-time (symmetrical) withstand current	REQUIRED
Rated short-time (symmetrical) withstand current duration	REQUIRED
Rated mechanical operations	REQUIRED
Rated mechanical terminal load	REQUIRED
Rated ice-breaking ability—manual (outdoor)	OPTIONAL
Rated ice-breaking ability—power: single attempt opening and closing (outdoor)	OPTIONAL
Rated ice-breaking ability—power: single attempt opening, multiple attempt closing (outdoor)	OPTIONAL

Rated load-making current	REQUIRED
Rated fault-making current	OPTIONAL
Rated capacitance-switching overvoltage ratio	REQUIRED ^a
Rated minimum differential-capacitance voltage	REQUIRED
Rated maximum differential-capacitance voltage	REQUIRED
Rated load-interrupting current and expected endurance	OPTIONAL ^b
Rated load-making current and expected endurance	OPTIONAL ^b
Rated load-switching current and expected endurance	OPTIONAL ^b
Rated unloaded transformer interrupting current and expected endurance	OPTIONAL ^a
Rated unloaded transformer making current and expected endurance	OPTIONAL ^a
Rated unloaded transformer switching current and expected endurance	OPTIONAL ^{La}
Rated unloaded transformer loop interrupting current and expected endurance	OPTIONAL ^a
Rated unloaded transformer loop making current and expected endurance	OPTIONAL ^a
Rated unloaded transformer loop switching current and expected endurance	OPTIONAL ^{La}
Rated cable-interrupting current and expected endurance	OPTIONAL ^b
Rated cable-making current and expected endurance	OPTIONAL ^b
Rated cable-switching current and expected endurance	OPTIONAL ^b
Rated line-interrupting current and expected endurance	OPTIONAL ^b
Rated line-making current and expected endurance	OPTIONAL ^b
Rated line-switching current and expected endurance	OPTIONAL ^b
Rated single-capacitance interrupting current and expected switching endurance	OPTIONAL ^a
Rated parallel-connected capacitance-switching current and expected switching endurance	OPTIONAL ^a

- 1 *a Required if the interrupter switch has capacitance-switching ratings.*
 2 *b At least one current-interrupting rating is required for interrupter switches.*

3 **5.1 Rated maximum voltage (V) or (U_r)**

4 Clause 4.1 of IEEE C37.100.1-2007 applies.

5 **5.1.1 Range I for rated maximum voltages of 245 kV and below**

6 Clause 4.1.1 of IEEE C37.100.1-2007 applies.

7 **5.1.2 Range II for rated maximum voltages above 245 kV**

8 Clause 4.1.2 of IEEE C37.100.1-2007 applies.

9
 10

1 **5.2 Rated insulation level (U_d), (U_p)**

2 Clause 4.2 of IEEE C37.100.1-2007 applies.

3

4 **5.2.1 Open Gap Withstand**

5 The air gap of fully open interrupter switches shall withstand voltages that are 110% of the rated lightning
6 impulse dry withstand and the power frequency dry withstand voltages given in C37.30.1-2011 Table 4.

7 Interrupter switches having solid insulation material across the open gap shall withstand 100 percent of the
8 voltages given in C37.30.1-2011 Table 4 and Table 8 and Table 10

9 Interrupter switches with solid insulation across the open gap shall withstand the rated wet withstand voltage
10 given in C37.30.1-2011 Table 4 and Table 8 and Table 10 Corona and Radio Influence Test Voltage Limits
11 For interrupter switches rated 123kV and above, subclause 6.1.1.7.3 of C37.30.1-2011 is applicable.

12

13 **5.2.2 Rated power frequency dry withstand voltage**

14 The rated power frequency dry withstand voltage is the power frequency withstand voltage that the switch is
15 required to withstand for a duration of 60s under dry conditions.

16 Insulation between the live parts of a switch and ground shall withstand 100% of the rated power frequency
17 dry withstand voltage.

18 Insulation across the open gap of switches shall withstand 100% or 110% of the rated power frequency dry
19 withstand voltage, if required by other standards, such as the C37.20 series.

20 **5.2.3 Rated power frequency wet withstand voltage**

21 The rated power frequency wet withstand voltage is the power frequency withstand voltage that an outdoor
22 switch is required to withstand for a duration of 10s under wet (rain) conditions. There are no power frequency
23 wet withstand requirements for indoor or enclosed switches.

24 Insulation between the live parts of an outdoor switch and ground shall withstand 100% of the rated power
25 frequency wet withstand voltage.

26 If, utilizing good engineering judgment, one cannot determine that solid insulation, which fully or partially
27 bridges the open gap, will not adversely affect the open-gap withstand, a wet-withstand test shall be made, and
28 the open gap shall withstand 100% of the rated wet power frequency withstand voltage.

29 **5.2.4 Rated power frequency dew withstand voltage**

30 The rated power frequency dew withstand voltage is the power frequency withstand voltage that an indoor or
31 an enclosed switch is required to withstand, without flashover or damage to any insulation, for a duration of 10
32 seconds with dew (condensate) over the switch's solid insulation. There is no power frequency dew withstand
33 requirement for outdoor switches. If the open gap of an enclosed switch is effectively bridged by a solid
34 insulation, a dew withstand test shall be made, and the open gap shall withstand 100% of the rated power
35 frequency dew withstand voltage.

36 **5.3 Rated power-frequency (f_r)**

37 Clause 4.3 of IEEE C37.100.1-2007 applies.

5.4 Rated continuous (normal) current (I_r)

Clause 4.4 of IEEE C37.100.1-2007 does not apply.

The rated continuous current is the maximum current the switch shall be required to carry continuously under usual service conditions without exceeding specified temperature limits. The current is in rms amperes at rated power frequency.

IEEE Std C37.30.1-2011 Table 3 applies to the switches when an interrupting aid is applied on a switch with an ACCC designation. Interrupting aids do not have continuous carrying current capability.

CAUTION

Interrupter switches are not required to interrupt currents beyond their interrupting rating.

The following table applies if IEEE Std C37.30.1 is not specified

Table 3: Total temperature limits for contacts, connections, and insulation of interrupting switch¹

Description of part and dielectric material ^{2,3,4}	Total temperature (°C)	Temperature-rise over 40 °C ambient (°C)
1. Contacts⁵		
Bare copper and bare copper alloy		
In air	75	35
In SF ₆	90	50
In oil	80	40
Silver-coated, nickel-coated, or equivalent		
In air	105	65
In SF ₆	105	65
In oil	90	50
Tin-coated		
In air	90	50
In SF ₆	105	65
In oil	90	50
2. Connections, bolted or the equivalent⁶		
Bare copper, bare copper, or aluminum alloy		
In air	90	50
In SF ₆	100	60
In oil	100	60
Silver-coated, nickel-coated, tin-coated, or equivalent		
In air	125	85

In SF ₆	125	85
In oil	100	60
3. All other contacts or connections made of bare metals or coated with other materials⁷		
4. Terminals for bolted connection to external conductors^{8,9}		
Bare	90	50
Silver, nickel, or tin-coated equivalent	105	65
5. Oil for oil switching devices		
Top oil [measured 2.5 cm (1 in) below the surface]	90	50
6. Metal parts acting as springs¹⁰		
7. Non-energized parts subject to contact by personnel		
Handled by operator	50	10
Accessible to operator	70	30
External surfaces accessible to operator	110	70
8. Insulating material in contact with current carrying parts		
Class 90 insulation	90	50
Class 105 insulation	105	65
Class 130 insulation	130	90
Class 155 insulation	155	115
Class 180 insulation	180	140
Class 220 insulation	220	180
9. Other current carrying parts		
Copper or copper alloy casting	105	65
Hard-drawn copper parts ¹¹	80	40
Heat treated aluminum parts	105	65
Woven-wire flexible connectors	75	35

1 Conditions applicable to Table 3 are below:

- 2 1. The treatment of total temperature limits for contacts, connections and insulation will conform to
- 3 the Common Clauses Document, C37.100.1, when applicable
- 4 2. The same part may belong to several categories as listed in the table. In this case the total
- 5 temperature limits and temperature-rise limits are lowest among the relevant categories.
- 6 3. For vacuum switching devices, the total temperature limits and temperature rise limits are not
- 7 applicable for parts in vacuum. The remaining parts shall not exceed the limits given in the table.
- 8 4. Total temperature limits may be restricted by the temperature of surrounding insulating
- 9 materials not directly in contact with current carrying parts.
- 10 5. When contact parts have different coatings, the total temperature limit and
- 11 temperature rise limit shall be those of the part having the lower limits in the table.
- 12 6. When connection parts have different coatings, the total temperature limits and temperature rise limit
- 13 shall be the lower of the limits for the different parts as listed in the table.

- 1 7. When other materials than those given in the table are used, their properties shall be considered in
2 order to determine the total temperature limit and temperature-rise limits.
3 8. The total temperature limits and temperature-rise limits are valid even if the conductor
4 connected to the terminals is bare.
5 9. The temperature of terminals may be limited by the temperature limits of insulated cable, of
6 connectors, or of terminators connected to the terminals.
7 10. The temperature shall not reach a value where the spring force of the material is impaired.
8 11. If annealing will not affect the performance of the switch, the total temperature and
9 temperature rise over a 40°C ambient for copper or copper alloy castings may be used.
10

11 **5.5 Rated short-time withstand current (I_k)**

12 Clause 4.5 of IEEE C37.100.1-2007 applies. Other acceptable ratings can be found in C37.30.1-2011.

13 **5.6 Rated peak withstand current (I_p)**

14 Clause 4.6 of IEEE C37.100.1-2007 applies.

15 **5.7 Rated duration of short-circuit (t_k)**

16 Clause 4.7 of IEEE C37.100.1-2007 applies.

17 **5.8 Rated supply voltage of closing and opening devices and of auxiliary and control** 18 **circuits (U_a)**

19 Clause 4.8 of IEEE C37.100.1-2007 does not apply. Refer to C37.30.1-2011 Table 13 for preferred values.
20

21 **5.9 Rated supply frequency of closing and opening devices and of auxiliary circuits**

22 Clause 4.9 of IEEE C37.100.1-2007 applies.

23 **5.10 Rated pressure of compressed gas supply for insulation and/or operation**

24 The value of the rated pressure shall be specified by manufacturer.

25 **5.11 Rated filling levels for insulation and/or operation**

26 The value of the rated filling levels shall be specified by manufacturer.

1 **5.12 Rated switching duties**

2 The following ratings are common duties associated with switches. To be classified as an interrupter switch,
3 the switch must be rated for one of the following duties, but not necessarily rated for all.

4 **5.12.1 Rated load-switching current and associated TRV**

5 The rated load-switching current is the maximum rms symmetrical power frequency load current flowing in a
6 circuit that the switch shall be required to make and interrupt at its rated maximum voltage.

8 **5.12.2 Rated loop-switching currents**

9 **5.12.2.1 Rated line or cable loop-switching current and associated TRV**

10 The rated line or cable loop-switching current is the maximum rms symmetrical power frequency circulating
11 current flowing in a line or cable formed loop circuit that the switch shall be required to make and interrupt at
12 its rated loop switching voltage.

14 **5.12.2.2 Rated parallel transformer loop-switching current**

15 The rated parallel transformer loop-switching current is the maximum rms symmetrical power frequency
16 circulating current flowing between adjacent parallel transformers that the switch shall be required to make
17 and interrupt at its rated loop switching voltage.

20 **5.12.3 Rated line-charging switching current**

21 The rated line-charging switching current is the maximum rms symmetrical power frequency charging current
22 flowing into an unloaded line that the switch shall be required to make and interrupt at its rated maximum
23 voltage.

24 NOTE— Making current will include a transient whose magnitude is much higher than that of the rated line-
25 charging switching current.

26 **5.12.4 Rated cable-charging switching current**

27 The rated cable-charging switching current is the maximum rms symmetrical charging current flowing into an
28 unloaded cable that the switch shall be required to make and interrupt at its rated maximum voltage.

29 NOTE— Making current will include a transient whose magnitude is much higher than that of the rated cable-
30 charging switching current.

31 **5.12.5 Rated unloaded transformer switching current**

32 The rated unloaded transformer switching current is the maximum transformer exciting current that the switch
33 shall be required to make and interrupt at its rated maximum voltage. The current is expressed in rms
34 symmetrical amperes. Optionally, the rating may be expressed as the maximum transformer size whose
35 exciting current can be switched.

36 NOTE— Making current may include a transient current, several orders of magnitude larger than that of the
37 rated unloaded transformer switching current.

1 **5.12.6 Rated shunt capacitor bank switching current**

2 The rated shunt capacitor bank switching current is the maximum rms symmetrical power frequency capacitor
3 bank current that the switch shall be required to make and interrupt at its rated maximum voltage, within its
4 rated differential capacitance voltage. Filter bank switching requires special consideration and is not currently
5 covered by this document. The capacitive switching current rating has two associated ratings and a class of
6 rating:

- 7 • Rated peak capacitive inrush current, which determines the switch's suitability for switching
8 back-to-back applications;
- 9 • Rated shunt capacitor bank switching endurance, which determines the switch's suitability for
10 long-term repetitive switching of capacitors.

11 The classes of shunt capacitor bank switching current ratings are: Class C0, C1 and C2; as defined by
12 differences in the specified test procedure (see C37.100.2, Shunt Capacitor Switching Tests); C2 most severe
13 with respect to re-striking, C1 somewhat less severe, and C0 no test criteria directed at restrikes.

14 NOTE— Grounded systems have lower transient recovery voltage requirements. Switches rated "systems with
15 grounded sources and loads only" may not be used in non-grounded systems. The harmonic content of the
16 rated switching current shall be <10% and should cause no extraneous current zeros.

17 **5.12.6.1 Rated peak capacitive inrush current**

18 The rated peak capacitive inrush current is the maximum instantaneous value of transient inrush current that
19 the switch shall be required to make when energizing either single or parallel capacitor banks.

20 NOTE— Expected maximum ratios of (rated peak capacitive inrush current) / (rated capacitive switching
21 current) are in the range of 200 for back-to-back capacitors. For single capacitors the ratio is normally less
22 than 20.

23 **5.12.6.2 Shunt capacitor switching endurance**

24 The shunt capacitor switching endurance is the number of shunt capacitor switching operations that the switch
25 shall be capable of successfully performing, while maintained per the manufacturer's instructions.

26 **5.13 Visible corona-free voltage**

27 The visible corona onset voltage is the line-to-ground voltage at which there is an onset of visible plumes or
28 spikes under dark conditions. Outdoor switches, rated 123 kV and above, when tested at voltage levels that
29 are 110% of the line-to-ground equivalent of rated maximum voltage, shall be free of visible corona plumes or
30 spikes produced by the corona discharge.

31 **5.14 Radio influence voltage limit**

32 The radio influence voltage limit is the maximum allowable radio influence voltage at a specified detection
33 frequency and at a specified distance, produced by a switch when energized at a specified voltage at rated
34 power frequency. The limits of radio-influence voltage are given in C37.30.1-2011, Column 6.

35 **5.15 Rated ice breaking ability**

36 The rated ice breaking ability is the maximum thickness of ice under which the switch shall be required to
37 successfully open or close.

38 Clause 6.1.1.4 of C37.30.1-2011 applies to outdoor switches. Indoor and enclosed switches have no ice
39 breaking requirements.

1 **5.16 Rated mechanical operations**

2 The rated mechanical operations is the minimum number of mechanical operating cycles that a switch shall be
3 required to perform without requiring maintenance or adjustment. An operating cycle shall be one close
4 operation and one open operation.

5 **5.17 Rated mechanical terminal load**

6 The rated mechanical terminal load is the static force, equivalent to an external mechanical load, applied at
7 each terminal in a specified direction, that a switch shall withstand, while stationary and during operation. For
8 outdoor switches, a specified number of operations must be accomplished with various terminal loads.
9 The preferred rated terminal loading for outdoor interrupter switches are specified in C37.30.1-2011 table 13.
10 Indoor and enclosed switches have no preferred rated terminal loadings.

11 **5.18 Rated closing time (for power operated switches) -Optional**

12 The rated closing time of a switch is the specified interval in a closing operation between the energizing of the
13 close coil, at the lower limit of the rated control-voltage range, and the making of the current-making switch
14 contacts.
15

16 **5.19 Rated operating duty cycles**

17 The number of operations specified in Table 4 is used to demonstrate the ability of a switch to interrupt the
18 specified duty. Switches rated for two or more of the duties outlined in Table 4 are likely to be called upon to
19 switch these duties randomly throughout their life. All tests outlined in Table 4, for which ratings are desired,
20 are to be performed on the same switch and in any order except that cable-charging switching, line-charging
21 switching, and unloaded transformer switching shall be performed in any order after load-switching and
22 loop-switching tests. The complete set of rated test duties need not, however, be performed for each design
23 modification of a previously certified switch design. To assure that the overall switch performance has not
24 been adversely affected as a result of design modification, the manufacturer shall certify that the modified
25 switch will pass all omitted switching tests. Test duties for which the switch will not be rated shall be skipped.
26 Capacitor bank current switching tests are specifically not part of the sequence outlined in Table 4.
27 Maintenance that could be expected to enhance subsequent interrupting test results during the sequential
28 testing shall not be performed on the switch. Such maintenance may be, but is not limited to, replacing,
29 filtering, or reconditioning the insulation medium or repairing the current-carrying contacts. Equipment
30 repairs may be made where it can be demonstrated that such repairs would not influence the cumulative
31 conditioning effects of previous tests in the design test sequence.

32
33 The number of operations specified in Table 4 is meant only to test the ability of the switch to interrupt the
34 specified duty. If a switch is to be rated for an extended number of operations, a new switch may be used
35 in a separate test to confirm the extended number of operations. Switches rated for more than one
36 type of application shall be tested for each applicable test type in Table 4. Single phase
37 testing is acceptable, refer to C37.30.4.
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Table 4: Switching duties

Test type	Number of operations	Current
Load-switching	10	100% rated load

Loop-switching (Note 3)	10	100% rated loop
5% load-switching	20	5% rated load
Unloaded transformer switching (Note 2)	20	100% rated unloaded transformer
Cable-charging switching (Note 1)	20	100% rated cable-charging
Line-charging switching (Note 1)	20	100% rated line-charging

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Note 1- Quick break whips may require additional operations to validate its use. Check with manufacturer for other requirements.

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Note 2- It is assumed that a switch that has passed the load-switching tests specified in sub-clause 5.12.1 and test requirement section 7, will also interrupt unloaded transformer magnetizing currents corresponding to a distribution transformer, rated 38 kV or less and also rated 2500 kVA or less; therefore, no tests are specified.

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Note 3- Testing with a load-switching circuit that utilizes a 20% source impedance may be substituted for the loop-switching test.

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Note 4- Test duties assigned can be open, close or both close and open

10 5.20 Rated fault-making current

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The rated fault-making current is the maximum rms power-frequency current, expressed in symmetrical amperes, that the switch shall be required to make and carry at its rated maximum voltage for a specified duration. The switch shall have the related ability to make and carry the asymmetrical current (based on an approximate X/R of 17 at 60 Hz with a peak current of 2.6 times the symmetrical fault-making current) associated with the symmetrical fault-making current.

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18 5.20.1 Fault-making current rating

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Only switches having a closing speed that is independent of operating personnel may have a fault-making current rating.

20

21 5.20.2 Fault-making current capability

22

Switches having a closing speed that is dependent on operating personnel may have a fault-making current capability, which indicates that successful circuit closing is dependent upon proper operation of the switch. Nameplates of switches with a fault-making current capability shall have a caution that references the switch's instruction manual and indicates that successful circuit closing is dependent upon proper operation of the switch.

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28 6. Design and construction

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Clause 5 of IEEE C37.100.1-2007 applies.

1 **6.1 Requirements for liquids in switchgear**

2 Clause 5.1 of IEEE C37.100.1-2007 applies

3 **6.2 Requirements for gases in switchgear**

4 Clause 5.2 of IEEE C37.100.1-2007 applies

5 **6.3 Grounding provisions**

6 Clause 5.3 of IEEE C37.100.1-2007 applies

7 **6.4 Auxiliary and control equipment**

8 Table 13 of IEEE C37.30.1-2011 applies.

9 **6.5 Dependent power operation**

10 Clause 5.5 of IEEE C37.100.1-2007 applies.

11 **6.6 Stored energy operation**

12 See applicable standard

13 **6.7 Independent manual operation**

14 Clause 5.7 of IEEE C37.100.1-2007 applies.

15 **6.8 Operation of releases**

16 Refer to applicable standard.

17 **6.9 Low- and high-pressure interlocking and monitoring devices**

18 Clause 5.9 of IEEE C37.100.1-2007 applies.

19 **6.10 Nameplate markings**

20 Clause 5.10 of IEEE C37.100.1-2007 applies with the following additions. Specific rating may be agreed
21 upon between manufacturer and the user. For additional nameplate marking refer to C37.30.1

1 **6.11 Interlocking devices**

2 Clause 5.11 of IEEE C37.100.1-2007 applies.

3 **6.12 Position indicator**

4 Clause 5.12 of IEEE C37.100.1-2007 applies.

5 **6.13 Degrees of protection by enclosures**

6 Clause 5.13 of IEEE C37.100.1-2007 applies

7 **6.14 Creepage distances for outdoor insulators**

8 Clause 5.14 of IEEE C37.100.1-2007 applies, when required.

9 **6.15 Gas and vacuum tightness**

10 Refer to applicable standard.

11 **7. Design (type) tests**

12 Clause 6 of IEEE C37.100.1-2007 applies with the following additions and exceptions

Test	Applicable standard
Withstand voltage tests	C37.30.1
Continuous current tests	C37.30.1
Switching tests	C37.30.4
Unit testing	C37.09
Test duties	C37.30.4 and C37.100.2
Load-switching tests	C37.30.4
Loop-switching tests	C37.30.4
Parallel transformer loop-switching	C37.30.4
Cable-charging switching tests	C37.100.2
Line-charging switching tests	C37.100.2
Unloaded transformer switching tests	C37.30.4
Shunt capacitor switching tests	C37.100.2
Short time withstand current tests	C37.30.1
Fault-making current tests	C37.30.4
Ice loading test	C37.30.1
Mechanical operations tests	C37.30.1
Corona tests	C37.30.1
Radio-influence voltage tests	C37.30.1
Partial discharge test	C37.30.1

13

1 **7.1 Electromagnetic compatibility tests**

2 Clause 6.9 of IEEE C37.100.1-D2.1-2015 does not apply.

3 **7.2 Additional tests on auxiliary and control circuits**

4 Clause 6.10 of IEEE C37.100.1-2007 applies.

5 **7.3 X-Radiation procedure for vacuum interrupters**

6 Clause 6.11 of IEEE C37.100.1-2007 applies.

7 **8. Production tests (Routine tests)**

8 Clause 7 of IEEE C37.100.1-2007 applies with the following exceptions.

9 **8.1 Dielectric withstand test; one minute dry power-frequency**

10 Clause 7.1 of IEEE C37.100.1-2007 does not apply.

11 **8.2 Dielectric test on auxiliary and control circuits**

12 Refer to applicable standard.

13 **8.3 Measurement of the resistance of the main circuit**

14 Clause 7.3 of IEEE C37.100.1-2007 applies with the following exception:

15 Source current level is at the discretion of the manufacturer.

16 Testing of devices rated 38kV and below are optional.

17 **8.4 Tightness Tests**

18 Clause 7.4 of IEEE C37.100.1-2007 applies when required.

19 **8.5 Design and visual checks**

20 Clause 7.5 of IEEE C37.100.1-2007 applies.

21

1 **Annex A**

2 (informative)

3 **Bibliography**

4 Bibliographical references are resources that provide additional or helpful material but do not need to be
5 understood or used to implement this standard. Reference to these resources is made for informational use
6 only.

7 [B1] ANSI Std C37.30.1-2011, American National Standard Schedules of Preferred Ratings,
8 Manufacturing Specifications, and Application Guide for High-Voltage Air Switches, Bus Supports, and
9 Switch Accessories

10 [B2] ANSI/IEEE Std 386, IEEE Standard For Separable Insulated Connectors System For Power
11 Distribution Systems Above 600 V

12 [B3] IEEE Std 1-2011 IEEE Standard General Principles For Temperature Limits In The Rating Of
13 Electric Equipment And For The Evaluation Of Electrical Insulation (ANSI)

14 [B4] IEEE Std C37.010-2005, IEEE Application Guide For Alternating Current High-Voltage Circuit
15 Breakers Rated On A Symmetrical Current Basis (ANSI)

16 [B5] ANSI/IEEE Std C37.60-2012, Standard Requirements For Overhead, Pad-Mounted, Dry-Vault, And
17 Submersible Automatic Circuit Reclosers And Fault Interrupters For AC Systems

18 [B6] ANSI/IEEE C37.20.4 - 2013, Standard For Indoor AC Medium Voltage Switches For Use In Metal-
19 Enclosed Switchgear

20 [B7] ANSI/IEEE C37.30.4, Standard Requirements for Test Code for Switching and Fault Making Tests
21 for High Voltage Interrupter Switches, Interrupters or Interrupting Aids Used on or Attached to Switches
22 Rated for High-Voltage AC Above 1000 Volts

23 [B8] ANSI/IEEE C37.30.4, Standard Requirements for Test Code for Switching and Fault Making Tests
24 for High Voltage Interrupter Switches, Interrupters or Interrupting Aids Used on or Attached to Switches
25 Rated for High-Voltage AC Above 1000 Volts

26 [B9] Accredited Standards Committee C2-2012, National Electrical Safety Code (NESC®) ¹

27 [B10] NEMA C29.1-2012, Test Methods For Electrical Power Insulators ²

28 [B11] NEMA C29.8-2012, Wet-Process Porcelain Insulators—Apparatus, cap and pin type

29 [B12] ANSI C29.9-2012, Wet-Process Porcelain Insulators—Apparatus, Post Type

30 [B13] ANSI C37.22 - 1997, American National Standard Preferred Ratings And Required Capabilities For
31 Indoor Medium-Voltage Switches Used In Metal-Enclosed Switchgear

32 [B14] ANSI C63.2-2009, American National Standard Electromagnetic Noise And Field Strength, 10 KHz
33 To 40 GHz — Specifications

34 [B15] ANSI/IEEE Std C37.57-2010, Standard For Switchgear-Metal-Enclosed Interrupter Switchgear
35 Assemblies-Conformance Testing

36 [B16] ANSI/IEEE Std C37.100-2007 IEEE Standard Definitions For Power Switchgear

¹ The NESC is available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA

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

- 1 [B17] ANSI/IEEE 142-2007, IEEE Recommended Practice For Grounding Of Industrial And Commercial
2 Power Systems
- 3 [B18] IEC 62271-103-2011: Switches for rated voltages above 1 kV and less than 52 kV ³
- 4 [B19] IEC 62271-104-2015: High-voltage switches for rated voltages of 52 kV and above
- 5 [B20] IEEE Std C37.09-2007, IEEE Standard Test Procedure For AC High-Voltage Circuit Breakers Rated
6 On A Symmetrical Current Basis (ANSI) ⁴
- 7 [B21] IEEE Std C37.20.2-2005, IEEE Standard For Metal-Clad And Station-Type Cubicle Switchgear
8 (ANSI)
- 9 [B22] IEEE Std C37.20.3-2013, IEEE Standard For Metal-Enclosed Interrupter Switchgear (ANSI)
- 10 [B23] IEEE Std C37.23 -2008, IEEE Standard For Metal-Enclosed Bus And Calculating Losses In
11 Isolated-Phase Bus (ANSI)
- 12 [B24] IEEE Std C37.30.1-2011, Standard Requirements For High-Voltage Air Switches
- 13 [B25] IEEE Std C37.41-2008, Standard Design Tests For High Voltage Fuses, Distribution Enclosed
14 Single-Pole Air Switches, Fuse Disconnecting Switches And Accessories
- 15 [B26] IEEE Std 4 -2013, IEEE Standard Techniques For High-Voltage Testing (ANSI)
- 16 [B27] OSHA Rule 1910.269 -2014, Electric Power Generation, Transmission, and Distribution: Electrical
17 Protective Equipment ⁵

18
19 Note: Other Standards in document, but not exact matches to the Documents in 2.

20 Normative references

- 21 [B28] IEEE Std C37.100.1- Common requirements for HV power switch gear
- 22 [B29] IEEE Std C37.100.2 – Common clauses for capacitance switching

23

³ IEC standards 3, rue de Varembe, P.O. Box 131, CH - 1211 Geneva 20 – Switzerland

⁴ IEEE publications are available from the Institute of Electrical and Electronics Engineers, Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

⁵ OSHA publications are available from the OSHA Publications Office, U.S. Department of Labor, 200 Constitution Avenue, N.W., Room N310I, Washington DC 20210.