

C37.60™

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

IEEE Power Engineering Society

Sponsored by the
Switchgear Committee



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Abstract: Required definitions, ratings, procedures for performing design tests, production tests, and construction requirements for overhead, pad-mounted, dry vault, and submersible automatic circuit reclosers and fault interrupters for alternating systems up to 38 kV are specified.

Keywords: dry vault, fault interrupter, overhead, pad-mounted, recloser, submersible, standard operating duty, switchgear

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Introduction

(This introduction is not part of IEEE Std C37.60-2003, IEEE Standard for Overhead, Pad-Mounted, Dry Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for Alternating Current Systems Up to 38 kV.)

This standard has been revised from IEEE Std C37.60-1981, incorporating significant improvements that reflect the present state of the art in recloser technology. These include changes and additions in the following areas:

- a) Expanded the standard to include gas-insulated reclosers.
- b) Revised the title and scope to limit the standard to 38 kV; deleted ratings above 38 kV nominal.
- c) Added voltage ratings commonly used outside of North America with related dielectric withstand capabilities taken from IEC 60694-2002-01.^a
- d) Added several new interrupting ratings in the 15.5 kV, 27 kV, and 38 kV ranges.
- e) Revised limits of temperature and temperature rise to be consistent with circuit breaker standards.
- f) Reorganized the switching tests into 6.3 following a format similar to IEEE Std 1247TM-1998 and referenced IEEE Std 1247-1998 for switching test procedures.
- g) Removed the requirement for transformer magnetizing tests; reference discussion in IEEE Std 1247-1998.
- h) Clarified the intent of the switching tests as related required capabilities and prohibited the use of single-phase tests to qualify three-phase reclosers in the performance of the switching tests.
- i) Removed the altitude correction factors. (Refer to the following paragraph and informative Annex E.)
- j) Removed the X/R footnote and table of multiplication factors from old 5.6 to new informative Annex A with expanded information and data.
- k) Added new informative Annex B.
- l) Added transient recovery voltage (TRV) specifications and informative Annex C and Annex D.
- m) Restricted the use of single-phase testing to verify three-phase performance.
- n) Reduced radio influence voltage (RIV) limits.
- o) Added Partial Discharge as a design and production test.
- p) Reduced dc withstand voltage test time from 15 min. to 5 min.

Although this revised standard will be published before the work on IEEE PC37.100.1, Draft Standard Requirements for Power Switchgear [B13]^b is completed, it is the intention of the Recloser Working Group to issue supplements or revisions to adopt common requirements. There was considerable discussion in the Recloser Working Group regarding the addition of the partial discharge test requirements suggesting that this topic should be revisited at the next revision cycle to see if the data collected between now and then shall warrant any changes in the test procedure or test limits.

^aInformation on references can be found in Clause 2.

^bThe numbers in brackets correspond to the numbers of the bibliography in Annex F.

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Contents

1. Scope	1
2. References	1
3. Definitions	3
4. Service conditions.....	4
4.1 Usual service conditions	4
4.2 Unusual service conditions	4
5. Rating.....	5
5.1 Rating information	5
5.2 Rated maximum voltage.....	5
5.3 Rated power-frequency	6
5.4 Rated continuous current	6
5.5 Rated minimum tripping current (for series-trip reclosers/FIs)	7
5.6 Rated symmetrical interrupting current.....	7
5.7 Rated symmetrical making current.....	9
5.8 Rated lightning impulse withstand voltage.....	9
5.9 Rated control voltage and ranges.....	9
5.10 Rated line and cable charging interrupting currents (where applicable).....	9
6. Design tests (type tests).....	15
6.1 General.....	15
6.2 Insulation (dielectric) tests	15
6.3 Switching tests.....	18
6.4 Making current capability.....	21
6.5 Rated symmetrical interrupting current tests	21
6.6 Minimum tripping current tests.....	32
6.7 Partial discharge (corona) tests.....	33
6.8 Radio influence voltage tests (RIV).....	34
6.9 Surge current test; series-trip reclosers/FIs	35
6.10 Temperature rise test.....	36
6.11 Time-current tests.....	38
6.12 Mechanical duty test.....	39

6.13	Control electronic elements surge withstand capability (SWC) tests	39
6.14	Condition of recloser/FI after each test of 6.3 and 6.5	41
7.	Production tests (routine tests)	42
7.1	Reclosing and overcurrent trip calibration	43
7.2	Control, secondary wiring, and accessory devices check tests.....	43
7.3	Dielectric withstand test; 1-min. dry power-frequency	43
7.4	Partial discharge test	43
7.5	Mechanical operations tests	43
7.6	Water leak test	44
8.	Field tests on units in service, including dc withstand tests on cables	44
9.	Construction requirements	45
9.1	Tank construction: submersible or dry vault reclosers/FIs	45
9.2	Grounding provisions	45
9.3	Insulating medium quantity indicators	46
9.4	Oil sampling provision (submersible reclosers/FIs)	46
9.5	Manual operating provision	46
9.6	Position indicator	46
9.7	Nameplate markings	46
9.8	Stored energy mechanism charge indicator	47
9.9	Enclosure integrity	47
9.10	Counters	47
9.11	Conductor terminal sizes	47
9.12	Tank construction—pressurized reclosers/FIs only	47
Annex A	(informative) X/R Ratios.....	48
Annex B	(informative) Simulated surge arrester operation tests.....	50
Annex C	(normative) Method of drawing the envelope of the prospective transient recovery voltage of a circuit and determining the representative parameters	53
Annex D	(informative) Background basis of recloser TRV values	55
Annex E	(informative) Altitude correction factors	59
Annex F	(informative) Bibliography.....	62

IEEE Standard for Overhead, Pad-Mounted, Dry Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for Alternating Current Systems up to 38 kV

1. Scope

This standard applies to all overhead, pad-mounted, dry vault, and submersible single- or multipole alternating current automatic circuit reclosers and fault interrupters for rated maximum voltages above 1000 V and up to 38 kV.

In order to simplify this standard where possible, the term *recloser/FI* (*reclosers/FIs*) has been substituted for *automatic circuit recloser* or *fault interrupter* or both.

NOTE—When reclosers are applied in a substation, special considerations may apply, see 6.5.1.5.3.

2. References

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

ANSI C37.06-2000, American National Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis—Preferred Ratings and Related Required Capabilities.¹

ANSI C37.06.1-2000, American National Standard Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis—Designated “Definite Purpose for Fast Transient Recovery Voltage Rise Times.”

¹ANSI 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>).

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

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

ANSI C63.2-1996, American National Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 kHz to 40 GHz—Specifications.

ASME BPVC-1998, Boilers and Pressure Vessels Code—Section VIII: Rules for Construction of Pressure Vessels—Division 1.²

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

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

IEC 60502-1-1998-11, Power Cables with Extruded Insulation and Their Accessories for Rated Voltages from 1 kV ($U_m = 1,2$ kV) Up to 30 kV ($U_m = 36$ kV)—Part 1: Cables for Rated Voltages of 1 kV ($U_m = 1,2$ kV) and 3 kV ($U_m = 3,6$ kV).

IEC 60502-2-1998-11, Power Cables with Extruded Insulation and Their Accessories for Rated Voltages from 1 kV ($U_m = 1,2$ kV) Up to 30 kV ($U_m = 36$ kV)—Part 2: Cables for Rated Voltages from 6 kV ($U_m = 7,2$ kV) Up to 30 kV ($U_m = 36$ kV).

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

IEC 62271-100-2003-05, High-Voltage Switchgear and Controlgear—Part 100: High-Voltage Alternating-Current Circuit-Breakers.

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

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

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

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

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

IEEE Std C37.04-1999, IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers.

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

²ASME publications are available from the American Society of Mechanical Engineers, 3 Park Avenue, New York, NY 10016-5990, USA (<http://www.asme.org>).

³IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iec.ch/>). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (<http://www.ansi.org>).

⁴The IEEE standards or products referred to in Clause 2 are trademarks owned by the Institute of Electrical and Electronics Engineers, Inc.

⁵IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (<http://standards.ieee.org/>).

IEEE Std C37.41™-2000, IEEE Standard Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.

IEEE Std C37.90.1™-2002, IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

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

NEMA 107-1987 (Reaff 1993), Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus.⁶

3. Definitions

The definitions of terms contained in this standard, and to the related standards for recloser/FIs, shall be in accordance with IEEE Std C37.100-1992. These definitions are not intended to embrace all possible meanings of the terms. They are applicable only to the subject treated in this standard.

unit operation (of a recloser): An interrupting operation followed by a closing operation. The final interruption is also considered one unit operation.

NOTE—See Figure 1.

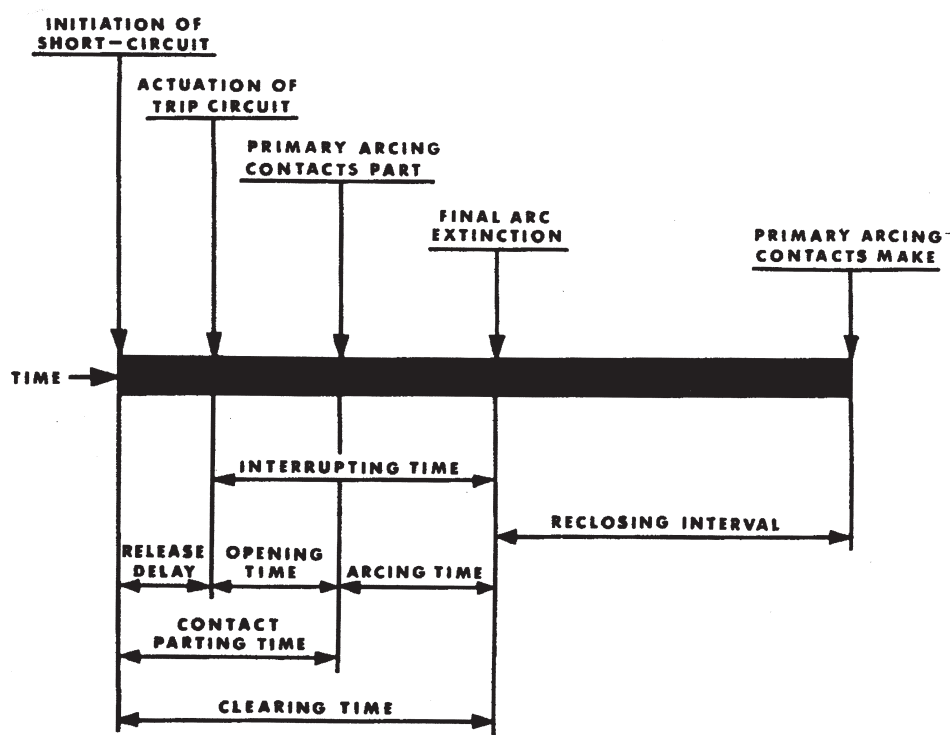


Figure 1—Unit operation

⁶NEMA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112-5704, USA (<http://global.ihs.com/>).

4. Service conditions

4.1 Usual service conditions

Reclosers/FIs conforming to this standard shall be suitable for operation at their standard ratings provided that:

- a) The temperature of the air (ambient temperature) is not above 40 °C or below −30 °C.
- b) The altitude does not exceed 1000 m.
- c) For submersible units, the water head does not exceed 3 m above the base of the enclosure during occasional submersion. Exposure to chemical or electrochemical reactions may be encountered in a subgrade environment. The subgrade environment may contain chemicals that contribute to mild corrosive reactions.

4.2 Unusual service conditions

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

- a) Actual service duty cycle
- b) System conditions
- c) Site conditions
- d) Shock and/or vibration
- e) Damaging fumes or vapors
- f) Excessive or abrasive dust
- g) Explosive mixtures of dust or gases
- h) Salt air or extreme humidity

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

4.2.1 Abnormal ambient temperatures

Reclosers/FIs may be applied at higher or lower ambient temperatures than specified, but performance may be affected and special consideration shall be given to these applications.

4.2.2 Altitudes above 1000 m

Reclosers/FIs may be applied at altitudes higher than 1000 m; however, the rated lightning impulse withstand voltage, rated maximum voltage and rated continuous current shall be multiplied individually by the correction factor (see following note) to obtain values at which the application may be made. The rated symmetrical interrupting current, related required capabilities, and interrupting times are not affected by altitude.

NOTE—Altitude correction factors are being studied by the Switchgear Committee and will be adopted by issuance of a supplement or revision to this standard when they are approved. In the meantime, users should consult the manufacturer for appropriate derating when the equipment is applied above 1000 m. Refer also to Annex E.

5. Rating

5.1 Rating information

The ratings shall include the following:

- a) Rated maximum voltage
- b) Rated power-frequency
- c) Rated continuous current
- d) Rated minimum tripping current (series-trip reclosers only)
- e) Rated symmetrical interrupting current
- f) Rated symmetrical making current
- g) Rated lightning impulse withstand voltage
- h) Rated control voltage

NOTE—Switching tests as specified in 6.3 are related required capabilities.

5.2 Rated maximum voltage

The preferred values of rated maximum voltage of reclosers/FIs are those shown in Column 2 of Table 1a) and Table 1b).

**Table 1a)—Preferred voltage ratings and related test requirements for reclosers
(except those covered in Table 1b) (Note 1)**

Line no. (Note 2)	Rated maximum voltage kV	Rated lightning impulse withstand peak voltage kV (Note 3)	Power-frequency insulation level withstand test kV (Warning Box and Note 3)	
			1 min. dry	10 s wet
Column 1	Column 2	Column 3	Column 4	Column 5
1	15	95	36	30
2	15.5	110	50	45
3	27	(Note 4)	60	50
4	38	150	70	60
11	12	75	28	23
12	17.5	95	38	32
13	24	125	50	45
14	36	170	70	60

WARNING

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

NOTES

1—The test values shown in Table 1a) are for design tests; refer to Clause 8 for field testing.

2—Lines 11–14 refer to distribution systems commonly found outside of North America; the test withstand levels were taken from IEC 60694-2002-01, Table 1a).

3—These are performance characteristics specified as test requirements in this standard.

4—For oil interrupting reclosers, 150 kV; for all others, 125 kV.

Table 1b)—Preferred voltage ratings and related test requirements for pad-mounted, dry vault and submersible reclosers, and nonreclosing fault interrupters, all with vacuum or SF₆ interrupters (Note 1)

Line no. (Note 2)	Rated maximum voltage kV	Rated lightning impulse withstand peak voltage kV (Note 3)	Power-frequency insulation level withstand test kV (Warning Box and Note 3)		Withstand test dc voltage kV (Warning Box and Note 4) 5 min.
			1 min. dry	10 s wet	
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
1					
2	15.5	95	35	Not required	53
3	27	125	40	Not required	78
4	38	150	50	Not required	103 (Note 3)
11	12	60	28	Not required	42
12	17.5	75	38	Not required	57
13	24	95	50	Not required	78
14	36	145	70	Not required	103 (Note 3)

WARNING

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

NOTES

- 1—The test values shown in Table 1b) are for design tests; refer to Clause 8 for field testing.
- 2—Lines 11–14 refer to distribution systems commonly found outside of North America; the test withstand levels were taken from IEC 60694-2002-01, Table 1a).
- 3—These are performance characteristics specified as test requirements in this standard.
- 4—DC withstand tests are required for pad-mounted, dry vault and submersible gear since this type of equipment is interfaced to the power system via separable connectors. The test requirements of separable connectors are specified in Table 1 of IEEE Std 386-1995 and these values are reproduced here in Column 6. DC withstand testing of 36/38 kV cables is not a recommended practice. Very low frequency (VLF) testing is a relatively new practice being used as an alternative to the dc withstand test. Reference IEEE Std 433TM-1979 [B8]⁷. The dc withstand test requirement on the recloser/FI demonstrates its capability to withstand either dc withstand or VLF testing of connected cables.

5.3 Rated power-frequency

The rated power-frequency shall be the frequency at which the recloser/FI and its components are designed to operate. The preferred rated power-frequencies are 50 Hz or 60 Hz.

5.4 Rated continuous current

The preferred ratings for the continuous current of reclosers/FIs are those shown in Table 2.

5.4.1 Conditions of continuous current rating

- a) Reclosers/FIs shall be used under the usual service conditions defined in 4.1.
- b) Current ratings shall be based on the total temperature limits of the materials used. A temperature rise reference is given to permit testing at reduced ambient.

⁷The numbers in brackets correspond to those of the bibliography in Annex F.

Table 2—Preferred continuous current ratings for reclosers and fault interrupters

Recloser or fault interrupter type	Preferred continuous current ratings (A)		
	5	35	200
Series-trip reclosers/FIs	10	50	280
	15	70	400
	25	100	560
		140	
Oil interrupting shunt-trip reclosers/FIs	50	280	560
	100	400	1120
All other reclosers or fault interrupters	100	315	800
	200	400	1000
	250	500	1250
		630	

NOTE—It is recognized that reclosers/FIs designed under an earlier revision of this standard may have continuous current ratings not shown in Table 1. Examples include ratings of 560 A, 600 A, and 1200 A.

- c) Reclosers/FIs designed for installation in enclosures shall have their ratings based on the ventilation of such enclosures and a 40 °C ambient temperature outside the enclosure.
- d) Outdoor reclosers/FIs and indoor reclosers/FIs without enclosures shall have ratings based on a 40 °C ambient temperature.

5.4.2 Limits of observable temperature rise

At rated current, the observable hottest-spot temperature rise above ambient and the total temperature of each of the various parts shall not exceed those listed in Table 3.

5.5 Rated minimum tripping current (for series-trip reclosers/FIs)

The preferred rated minimum tripping current shall be twice the continuous current rating with a tolerance of $\pm 10\%$.

NOTE—The minimum tripping current for shunt-trip reclosers/FIs is variable and has no relation to the rated continuous current. Information on specific reclosers/FIs should be obtained from the manufacturer.

5.6 Rated symmetrical interrupting current

The preferred values for the rated symmetrical interrupting currents of reclosers/FIs are as given in Table 4 for series-trip reclosers/FIs and Column 4 of Table 5a), Table 5b), and Table 6 for shunt-trip reclosers/FIs.

The rated symmetrical interrupting current shall be based on the capability of the reclosers/FIs to interrupt the corresponding asymmetrical current in circuits having X/R values as given in Columns 5, 7, and 9 of Table 5a), Table 5b), and Table 6 and with a power-frequency recovery voltage equal to the rated maximum voltage and with transient recovery voltages as defined in 6.5.1.5.

Table 3—Limits of temperature and temperature rise for various parts and materials of reclosers/FIs

Nature of the part and material (Notes 1, 2, and 3)		Total temperature (°C)	Temperature rise at ambient (40 °C)
1. Material used as insulation and metal parts in contact with insulation of these classes (Note 4)	O (90 °C)	90	50
	A (105 °C)	105	65
	B (130 °C)	130	90
	F (155 °C)	155	115
	H (180 °C)	180	140
	C (220 °C)	220	180
	Oil (Note 5)	90	50
2. Contacts (Note 6)	Bare copper and bare-copper alloy		
	—in air	75	35
	—in SF ₆ (sulfurhexafluoride)	105	65
	—in oil	80	40
	Silver-coated or nickel-coated (Note 7)		
	—in air	105	65
	—in SF ₆	105	65
	—in oil	90	50
	Tin-coated (Note 7)		
	—in air	105	65
	—in SF ₆	105	65
	—In oil	90	50
3. Connections, bolted or the equivalent (Note 8)	Bare-copper, bare-copper alloy, bare aluminum or bare-aluminum alloy		
	—in air	90	50
	—in SF ₆	115	75
	—in oil	100	60
	Silver-coated or nickel-coated		
	—in air	115	75
	—in SF ₆	115	75
	—in oil	100	60
	Tin-coated		
	—in air	105	65
	—in SF ₆	105	65
	—in oil	100	60
4. All other contacts or connections made of bare metals or coated with other materials		(Note 9)	(Note 9)
5. Terminals for the connection to external conductors by screws or bolts (Note 10)	Bare-copper and bare-copper alloy	90	50
	Silver-coated, nickel-coated, tin-coated	105	65
	Other coatings	(Note 9)	(Note 9)
6. Metal parts acting as springs		(Note 11)	(Note 11)

NOTES

- 1—According to its function, the same part may belong to several categories as listed in Table 3. In this case, the permissible maximum values of total temperature and temperature rise to be considered are the lowest among the relevant categories.
- 2—For sealed interrupters, the values of total temperature and temperature-rise limits are not applicable for parts inside the sealed interrupter. The remaining parts shall not exceed the values of temperature and temperature rise given in Table 3.
- 3—The temperatures of conductors between contacts and connections are not covered in Table 3, as long as the temperature at the point of contact between conductors and insulation does not exceed the limits established for the insulating material.
- 4—The classes of insulating materials are those given in IEC 60694-2002-01.
- 5—The top oil (upper layer) temperature shall not exceed 40 °C rise or 80 °C total. The 50 °C and 90 °C values refer to the hottest spot temperature of parts in contact with oil.
- 6—When contact parts have different coatings, the permissible temperatures and temperature rises shall be those of the part having the lower value permitted in Table 3.
- 7—The quality of the coated contacts shall be such that a layer of coating material remains at the contact area:
 - (a) After making and breaking tests (if any);
 - (b) After short-time withstand current tests;
 - (c) After the mechanical endurance test according to the relevant specifications for each piece of equipment. Otherwise, the contacts shall be regarded as “bare.”
- 8—When connection parts have different coatings, the permissible temperatures and temperature rises shall be those of the part having the lower value permitted in Table 3.
- 9—When materials other than those given in Table 3 are used, their properties shall be considered in order to determine the maximum permissible temperature rises.
- 10—The values of temperature and temperature rise are valid even if the conductor to the terminals is bare.
- 11—The temperature shall not reach a value where the temper of the material is impaired.

5.7 Rated symmetrical making current

The rated symmetrical making current shall be the same value as the rated symmetrical interrupting current, with maximum asymmetry corresponding to the X/R ratio in Column 9 of Table 5a), Table 5b), and Table 6.

5.8 Rated lightning impulse withstand voltage

The preferred values for the rated lightning impulse withstand voltage of reclosers/FIs are those given in Column 3 of Table 1a) and Table 1b) for both negative and positive test polarities. The voltage wave shall reach its peak value in 1.2 μ s and decay to one-half its peak value in 50 μ s.

5.9 Rated control voltage and ranges

When measured at the control power terminals of the operating mechanisms with the maximum operating current flowing, the preferred rated control voltages for the control power supply of switching and interrupting devices are those shown in Table 7.

5.10 Rated line and cable charging interrupting currents (where applicable)

The preferred line and cable charging interrupting current ratings for reclosers/FIs having these capabilities are as given in Table 8.

Table 4—Preferred values for symmetrical interrupting current ratings of series-trip reclosers/FIs

Continuous current rating (A)	Symmetrical interrupting current rating in amperes						
	Single-phase reclosers/FIs						
	Recloser line number (Table 4a)						
	1	2	3	4	5	6	7
	Rated maximum voltage, kV						
	15	15.5	15.5	15.5	27.0	27.0	38.0
5	125	200	—	—	200	—	—
10	250	400	—	—	400	—	—
15	375	600	—	—	600	—	—
25	625	1000	1500	—	1000	—	—
35	875	1400	2100	—	1400	—	—
50	1250	2000	3000	—	2000	3000	—
70	—	2000	4000	—	2500	4000	—
100	—	2000	4000	6000	2500	4000	6000
140	—	—	4000	8400	—	4000	8000
200	—	—	4000	10000	—	4000	8000
280	—	—	4000	10000	—	4000	8000
400	—	—	—	10000	—	—	8000
560	—	—	—	10000	—	—	8000

Continuous current rating, (A)	Three-phase reclosers/FIs						
	Recloser/FI line number (Table 4b)						
	1	2	3	4	5 and 9	8	13
	Rated maximum voltage, kV						
	15	15.5	15.5	15.5	15.5 and 27	27	38
5	125	200	—	—	—	200	—
10	250	400	—	—	—	400	—
15	375	600	—	—	—	600	—
25	625	1000	1500	1500	—	1000	1500
35	875	1400	2100	2100	—	1400	2100
50	1250	2000	3000	3000	—	2000	3000
70	—	2000	4000	4000	—	2500	4200
100	—	2000	4000	4000	6000	2500	6000
140	—	—	4000	4000	8000	—	6000
200	—	—	4000	4000	8000	—	6000
280	—	—	4000	4000	8000	—	6000
400	—	—	—	4000	8000	—	6000
560	—	—	—	—	8000	—	—

NOTE—Performance characteristics are the same as shown in Table 5a) and Table 5b) for the same line number.

Table 5a)—Preferred values for symmetrical rated interrupting current and performance characteristics of single-phase oil interrupting reclosers

		Current ratings (A)		Standard operating duty (Note 1)						
				Percent of interrupting rating						Total number of unit operations
				15–20		45–55		90–100		
Line no.	Rated maximum voltage kV	Continuous	Symmetrical interrupting	X/R (Note 3)	Number of unit operations	X/R (Note 3)	Number of unit operations	X/R (Note 3)	Number of unit operations	
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11
		Single-phase reclosers/FIs								
1	15	50	1250	2	40	4	40	8	20	100
2	15.5	100	2000	2	32	5	24	10	12	68
3	15.5	280	4000	3	32	6	20	12	12	64
4	15.5	560	10 000	4	28	8	20	(Note 2)	10	58
5	27	100	2500	2	32	5	24	12	12	68
6	27	280	4000	3	32	6	20	13	12	64
7	38	560	8000	4	28	8	20	(Note 2)	10	58

NOTES

- 1—These are performance characteristics specified as test requirements in this standard, IEEE Std C37.60-2003.
- 2—Refer to Column 9: *X/R* = 14 for 50 Hz and 17 for 60 Hz for a time constant of 45 ms.
- 3—For test purposes, *X/R* values are minimum values. Refer to 5.6 and 6.5.2.

Table 5b)—Preferred values for rated symmetrical interrupting current and performance characteristics of three-phase oil interrupting reclosers

		Current ratings (A)		Standard operating duty (Note 1)						
				Percent of interrupting rating						Total number of unit operations
				15–20		45–55		90–100		
Line no.	Rated maximum voltage, kV	Continuous	Symmetrical interrupting	X/R (Note 3)	Number of unit operations	X/R (Note 3)	Number of unit operations	X/R (Note 3)	Number of unit operations	
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11
		Three-phase reclosers/FIs								
1	15	50	1250	2	40	4	40	8	20	100
2	15.5	100	2000	2	32	5	24	10	12	68
3	15.5	280	4000	3	32	6	20	12	12	64
4	15.5	400								
5	15.5	560	8000	3	28	7	20	(Note 2)	10	58
6	15.5	560	16 000	4	28	8	20	(Note 2)	10	58
7	15.5	1120								
8	27	100	2500	2	32	5	24	12	12	68
9	27	560	8000	4	28	8	20	(Note 2)	10	58
10	27	560	10 000							
11	27	1120	8000							
12	27	560	12 000							
13	38	400	6000	4	28	8	24	(Note 2)	10	62
14	38	560	8000	4	28	8	20	(Note 2)	10	58
15	38	560	16 000							
16	38	1120	12 000							

NOTES

1—These are performance characteristics specified as test requirements in this standard, IEEE Std C37.60-2003.

2—Refer to Column 9: X/R = 14 for 50 Hz and 17 for 60 Hz for a time constant of 45 ms.3—For test purposes, X/R values are minimum values. Refer to 5.6 and 6.5.2.

Table 6—Preferred values of rated symmetrical interrupting current and performance characteristics of reclosers/FIs with vacuum or SF₆ interrupters (including pad-mounted, dry vault, and submersible reclosers, and nonreclosing fault interrupters)

				Standard operating duty (Notes 1 and 3)						
				Percent of interrupting rating						Total number of unit operations
				15–20 (Note 5)		45–55		90–100		
Line no.	Rated maximum voltage kV	Not used (Note 5)	Symmetrical interrupting (kA)	<i>X/R</i> (Note 4)	Number of unit operations	<i>X/R</i> (Note 4)	Number of unit operations	<i>X/R</i> (Note 4)	Number of unit operations	
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11
1	12, 15.5, and 17.5	—	2.0	2	52	5	68	10	18	138
2			6.0	3	48	7	60	14	16	124
3			8.0	4	44	8	56	(Note 2)	16	116
4			12.5							
5			16.0							
6			20.0							
7	24 and 27	—	8.0	3	44	8	56	(Note 2)	16	116
8			10.0							
9			12.5	4						
10			16.0							
11			20.0							
12	36 and 38	—	8.0	4	44	8	56	(Note 2)	16	116
13			12.5							
14			16.0							
15			20.0							

NOTES

- 1—These are performance characteristics specified as test requirements in this standard, IEEE Std C37.60-2003.
- 2—Refer to Column 9: *X/R* = 14 for 50 Hz and 17 for 60 Hz for a time constant of 45 ms.
- 3—The standard operating duty represents half-life as measured by contact erosion. Refer to manufacturer's methods for determining permissible contact erosion.
- 4—For test purposes *X/R* values are minimum values. Refer to 5.6 and 6.5.25.
- 5—Column 3 is not used in Table 6; it is included to provide consistency with Table 5a) and Table 5b).