

ANSI/IEEE C37.60-1981

(IEEE Reaffirmed 1986)

(ANSI Reaffirmed 1988)

(Revision of ANSI C37.60-1974)

An American National Standard

IEEE Standard Requirements for Overhead, Pad Mounted, Dry Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for AC Systems

Sponsor

**Switchgear Committee
of the
IEEE Power Engineering Society**

Secretariat

**Institute of Electrical and Electronics Engineers
National Electrical Manufacturers Association**

Approved March 15, 1979
Reaffirmed December 11, 1986
Reaffirmed June 18, 1992

IEEE Standards Board

Approved November 25, 1980
Reaffirmed May 10, 1988
Reaffirmed July 26, 1993

American National Standards Institute

©Copyright 1981 by

The Institute of Electrical and Electronics Engineers, Inc

345 East 47th Street, New York, NY 10017, USA

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

IEEE Standards documents are developed within the Technical Committees of the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Board. Members of the committees serve voluntarily and without compensation. They are not necessarily members of the Institute. The standards developed within IEEE represent a consensus of the broad expertise on the subject within the Institute as well as those activities outside of IEEE which have expressed an interest in participating in the development of the standard.

Use of an IEEE Standard is wholly voluntary. The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least once every five years for revision or reaffirmation. When a document is more than five years old, and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of all concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason IEEE and the members of its technical committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration.

Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE Standards Board
345 East 47th Street
New York, NY 10017
USA

Foreword

(This Foreword is not a part of ANSI/IEEE C37.60-1981, IEEE Standard Requirements for Overhead, Pad Mounted, Dry Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for AC Systems.)

This Standard is a revised and updated version of ANSI/IEEE C37.60-1974, incorporating significant improvements which reflect the present state of the art in recloser technology. These include changes and additions in the following areas:

- 1) Expansion of the standard to include pad mounted and submersible reclosers
- 2) Inclusion of information for reclosers utilizing vacuum interrupters
- 3) New and expanded information related to interrupting tests, particularly for (a) cable charging currents, (b) transformer magnetizing currents, and (c) load currents
- 4) The addition of surge withstand capability requirements for recloser control elements
- 5) Expanded production test requirements

Also included is the recognition of the need for partial discharge tests for some types of reclosers. While the procedure and related requirements have not yet been finalized, (see 6.6), effort is presently underway to develop this information, and it will be published after it has been completed and has gone through the full approval process.

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

C. L. Wagner, *Chair*

J. E. Beehler (*Executive Vice-Chairman of High Voltage Switchgear Standards*)

W. E. Laubach (*Executive Vice-Chairman of Low Voltage Switchgear Standards*)

S. H. Telander (*Executive Vice-Chairman of IEC Activities*)

J. D. Hopkins, *Secretary*

Organization Represented**Name of Representative**

Association of American Railroads
 Association of Iron and Steel Engineers
 Electric Light and Power Group

Vacant
 J. M. Tillman
 J. E. Beehler
 R. L. Capra (*Alt*)
 H. G. Darron
 H. F. Frus
 K. D. Hendrix
 R. L. Lindsey (*Alt*)
 J. P. Markey (*Alt*)
 E. E. Ramm (*Alt*)
 D. O. Craghead

Institute of Electrical and Electronics Engineers

M. J. Beachy (*Alt*)
 H. H. Fahnoe
 R. E. Friedrich
 M. J. Maier
 C. A. Mathews (*Alt*)
 H. W. Mikulecky D. C.
 Musgrave (*Alt*)
 C. A. Schwalbe
 G. W. Walsh

National Electrical Manufacturers Association

J. L. Drown
 R. W. Dunham
 D. G. Portman
 G. A. Wilson
 W. R. Wilson

Tennessee Valley Authority

Robert C. St. Clair

Testing Laboratory Group

L. Frier
 E. J. Huber
 R. W. Seelbach (*Alt*)

U.S. Department of the Army

Robert H. Bruck

U.S. Department of the Interior, Bureau of Reclamation

Edward M. Tomsic

U.S. Department of Defense, Defense Communications Agency

Vacant

U.S. Department of the Navy, Naval Construction Battalion Center

A. R. Hanks
 J. N. Montagna

At the time this standard was approved, the Reclosers and Sectionalizers Subcommittee of the IEEE Switchgear Committee had the following membership:

P. C. Lyons, Chair

R. H. Arndt
 M. J. Beachy
 G. W. Dolloff
 R. Donnelly
 R. A. Few

G. Genest
 P. F. Johnson
 L. V. McCall
 R. H. Miller
 N. L. Paulson

J. C. W. Ransom
 D. R. Shapleigh
 R. Singer
 K. Spuhler
 B. F. Wirtz

The NEMA Technical Committee on Automatic Circuit Reclosers which prepared Tables 2 through 7 and approved this standard had the following membership:

R. A. Few, *Chair*
D. Polasky, *Secretary*

R. E. Bennet
C. A. Popeck

John G. Leach
James C. W. Ransom

Clarence L. Welter
D. F. Winter

The C37 Subcommittee on Automatic Circuit Reclosers and Line Sectionalizers which approved this standard had the following membership:

B. H. Schulz, *Chair*
D. Polasky, *Secretary*

R. H. Arndt
M. J. Beachy
R. Bergstrom
H. L. Caldwell
R. L. Capra
G. W. Dollof
R. A. Few

P. F. Johnson
D. G. Kumbera
K. Lloyd
P. C. Lyons
L. V. McCall
R. H. Miller
R. W. Nelson

A. F. Parks
N. L. Paulson
J. P. Markey
G. W. Schneider
F. C. Teufel
B. F. Wirtz
J. D. Hopkins

When it approved this standard on March 15, 1979, the IEEE Standards Board had the following membership:

Joseph L. Koepfinger, *Chair*
Irvin N. Howell, Jr, *Vice Chair*
Ivan G. Easton, *Secretary*

G. Y. R. Allen
William E. Andrus
C. N. Berglund
Edward Chellotti
Edward J. Cohen
Warren H. Cook
R. O. Duncan
Jay Forster

Harold S. Goldberg
Richard J. Gowen
H. Mark Grove
Loering M. Johnson
Irving Kolodny
W. R. Kruesi
Leon Levy
J. E. May

Donald T. Michael*
R. L. Pritchard
F. Rosa
Ralph M. Showers
J. W. Skooglund
W. E. Vannah
B. W. Whittington

*Member emeritus

CLAUSE	PAGE
1. Scope	1
2. References	1
3. Service Conditions	2
3.1 Usual Service Conditions	2
3.2 Unusual Service Conditions	2
4. Definitions	3
5. Rating	4
5.1 Rating Information	4
5.2 Rated Maximum Voltage	4
5.3 Rated Frequency	4
5.4 Rated Continuous Current	5
5.5 Rated Minimum Tripping Current (for Series-Trip Reclosers)	12
5.6 Rated Symmetrical Interrupting Current	14
5.7 Rated Symmetrical Making Current	15
5.8 Rated Impulse Withstand Voltage	15
5.9 Rated Control Voltage and Ranges	18
5.10 Rated Cable Charging Interrupting Current (where applicable)	18
6. Design Tests	18
6.1 General	18
6.2 Insulation (Dielectric Tests)	19
6.3 Interruption Tests	20
6.4 Making Current Tests	23
6.5 Minimum Tripping Current Tests	23
6.6 Partial Discharge Tests	24
6.7 Radio Influence Voltage Tests (RIV)	24
6.8 Surge Current Test; Series Coil Reclosers	26
6.9 Temperature Rise Test	26
6.10 Time-Current Tests	28
6.11 Mechanical Operations Tests	29
6.12 Cable Charging Current Interrupting Test	30
6.13 Transformer Magnetizing Current Interruption Test	31
6.14 Control Elements Surge Withstand Capability Tests	32
7. Production Tests	33
7.1 Reclosing and Overcurrent Trip Calibration	34
7.2 Control, Secondary Wiring and Accessory Devices Check Tests	34
7.3 Dielectric Withstand Test; One Minute Dry Low Frequency	34
7.4 Mechanical Operations Tests	34
7.5 Leak Test	34
8. Construction Requirements	34
8.1 Tank Construction; Submersible or Dry Vault Reclosers	34

CLAUSE	PAGE
8.2 Grounding Provisions	35
8.3 Insulating Medium Quantity Indicators (Submersible Reclosers)	35
8.4 Oil Sampling Provisions (Submersible Reclosers)	35
8.5 Manual Operating Provision	35
8.6 Position Indicator	36
8.7 Nameplate Markings	36
8.8 Stored Energy Mechanism Charge Indicator	36
8.9 Safety Provisions	36
8.10 Separate Mounting of Control Apparatus	36
8.11 Counters	37
8.12 Conductor Terminal Sizes	37
8.13 Vacuum Interrupters	37

An American National Standard

IEEE Standard Requirements for Overhead, Pad Mounted, Dry Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for AC Systems

1. Scope

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

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

2. References

When the following American National Standards and Guides referred to in this standard are superseded by a revision approved by the American National Standards Institute, the latest revision shall be used.

[1] ANSI C37.85-1972 (R1978), Interrupters Used in Power Switchgear, X-Radiation Limits for AC High-Voltage Power Vacuum (includes ANSI C37.85a-1972)¹

[2] ANSI C84.1-1977, Voltage Ratings for Electric Power Systems and Equipment (60 Hz) (includes ANSI C84.1a-1980)

[3] ANSI/IEEE C37.09-1979, Test Procedure for High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis

¹ANSI documents are available from the American National Standard Institute, 1430 Broadway, New York, NY 10018.

[4] ANSI/IEEE C37.100-1981, Definitions for Power Switchgear

[5] ANSI/IEEE Std 386-1977, Separable Insulated Connectors for Power Distribution Systems Above 600 V

[6] IEEE Std 4-1978, Standard Techniques for High-Voltage Testing

[7] NEMA 107-1964 (1976), Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus²

3. Service Conditions

3.1 Usual Service Conditions

Reclosers conforming to this standard shall be suitable for operation at their standard rating provided that:

- 1) The temperature of the cooling air (ambient temperature) is not above 40 °C or below –30 °C.
- 2) The altitude does not exceed 1000 m (3300 ft).
- 3) For submersible units, the water head does not exceed 3 m (10 ft) above the base of the enclosure during occasional submersion. Exposure to chemical or electrochemical reactions may be encountered in a subgrade environment.

3.2 Unusual Service Conditions

3.2.1 Abnormal Ambient Temperatures

Reclosers 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.

3.2.2 Altitudes Above 1000 m (3300 ft)

Reclosers may be applied at altitudes higher than 1000 m (3300 ft). However, the basic impulse insulation level, rated maximum voltage and rated continuous current shall be multiplied individually by the correction factors in Table 1, Columns 3 and 4, to obtain values at which the application may be made. The rated interrupting current, related required capabilities, and rated interrupting time are not affected by altitude.

Reclosers designed for standard temperature rise may be used at normal current rating without exceeding total temperature limits provided that the ambient temperature does not exceed the ambient allowed in 3.1 multiplied by the factor shown in Column 5 of Table 1.

3.2.3 Other Conditions which May Affect Design and Application

Where other unusual conditions exist they should be brought to the attention of those responsible for the manufacture of the equipment. Examples of such conditions are:

²NEMA documents are available from National Electrical Manufacturers Association, Order Department, 2101 L Street, N.W., Washington, DC 20037.

Table 1— Altitude Correction

Altitude Correction Factor to be Applied to				
Meters	Feet	Voltage Rating	Current Rating	Ambient Temperature
(Col 1)	(Col 2)	(Col 3)	(Col 4)	(Col 5)
1000	3300	1.00	1.00	1.00
1200	4000	0.98	0.99	0.99
1500	5000	0.95	0.99	0.98
3000	10 000	0.80	0.96	0.92
4900	16 000	0.63	0.93	0.85

NOTE — Correction factors in Columns 4 and 5 shall not be applied simultaneously.

- 1) Abnormal vibration, shocks or tilting.
- 2) Unusual transportation or storage conditions.
- 3) Unusual operating duty, frequency of operation, inadequate maintenance, special insulation requirements.
- 4) For overhead, pad mounted, and dry vault reclosers: Exposure to damaging fumes or vapors, excessive or abrasive dust, explosive mixtures of dust or gases, salt air, extreme humidity.
- 5) For submersible reclosers: Exposure to tidal water, highly acidic water, water containing abnormal amounts of dissolved road salt or fertilizer, continuous submersion and stray direct currents.

4. Definitions

The definitions of terms contained in this standard or in other American National Standards referred to in this standard, are not intended to embrace all legitimate 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. (See Fig 1.)

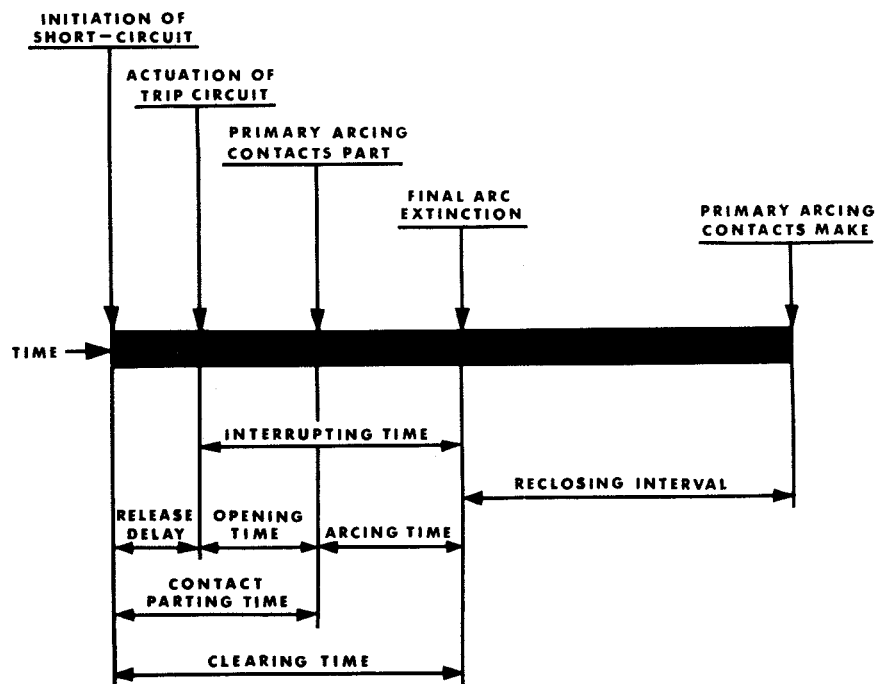


Figure 1— Unit Operation

5. Rating

5.1 Rating Information

The rating shall include the following terms:

- 1) Rated maximum voltage
- 2) Rated frequency
- 3) Rated continuous current
- 4) Rated minimum tripping current (series-trip coil reclosers only)
- 5) Rated symmetrical interrupting current
- 6) Rated symmetrical making current
- 7) Rated impulse withstand voltage
- 8) Rated control voltage
- 9) Rated cable charging interrupting current (where applicable)

5.2 Rated Maximum Voltage

The rated maximum voltage of reclosers shall be the values shown in Column 3 of Tables 2, 4 and 6.

5.3 Rated Frequency

The rated frequency of reclosers shall be 60 Hz.

5.4 Rated Continuous Current

The rated continuous currents of reclosers shall be the values shown in Column 7 of Tables 2, 4 and 6, except as limited by the series coil or minimum trip settings as given in Tables 3, 5 and 7.

5.4.1 Conditions of Continuous Current Rating

- 1) Reclosers shall be used under the usual service conditions defined in 3.1
- 2) Current ratings shall be based on the total temperature limits of the materials used for such parts. A temperature rise reference is given to permit testing at reduced ambient
- 3) Reclosers 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
- 4) Outdoor reclosers and indoor reclosers 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 8.

5.4.2.1

Classification of Insulating Materials: For the purpose of establishing temperature limits, insulating materials shall be classified as follows:

- 1) *Class 90 Insulation:* Materials or combinations of materials such as cotton, silk, and paper without impregnation. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 90 °C.
- 2) *Class 105 Insulation:* Materials or combinations of materials such as cotton, silk, and paper when suitably impregnated or coated or when immersed in a dielectric liquid such as oil. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 105 °C.
- 3) *Class 130 Insulation:* Materials or combinations of materials such as mica, glass fiber, asbestos, etc, with suitable bonding substances. Other materials or combinations of materials, not necessarily inorganic, may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 130 °C.
- 4) *Class 155 Insulation:* Materials or combinations of materials such as mica, glass fiber, asbestos, etc, with suitable bonding substances. Other materials or combinations of materials, not necessarily inorganic, may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 155 °C.
- 5) *Class 180 Insulation:* Materials or combinations of materials such as silicone elastomer, mica, glass fiber, asbestos, etc with suitable bonding substances such as appropriate silicone resins. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 180 °C.
- 6) *Class 220 Insulation:* Materials or combinations of materials that by experience or accepted tests can be shown to be capable of operation at 220 °C.
- 7) *Over Class 220 Insulation:* Insulation that consists entirely of mica, porcelain, glass, quartz, and similar inorganic materials. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at temperatures over 220 °C.

Table 2— Rated Maximum Voltage, Rated Continuous Current, Rated Interrupting Current, Rated Impulse Withstand Voltage, and Performance Characteristics of Oil Reclosers

Performance Characteristics of SW Reclosers														
Line No	Nominal System Voltage (kv) rms	Rated Maximum Voltage (kV) rms	Rated Impulse Withstand Voltage (kV) Crest	Low-Frequency Insulation Level Withstand Test* kV rms		Current Ratings, Amperes		Standard Operating Duty						
				1 min Dry	10 s Wet	Continuous 60 Hz	Symmetrical Interrupting† at Rated Maximum Volts	Percent of Interrupting Rating						Total Number of Unit Operations
								15–20		45–55		90–100		
								Minimum X/R	Number of Unit Operations	Minimum X/R	Number of Unit Operations	Minimum X/R	Number of Unit Operations	
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12	Col 13	Col 14	Col 15
Single-Phase Reclosers														
1	14.4	15.0	95	35	30	50	1250	2	40	4	40	8	20	100
2	14.4	15.5	110	50	45	100	2000	2	32	5	24	10	12	68
3	14.4	15.5	110	50	45	280	4000	3	32	6	20	12	12	64
4	14.4	15.5	110	50	45	560	10 000	4	28	8	20	15	10	58
5	24.9	27.0	150	60	50	100	2500	2	32	5	24	12	12	68
6	24.9	27.0	150	60	50	280	4000	3	32	6	20	13	12	64
7	34.5	38.0	150	70	60	560	8000	4	28	8	20	15	10	58
Three-Phase Reclosers														
8	14.4	15.0	95	35	30	50	1250	2	40	4	40	8	20	100
9	14.4	15.5	110	50	45	100	2000	2	32	5	24	10	12	68
10	14.4	15.5	110	50	45	280	4000	3	32	6	20	12	12	64
11	14.4	15.5	110	50	45	400	4000	3	32	6	20	12	12	64