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American National Standard

Switchgear Metal Enclosed Low Voltage AC Power Circuit Breaker Switchgear Assemblies— Conformance Test Procedures

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
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American National Standard
for Switchgear –

High-Voltage Current-Limiting Motor-Starter Fuses – Conformance Test Procedures

Secretariat

National Electrical Manufacturers Association
Institute of Electrical and Electronics Engineers

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American National Standard
for Switchgear –

High-Voltage Current-Limiting Motor-Starter Fuses – Conformance Test Procedures

1. Scope

This standard covers the conformance test procedures for alternating-current high-voltage motor-starter fuses covered in the applicable American National Standards listed in 2.1. High-voltage motor-starter fuses are backup, current-limiting fuses used in conjunction with high-voltage Class E2 motor starters.

This standard does not cover installations under the exclusive control of electric utilities for the purposes of communication or metering, or for the generation, control, transformation, transmission, and distribution of electric energy located in buildings used exclusively by utilities for such purposes, or located outdoors on property owned or leased by the utility or on public highways, streets, roads, and the like, or located outdoors by established rights on private property.

1.1 General. These tests shall be used to demonstrate that the motor-starter fuses being tested conform with the specified ratings and characteristics. The standard is designed to cover a product that can be used with Class E2 controllers (fused) as described in Table 27.1 and elsewhere in the American National Standard Safety Standard for High Voltage Industrial Control Equipment, ANSI/UL 347-1985.

1.2 Insulating Evaluation. Insulating materials for use in motor-starter fuses shall be evaluated with respect to their acceptability for the particular application. When a material is evaluated, the mechanical strength, dielectric properties, insulation resistance, and heat resistance qualities of the material are considered in conjunction with actual service conditions. The degree to which the fuse is enclosed or protected and any other features having a bearing on electrical shock or dielectric failure are also tested. All of these factors are considered with respect to thermal aging.

2. Referenced and Related Standards

2.1 Referenced American National Standards. This standard is intended for use in conjunction with the following American National Standards. When the referenced standards are superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply.

ANSI C37.46-1981 (R1987), Specifications for Power Fuses and Fuse Disconnecting Switches

ANSI C37.47-1981 (R1988), Specifications for Distribution Fuse Disconnecting Switches, Fuse Supports, and Current-Limiting Fuses

ANSI/IEEE C37.40-1981 (R1988), Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

ANSI/IEEE C37.41-1989, Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

ANSI/IEEE C37.48-1987, Guide for Application, Operation, and Maintenance of High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

ANSI/UL 347-1985, Safety Standard for High-Voltage Industrial Control Equipment

2.2 Related Standards. The following standards are listed for information only and are not necessary to complete the requirements of this standard.

ANSI/NFPA 70-1987, National Electrical Code

NEMA SG2-1986, High-Voltage Fuses[1]

3. General Test Conditions

Tests shall be conducted under conditions prevailing at the test site that shall conform to usual service conditions in accordance with 3.1 of ANSI/IEEE C37.40-1981, except that continuous current tests shall be conducted within the ambient temperature range of 10°C to 40°C (50°F to 104°F).

3.1 General. Tests shall be performed on a representative number of samples to evaluate performance in the following areas:

(1) Resistance
(2) Temperature rise
(3) Time-current characteristics
(4) Interrupting ability
  (a) Maximum interrupting capacity
  (b) Minimum interrupting capacity
  (c) Maximum arc energy
  (d) Let-through

3.2 Resistance Measurement. Three samples of each fuse rating shall be measured. Any other samples that may be required for the purpose of conducting the tests in 3.3, 3.4, and 3.5 shall also be subjected to this measurement.

3.3 Temperature-Rise Tests. One sample of each case size, having the maximum continuous current rating for that case size, shall be subjected to the temperature-rise test. The maximum rated continuous current shall be passed through the fuse. Temperature-rise tests shall be performed in accordance with Section 11 of ANSI/IEEE C37.41-1989.

Acceptable performance and limiting conditions shall be as specified in 4.4, 4.4.1, and 4.4.2 of ANSI C37.46-1989.

3.4 Melting-Time–Current Characteristics

3.4.1 Two samples of the intermediate (or minimum, if only two ratings are involved) continuous current rating selected from each case size shall be subjected to melting-time–current tests in accordance with 12.2.1 of ANSI/IEEE C37.41-1989.

3.4.2 Test currents shall be selected to produce melting times of approximately 15 seconds to 35 seconds. In each case, the melting-time–current characteristics shall be as specified in 3.4.2 of ANSI C37.46-1989.

3.5 Interrupting Tests

3.5.1 Test Practices. Interrupting-test practices shall be as specified for back up fuses in Section 6 of ANSI/IEEE C37.41-1989 except that Table 1 of this standard shall be used rather than Table 4 of ANSI/IEEE C37.41-1989.

3.5.2 Test Description. Tests shall be conducted in accordance with Table 1 of this standard and shall consist of the three series of tests described in 6.1.2.3 of ANSI/IEEE C37.41-1989.

3.5.3 Characteristics of the Test Circuit. The interrupting tests shall be conducted as described in 6.1.3 of ANSI/IEEE C37.41-1989, except that the parameters of the test circuits shall be as specified in Table 1 of this standard rather than Tables 2 through 6 of ANSI/IEEE C37.41-1989.

3.5.4 Test Procedure. Interrupting tests shall be conducted as described in 6.2 of ANSI/IEEE C37.41-1989.

3.5.4.1 Tests on the Device. The tests shall be performed as shown in 6.2.2 of ANSI/IEEE C37.41-1989, except the conditions specified in Table 1 of this standard shall be observed rather than the conditions in Tables 2, 3, or 4 of ANSI/IEEE C37.41-1989.

3.5.4.2 Condition after Interrupting Performance Tests. The condition of the fuses shall be as described in 6.4 of ANSI/IEEE C37.41-1989.

3.5.4.3 Peak Overvoltages. The peak overvoltages shall be in accordance with the requirements in 4.2.1.1 of ANSI/IEEE C37.46-1981, except that the notation to "E-rated voltages" does not apply.

3.5.4.4 Cutoff (Peak Let-Through) Current for Current-Limiting Power and Distribution Fuses. This current shall be determined as specified in 4.2.3 of ANSI C37.46-1981. Peak let-through current and clearing I^2t shall be measured by oscillograms. If the performance of the fuses makes the data obtained from the magnetic oscillograph record questionable, a cathode-ray oscillograph may be necessary to verify the test results.

3.6 Marking. A high-voltage motor circuit fuse shall be provided with the following marking:

(1) Manufacturer's name
(2) Catalog number
(3) Maximum voltage rating

[1]Copies are available from the National Electrical Manufacturers Association, 2101 L Street, N.W., Washington, DC 20037.

(4) Ampere rating or R-rating,[2] or both
(5) Frequency
(6) Maximum interrupting rating
(7) Minimum interrupting rating

4. Treatment of Failures

If failures occur during testing, the failure shall be evaluated and corrected, and retesting conducted. A design change made to motor-starter fuses to correct a failure in a test shall be evaluated for its effect on any other test.

5. Production Monitoring

5.1 Monitoring Tests. Unless otherwise specified, all production monitoring shall be done by the manufacturer at the factory on the completed fuses or their component parts for the purpose of checking the correctness of manufacturing operations and materials. Production monitoring shall include, but not be limited to, the following tests:

5.1.1 Incoming parts and materials shall be subjected to standard visual, mechanical, and electrical inspection, as appropriate.

5.1.2 Conventional control of material purchase specifications shall be utilized.

5.1.3 A cold resistance measurement shall be made on each completed fuse. The cold resistance shall be within the tolerances specified by the manufacturer.

5.1.4 Each completed fuse shall be checked to see that its overall dimensions are within the tolerances specified by the manufacturer.

5.1.5 On an audit basis, a completed fuse shall be subjected to a test to determine that the filler has been compacted to the degree specified by the manufacturer.

[2] In accordance with ANSI C37.46-1981.

5.2 Tests for Design Deviations. On a routine basis (not longer than 1 year), a completed fuse shall be disassembled and examined for any deviations from the intended design. At this time, the following routine procedures shall be observed:

5.2.1 Samples of the link shall be examined for any deviations from the intended design.

5.2.2 Samples of the fuse housing shall be subjected to mechanical strength tests (either burst or crush tests) to demonstrate the integrity of the fuse housing.

5.2.3 Samples of the assembly of ferrule and housing shall be subjected to a test verifying the mechanical integrity of the ferrule attachment.

6. Retesting

6.1 General. The retesting of a specific design fuse shall be conducted as described in the following paragraphs:

6.1.1 Annually, fuses shall be selected and subjected to temperature and melting-time–current characteristic tests in accordance with 3.3 and 3.4 of this standard.

6.1.2 Interrupting tests (see 3.5 and 3.6) shall be conducted after a period of 10 years.

6.2 Design Changes. A design change made to a high-voltage motor-starter fuse shall be evaluated for its effect on rated performance and only the relevant design tests should be conducted.

7. Requalification Tests

Requalification testing shall be required every 10 years if the design has not changed.

Table 1
Interrupting Performance Tests: Current-Limiting Motor-Starter Fuses
(Parameters of Test Circuits and Tests)

Parameters	Test Series 1	Test Series 2	Test Series 3*
Power frequency recovery voltage	Rated maximum voltage +5%, –0%	Rated maximum voltage +5%, –0%	Rated maximum voltage +5%, –0%
Prospective (available) current – RMS symmetric	I_1 +5%, –0%	I_2	I_3
X/*R* Ratio (Power Factor)	Not less than 15 Not more than 6.7%	Not less than 15 Not more than 6.7%	2.29 to 1.33† 40% to 60%
Making angle after voltage zero – degrees	Not applicable	0 to 20	Random
Instantaneous current at initiation of arcing	Not applicable	0.85 I_2 to 1.06 I_2	Not applicable
Initiation of arcing after voltage zero – degrees	For one test – from 40 to 65‡ For two tests – from 65 to 90	Not applicable	Not applicable
Duration of normal frequency recovery voltage after interruption	Not less than 1 minute**	Not less than 1 minute**	Not less than 1 minute**
Number of tests	3	3	2

* Series 3 tests are made with a current value corresponding to the manufacturer's stated minimum interrupting current with a tolerance of +0 and –10 percent. When testing-station limitations prevent the maintenance of constant current, the tolerance on the current can be exceeded in either direction during not more than 20 percent of the total melting time.

† The reactance of the test circuit shall be shunted by a resistance with a value equal to approximately 40 times the value of the reactance. However, if this value does not result in at least critical damping, the resistance shall be reduced to achieve critical damping. Critical damping is obtained when:

$$R = \frac{fo}{2fN} X,$$

where
fo = natural frequency of test circuit without damping,
fN = power frequency,
X = reactance of the circuit at power frequency.

‡ Since the operating conditions can produce a wide variety of stresses on the fuse, and as the interrupting tests are intended in principle to produce the most severe conditions mainly with regard to the arc energy and the thermal and mechanical stresses for this value of current, it is recognized that these conditions will be practically obtained at least once when making the three tests indicated.

** Should limitations of the test station so dictate, then subsequent to circuit interruption and within a period of no more than 15 seconds after interruption, the voltage may be interrupted for an interval no longer than 1 second. This interval may be used to effect switching to an auxiliary power supply of adequate kVA capacity from which the specified test voltage can be maintained for the remainder of the specified interval.