UL 2748

STANDARD FOR SAFETY

Arcing Fault Quenching Equipment

UL Standard for Safety for Arcing Fault Quenching Equipment, UL 2748

Second Edition, Dated September 6, 2024

Summary of Topics

This new Second edition of ANSI/UL 2748 dated September 6, 2024 incorporates editorial changes including renumbering and reformatting to align with current style, and the following changes in requirements:

> ***– Addition of Requirements for Option to Perform Arc Transfer Test at Less Than Maximum Rated Voltage; 5.4, 19.1 – 19.4, Sections 20 – 22***

The new requirements are substantially in accordance with Proposal(s) on this subject dated March 29, 2024 and July 19, 2024.

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SEPTEMBER 6, 2024

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UL 2748

Standard for Arcing Fault Quenching Equipment

Prior to the first edition, the requirements for the products covered by this Standard were included in the Outline of Investigation for Arcing Fault Quenching Equipment, UL 2748.

First Edition – September, 2017

Second Edition

September 6, 2024

This ANSI/UL Standard for Safety consists of the Second Edition.

The most recent designation of ANSI/UL 2748 as an American National Standard (ANSI) occurred on September 6, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in ULSE's Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover equipment intended to quench arcing faults by creating a lower impedance current path, located within a controlled compartment, to cause the arcing fault to transfer to the new current path.

1.2 These requirements cover equipment that may either be completely enclosed units or intended to be installed within power distribution equipment.

1.3 These requirements cover equipment rated up to 52 kV ac maximum.

1.4 This Standard does not include the requirements for arc detection relays and related sensors intended to detect arcing faults or devices that are intended to interrupt arcing fault currents.

1.5 This Standard does not include all the requirements for integration and testing of arc quenching equipment within equipment it is intended to protect.

1.6 This Standard does not contain requirements for investigation of the performance of an entire arc mitigation system, which would consist of arc sensors, relays, quenching equipment and other ancillary equipment necessary to form a complete system.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this Standard shall comply with the requirements for that component.

2.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this Standard, or

b) Is superseded by a requirement in this Standard.

2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4 Referenced Publications

4.1 Any undated reference to a code or standard appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of that code or standard.

4.2 The following publications are referenced in this Standard:

IEEE C37.20.1, *Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear*

IEEE C37.20.2, *Metal Clad Switchgear*

IEEE C37.20.3, *Metal-Enclosed Interrupter Switchgear*

IEEE C37.20.7, *Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults*

IEEE C37.90, *Relays and Relay Systems Associated with Electric Power Apparatus*

IEEE C37.90.1, *Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electrical Power Apparatus*

IEEE C37.90.2, *Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers*

IEEE C37.90.3, *Standard for Electrostatic Discharge Tests for Protective Relays*

NEMA C37.51, *Metal-Enclosed Low-Voltage AC Power Circuit Breaker Switchgear Assemblies – Conformance Test Procedures*

NEMA C37.57, *Metal-Enclosed Interrupter Switchgear Assemblies – Conformance Testing*

UL 50E, *Enclosures for Electrical Equipment, Environmental Considerations*

UL 508, *Industrial Control Equipment*

UL 840, *Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment*

UL 1558, *Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear*

UL 60947-1, *Low-Voltage Switchgear and Controlgear – Part 1: General Rules*

5 Glossary

5.1 For the purpose of this Standard, the following definitions apply.

5.2 ARCING FAULT – A non-intentional discharge of electrical energy in air or other gas, including discharges across the surface of an insulating material.

5.3 ARC TRANSFER TIME – The interval between triggering of the arc quenching device and the quenching of the arcing fault.

5.4 BOLTED FAULT – A short circuit or electrical contact between two conductors at different potentials in which the impedance or resistance between the conductors is essentially zero.

5.5 CONTROLLED COMPARTMENT – A portion of equipment, intended to enclose the new current path when an arcing fault is transferred. This compartment may be provided with openings or flaps for pressure relief.

5.6 LOW-VOLTAGE – A voltage of 1000 V ac or less.

5.7 MEDIUM-VOLTAGE – A voltage of greater than 1000 V ac, up to 52 kV ac.

5.8 POLLUTION DEGREE 2 MICROENVIRONMENT – An area where normally, only nonconductive pollution occurs, but where occasional, temporary conductivity may be expected. Typical constructions that reduce the possibilities of conductive pollution and condensation or high humidity are;

a) Un-ventilated enclosures that are provided with continuous application of heat through the use of heaters or through continuous energization of the equipment, with interruptions such that cooling to the point of condensation does not occur or

b) The use of ventilated enclosures where all openings are provided with filters.

5.9 QUENCHING DEVICE – Equipment that is used to extinguish or redirect an arcing fault.

5.10 RESETTABLE (as applied to quenching devices) – capable of being reset and returned to service without replacement or repair of components.

CONSTRUCTION

6 General

6.1 Where referenced in this Standard, requirements contained in UL 1558, are applicable to low-voltage quenching devices, and the requirements contained in IEEE C37.20.3 are applicable to medium-voltage quenching devices.

7 Enclosure

7.1 Other than as noted in 7.2, quenching devices shall comply with the requirements of 7.3 – 7.6.

7.2 Devices covered by this Standard that are intended for installation completely within the enclosure of other equipment need not be provided with an enclosure.

7.3 Low-voltage devices provided with complete enclosures shall comply with the enclosure requirements of UL 1558. Medium-voltage devices provided with complete enclosures shall comply with the enclosure requirements of IEEE C37.20.3.

7.4 Where a portion of the quenching device is intended to fill or protrude through an opening, or otherwise form a portion of the enclosure of the overall equipment, it shall be investigated in accordance with the enclosure requirements of the standard for the overall equipment.

7.5 Devices described in 7.3 and 7.4 may be assigned one or more enclosure type designations in accordance with 24.10. The devices shall comply with the requirements of UL 50E for each assigned type designation when installed.

7.6 Gaskets relied upon to maintain the environmental rating of the equipment shall comply with the gasket requirements of UL 50E.

8 Primary or Power Carrying Circuits

8.1 Low-voltage equipment shall comply with Section 6, Primary or Power Carrying Circuits, of UL 1558.

8.2 Medium-voltage equipment shall comply with Section 7.1, Buses and primary connections, of IEEE C37.20.3.

9 Grounding

9.1 There shall be provision for grounding all non-current carrying metal parts of the equipment. In addition, the following parts shall be grounded:

a) The metal case of a frame or instrument transformer;

b) The metal case of an instrument, meter or relay; and

c) The secondary circuit of a current or voltage transformer, if there are provision for field connection to the secondary circuit. Secondary circuits that are not intended for field connection are not required to be grounded..

9.2 The case of an instrument, relay, meter, or similar device, if mounted on a grounded metal surface and secured thereto by means of metal screws, is considered to be grounded.

10 Control and Secondary Wiring

10.1 An insulated conductor provided as part of a control circuit or secondary wiring shall be rated for the particular application and shall have an ampacity not less than the continuous current rating of the circuit in which it is connected. Where loads are of an intermittent nature, such as in trip and closing circuits, conductors shall be sized to provide their intended function with respect to voltage drop and mechanical strength.

11 Creepage and Clearance Distance

11.1 Section 12, Spacings, of UL 1558 applies to the power circuits of low-voltage quenching equipment, other than as noted in 11.3.

11.2 No minimum creepage or clearance distances are specified for medium-voltage circuits in quenching equipment, other than distances sufficient to meet the dielectric requirements specified in this Standard for the voltage rating of the equipment.

11.3 No minimum creepage or clearance distances are specified across the contacts of the quenching means when these contacts are contained within a pollution degree 2 microenvironment, and the quenching equipment meets the dielectric test requirements of this Standard with the quenching device in the open position.

11.4 Creepage and clearance distances within low-voltage control circuits of quenching devices shall comply with the creepage and clearance distance requirements of UL 508 or UL 60947-1. Creepage and clearance distances between low-voltage control circuits and medium-voltage circuits shall be no smaller than the creepage and clearance distances required from the medium-voltage circuit to grounded metal, and shall also be sufficient to meet the dielectric requirements specified in this Standard for the maximum voltage rating of the equipment, with the control circuits grounded during testing.

11.5 The pollution degree 2 microenvironment specified in 11.3 need not be maintained during or after the quenching of an arcing fault if servicing of the quenching means is required after an arcing fault event, and the quenching means is marked in accordance with 24.5.

11.6 For printed wiring boards, the creepage and clearance distances shall comply with requirements of the Standard for Insulation Coordination Including Clearance and Creepage Distances for Electrical Equipment, UL 840. For the purpose of determining required creepage and clearance distances, quenching devices shall be considered to be located within circuits of overvoltage category 3. All

quenching devices are considered to be installed in pollution degree 3 environments, except for portions of the device located in a pollution degree 2 microenvironment.

11.7 Pollution Degree 2 shall be considered to exist on a printed-wiring board where a coating provides an uninterrupted covering of the conductive material for at least one of two conductive materials and covers the entire space between the two conductive materials for which the spacing is being evaluated.

12 Wiring

12.1 Insulated conductors provided as part of a quenching device shall be rated for the particular application and shall have an ampacity no less than the maximum current rating of the circuit to which they are connected.

12.2 Wiring shall be located or protected to prevent contact with any sharp edge or moving part that could damage the insulation.

12.3 Insulated conductors shall be separated from wiring and uninsulated live parts connected to other circuits, unless both circuits are provided with insulation rated for the highest voltage.

13 Operation

13.1 Quenching devices with adjustable sensitivity shall comply with the requirements of this Standard over the entire range of possible settings.

13.2 Quenching devices that have provisions for disabling the quenching function shall have provisions for local and remote indication that the device has been disabled. Devices with provisions for intentionally delaying the time between detection of an arcing fault and operation of the quenching function shall have provisions for local and remote indication that operation of the quenching function will be intentionally delayed.

13.3 Quenching devices shall be provided with visual indication that the quenching function has operated. Devices shall also have provisions for remote indication of quenching function operation.

13.4 Quenching devices that are intended to be replaced or serviced after every quenching function operation shall have provisions for interlocking such that the circuit protected by the quenching device cannot be reenergized until the quenching device has been replaced or serviced. These devices shall be marked in accordance with 24.5. While mechanical interlocking is preferred, where mechanical interlocking is not practicable, electrical interlocking is acceptable.

PERFORMANCE

14 General

14.1 Quenching devices shall comply with the requirements of this section with the quenching device installed and connected in accordance with the manufacturer's installation instructions.

14.2 Quenching devices with adjustable settings shall be tested to demonstrate compliance with the performance requirements over the range of possible settings, including minimum and maximum settings.

14.3 When provided, output circuits for energizing the trip coils of circuit breakers shall comply with the requirements for Make, Carry, and Interrupt Ratings for Tripping Output Circuits as detailed in IEEE C37.90.

14.4 Arc mitigation equipment that is provided with electronic circuitry shall meet the requirements of IEEE C37.90.1.

14.5 Arc mitigation equipment that is provided with electronic circuitry shall meet the requirements of the IEEE C37.90.2.

14.6 Arc mitigation equipment that is provided with electronic circuitry shall meet the requirements of the IEEE C37.90.3.

14.7 Insulating materials in contact with medium-voltage parts, or used to isolate medium-voltage parts, shall comply with 6.2.7, Tests for Insulating Materials, of IEEE C37.20.2.

15 Continuous Current Test

15.1 Other than as noted in 15.3, low-voltage quenching devices shall be subjected to a continuous current test in accordance with NEMA C37.51. During the continuous current test, the device shall operate without exceeding the allowable temperature limits specified in Tables 3 and 4 of (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear, IEEE C37.20.1, and in Maximum temperature rises, Table 43.1 and Maximum enclosure surface temperature rises, Table 43.1A of UL 508 or UL 60947-1.

15.2 Other than as noted in 15.3, medium-voltage quenching devices shall be subjected to a continuous current test in accordance with NEMA C37.57. During the continuous current test, the device shall operate without exceeding the allowable temperature limits specified in Table 2 of IEEE C37.20.3, and in Maximum temperature rises, Table 43.1 and Maximum enclosure surface temperature rises, Table 43.1A of UL 508 or UL 60947-1.

15.3 Quenching devices that do not carry the current of the main circuit under normal conditions, and conduct only during the quenching operation, are not required to carry this current during the continuous current test. Control circuits that are energized under normal conditions shall be tested in accordance with the continuous current test specified in UL 508 or UL 60947-1.

16 Power-Frequency Withstand Voltage Tests

16.1 Low-voltage quenching devices shall comply with the power-frequency withstand voltage tests of NEMA C37.51.

16.2 Medium-voltage quenching devices shall comply with the power-frequency withstand voltage tests of NEMA C37.57.

17 Maximum Withstand Current Test

17.1 Quenching devices shall be subjected to a maximum withstand current test to demonstrate the ability of the quenching device, including the bus and connections, to carry current equal to the maximum arcing fault current rating assigned to the device for the rating short-time withstand duration.

17.2 The test method for low-voltage quenching devices shall be similar to the Short-Time Withstand Current Test method described in NEMA C37.51, with the following modifications:

a) The available short-time withstand current shall be calibrated at the line terminals of the equipment in which the quenching device is installed during the test. Calibration of the test circuit shall demonstrate the circuit is capable of delivering the rated maximum withstand current for the entire rated short-time withstand current duration of the quenching device.

b) The short-time withstand current is to be initiated by action of the quenching device. Alternatively, the test may be conducted using a previously triggered quenching device, by closing the test station switching device onto the circuit. The current is to be maintained for no less than the rated short-time withstand current duration of the quenching device. The actual current through the quenching device is to be measured during the duration of the test. The actual current delivered to the test point will be reduced by the impedance of the arc and the test sample.

c) Tests shall be conducted with a three phase source of supply. Testing with a single phase source of supply is not representative of three phase testing.

d) The quenching device shall carry the test current for the entire duration of the test. Interruption of the test current prior to rated short-time withstand current duration shall be considered an unacceptable result.

e) The contacts of the quenching device may be welded in the closed position at the conclusion of the test. Quenching devices complying with 13.4 are not required to be functional at the conclusion of the test.

f) All local and remote indication means provided shall indicate that the arc quenching function has operated, and shall not reset automatically.

g) Quenching devices that are intended to be reset, rather than repaired or replaced, after a quenching operation shall meet the required electrical creepage and clearance distances of Section 11 after the device has been reset following the short-time withstand test. Quenching devices that require repair or replacement after a quenching operation are not required to meet the required creepage and clearances at the conclusion of the short-time withstand test.

17.3 The test method for medium-voltage quenching devices shall be similar to the Short-Time Withstand Current Test method described in NEMA C37.57, with the following modifications:

a) The available short-time withstand current shall be calibrated at the line terminals of the equipment in which the quenching device is installed during the test. Calibration of the test circuit shall demonstrate the circuit is capable of delivering the rated maximum arcing fault current for the entire rated short-time withstand current duration of the quenching device.

b) The short-time withstand current is to be initiated by action of the quenching device. Alternatively, the test may be conducted using a previously triggered quenching device, by closing the test station switching device onto the circuit. The current is to be maintained for no less than the rated short-time withstand current duration of the quenching device. The actual current through the quenching device is to be measured during the duration of the test. The actual current delivered to the test point will be reduced by the impedance of the arc and the test sample.

c) Tests shall be conducted with a three phase source of supply. Testing with a single phase source of supply is not representative of three phase testing.

d) The quenching device shall carry the test current for the entire duration of the test. Interruption of the test current prior to rated short-time withstand current duration shall be considered an unacceptable result.

e) The contacts of the quenching device may be welded in the closed position at the conclusion of the test. Quenching devices complying with 13.4 are not required to be functional at the conclusion of the test.

f) All local and remote indication means provided shall indicate that the arc quenching function has operated, and shall not reset automatically.

18 Internal Arcing Fault Test

18.1 The purpose of this test is to demonstrate the quenching device does not create an arc fault hazard during the quenching operation. The quenching device shall be installed in complete equipment in accordance with the manufacturer's installation instructions, or may be tested as an open device without an enclosure. The equipment shall be subjected to testing in accordance with IEEE C37.20.7.

18.2 When tested in complete equipment, indicators shall be provided around the vertical section of the equipment containing the quenching device. Indicator placement shall be in accordance with the requirements of IEEE C37.20.7 for the accessibility type of the equipment containing the arc quenching device. When tested as an open device, indicators shall be placed around the entire quenching device in a similar manner, at a distance of 4 inches from each surface of the quenching device.

18.3 The arc initiation wire shall be in accordance with the requirements of the appropriate Annex of IEEE C37.20.7, based upon the type of equipment in which the quenching device is intended to be installed. The arc shall be initiated within the circuit that is protected by the arc quenching device. The arc initiation is not required to be within the compartment or vertical section containing the quenching device. When a quenching device is intended for use in more than one type of equipment, it may be necessary to conduct testing using arc initiation wires in accordance with more than one Annex from IEEE C37.20.7.

18.4 When testing as an open device, the test is considered acceptable if there is no ignition of any indicators, and no evidence of damage to the quenching device other than contact welding at the conclusion of the test. Minor cracking of insulators that does not result in expulsion of gases or particles is acceptable, if the mounting of live parts is not impaired.

18.5 This test may be combined with the Arc Transfer Test, Section 19, if the parameters for both tests are met during the combined test.

18.6 Quenching devices that are not resettable shall be subject to one operation. Resettable quenching devices shall be subjected to the rated number of quenching operations as specified by the manufacturer. After the rated number of operations has been completed, the quenching device shall be subjected to one additional operation. The device shall successfully quench the arc without creating an arc fault hazard during the final operation, but need not be functional after the test.

19 Arc Transfer Test

19.1 Arc transfer testing shall be conducted to demonstrate the maximum time for an arcing fault to transfer to the intended lower impedance fault.

19.2 The test shall be conducted as described in 18.3.

19.3 This test shall be conducted at maximum rated voltage and shall demonstrate the transfer time required at the maximum rated withstand current. For quenching devices with a specified minimum rated arcing fault current, the test shall also be conducted at the minimum rated arcing fault current.

19.4 For devices that are rated for applications greater than 5000 V, and which create a bolted fault through a switching action, the Arc Transfer Test may be performed at a voltage less than the maximum rated voltage of the quenching device in order to accommodate lab limitations. When less than maximum rated voltage is used, the tests specified in Section 20, Arc Transfer Test at Reduced Voltage, and Section 21, Fault Close Test at Rated Voltage, shall be conducted.

19.5 The elapsed time between triggering of the quenching unit and the quenching of the arc shall be recorded during the testing in 19.1. The recorded time shall be less than the maximum rated transfer time,