UL 347A

STANDARD FOR SAFETY

Medium Voltage Power Conversion Equipment

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UL Standard for Safety for Medium Voltage Power Conversion Equipment, UL 347A

Second Edition, Dated January 5, 2021

Summary of Topics

This revision of ANSI/UL 347A dated October 30, 2024 includes replacing withdrawn reference ANSI/ISA MC96.1 with ASTM E230/E230M: 4.2 and 32.2.27.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated September 27, 2024.

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Standard for Medium Voltage Power Conversion Equipment

First Edition – September, 2015

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January 5, 2021

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The most recent designation of ANSI/UL 347A as an American National Standard (ANSI) occurred on October 30, 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 the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover enclosed medium voltage power conversion equipment, such as variable frequency controllers, that control and transfer power to motors. These requirements also cover power-supply modules, input/output modules, and electronic assemblies, for use in or with power conversion equipment.

1.2 These requirements cover equipment rated above 1500 volts to 38kV. The equipment may have input ratings greater than 1500 V, output ratings greater than 1500 V, or both.

1.3 These requirements do not cover equipment for use in hazardous locations as defined by the National Electrical Code, NFPA 70.

1.4 These requirements do not cover solid state reduced voltage motor controllers (soft starters). This type of equipment is covered by the Standard for Medium Voltage AC Contactors, Controllers, and Control Centers, UL 347.

1.5 These requirements do not cover low voltage power conversion equipment with both input and output voltage ratings of 1500 volts and below. This type of equipment is covered by the Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1.

2 Glossary

2.1 For the purpose of this document, the following definitions apply.

2.2 AMBIENT TEMPERATURE – The temperature of the air medium into which the heat of the equipment is dissipated. See 32.1.3.

2.3 BUS – A conductor, or group of conductors, that serve as a common connection for two or more circuits.

2.4 BUS, HORIZONTAL – A bus that extends through a vertical section, that is intended to connect to another vertical section, that may be provided in the future.

2.5 BUS, VERTICAL – A bus that connects one or more controllers in a vertical section together. Where the assembly also contains a horizontal bus, the vertical bus connects the controllers in a vertical section to the horizontal bus.

2.6 BYPASS CIRCUIT – A circuit, typically consisting of a switch or contactor, that when closed, creates an alternate path for current flow in parallel with the circuit being bypassed, allowing the original circuit to be turned off while maintaining current flow to the load.

2.7 CONTACTOR – A two-state (ON-OFF) device for repeatedly establishing and interrupting an electric power circuit.

2.8 CONTACTOR, AIR-GAP – A contactor that introduces a gap (in air) between contacts to interrupt a circuit.

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2.9 CONTACTOR, SOLID-STATE – A contactor that introduces a high impedance to interrupt a circuit. Typical solid-state contactors use silicon controlled rectifiers (SCR) or insulated gate bipolar transistors (IGBT) as the switching device(s).

2.10 CONTACTOR, VACUUM – A contactor that introduces a gap between contacts (located in a vacuum) to interrupt a circuit.

2.11 CONTROL CIRCUIT – A circuit that carries the electric signals directing the performance of a controller, and that does not carry the main power circuit. A control circuit is generally limited to 15 amperes or less.

2.12 CONTROLLER – A device or group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

2.13 COVER – An unhinged portion of an enclosure that covers an opening.

2.14 DOOR – A hinged portion of an enclosure that covers an opening, that is intended to be opened during routine maintenance, operations and adjustments.

2.15 ENCLOSURE – A surrounding case designed to protect:

a) Personnel against injury due to accidental contact with electrical or moving mechanical parts of the enclosed device(s), and

b) Internal device(s) against specified external conditions.

2.16 FAULT CURRENT – A current that results from the loss of insulation between conductors or between a conductor and ground.

2.17 GALVANICALLY ISOLATED SECONDARY CIRCUIT – A circuit having no direct electrical connection to a medium voltage circuit, with isolation between the circuits obtained by the use of transformers or optical isolation.

2.18 INTERLOCK – A device that prevents operation of some other device with which it is directly associated under specific conditions. Interlocks may be electrical, mechanical, or a combination of both.

2.19 INTERLOCK, MECHANICAL – An interlock that performs its function solely by mechanical means.

2.20 ISOLATED SECONDARY CIRCUIT – A circuit derived from an isolating source (such as a transformer, optical isolator, voltage divider or electro-mechanical relay) and having no direct connection back to the primary circuit.

2.21 ISOLATING MEANS – A mechanical switching device that provides, in the open position, isolating distance in the main circuit, from the source of power.

2.22 LOW VOLTAGE – Voltage of 1500 V or less.

Note: The National Electrical Code, NFPA 70 defines low voltage to be voltages of 1000 V or less.

2.23 LOW VOLTAGE SECTION (of a voltage divider) – That portion of a voltage divider where a small fraction (no greater than 1500 V total) of the input voltage is present during normal operation.

2.24 MEDIUM VOLTAGE – Voltage greater than 1500 V, up to and including 38 kV.

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Note: National Electrical Code, NFPA 70 defines any voltage above 1000 V as High Voltage.

2.25 OVERCURRENT – Overcurrent is a current in excess of the continuous rated current.

2.26 PANEL, HINGED – A portion of an enclosure that has hinges, but no hand-operable latching system, secured in the closed position by multiple bolts or other hardware requiring a tool other than a key to operate.

Note: Hinged panels are not intended to be opened during normal operation, routine adjustment or simple maintenance operations such as replacement of fuses.

2.27 PHASE LEAST LIKELY TO STRIKE GROUND – A phase that is referenced to ground or by virtue of its position, potential, or both, relative to other phases of the device is defined as less likely than any other phase to strike ground. In a three phase device, this phase is usually the center phase. It is possible for several phases to be equally likely to strike to ground.

2.28 POLLUTION DEGREE 1 – No pollution or only dry, nonconductive pollution occurs. The pollution has no influence.

2.29 POLLUTION DEGREE 2 – Normally, only nonconductive pollution occurs; however, temporary conductivity is expected when equipment is out of operation.

2.30 POLLUTION DEGREE 3 – Conductive pollution occurs, or dry, nonconductive pollution occurs that becomes conductive due to condensation that is expected.

2.31 PRIMARY CIRCUIT – A circuit in which the wiring and components are conductively connected to the branch circuit.

2.32 PRIMARY SECTION (of a voltage divider) – That portion of a voltage divider where a large fraction of the input voltage is present during normal operation.

2.33 PROTECTION, OVERLOAD – A protective device or circuit that detects excessive current, (not necessarily short-circuit current) and functions to cause interruption or limitation of the flow of current through the protected device or circuit.

2.34 PROTECTION, OVERVOLTAGE – A protective device or circuit that detects excessive voltage and functions to interrupt power or reduce voltage to the protected device or circuit.

2.35 RATING – A designated limit of operating characteristics based on definite conditions. Operating characteristics such as current, voltage, frequency, and other characteristics comprise the rating.

2.36 RELAY, OVERLOAD – A relay that functions at a predetermined value of overcurrent to provide a signal or to result in disconnection of the load from the power supply, or both. An overload relay is intended to protect the motor branch circuit conductors, the motor control apparatus, and the motor against overcurrent. It does not necessarily protect itself.

2.37 REVERSING – Reversing is a control function that provides for changing operation of the controlled motor from one direction to the other.

2.38 ROUTINE MAINTENANCE – Maintenance that involves simple tasks such as changing of filters, adjustment of controls, replacement of fuses, or resetting of protective functions or devices. Routine maintenance does not include repair or replacement of components other than fuses or filters.

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2.39 SOLID STATE MOTOR OVERLOAD PROTECTION – Circuitry integral to the power conversion equipment that acts to protect a motor under overload conditions by reducing current flow to the motor output terminals. This protection is typically achieved through an algorithm based on the I^2t of the current to the motor. The protection circuitry is usually comprised of hardware, firmware and software components.

2.40 SOLID STATE SHORT CIRCUIT PROTECTION – Circuitry integral to power conversion equipment that acts to suspend current flow to the motor output terminals upon sensing a preset or predetermined condition such as a rapid rate of change in output current or bus voltage. The protection circuitry may be comprised of hardware, firmware and software components.

2.41 SWITCH, ISOLATING – A switching device intended for isolating an electric circuit from the source of power. It does not have an interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means.

2.42 SWITCH, LOAD BREAK – A switch that has an interrupting rating equal to or greater than the circuit that it controls, and is intended for control of the particular load type to which it is connected.

2.43 TRIP CURRENT – Current above rated output motor current at which the motor overload protection circuitry will function. May be provided as a percent of motor current or as an actual stated current value. Typical values are 125 percent of full load motor current or less.

2.44 VOLTAGE DIVIDER – A combination of components intended to produce an output voltage that is a fraction of the voltage input to the combination.

3 Components

3.1 Other than where specifically referenced in this standard, or as indicated in 3.2, a component of a product covered by this standard shall comply with the requirements for that component.

3.2 A component need not comply with a specific requirement that:

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

b) Is superseded by a requirement in this standard.

3.3 An unevaluated component, such as a capacitor, resistor, or inductor, is not required to comply with a specific requirement when the system incorporating the component complies with the requirement.

3.4 A low voltage subassembly located in low voltage circuitry, that is both physically and electrically isolated by a transformer, electromechanical relay, or other isolation device, from medium voltage equipment shall be investigated in accordance with the Standard for Industrial Control Panels, UL 508A. Any protection circuitry shall be evaluated with the controller to the requirements of this standard.

3.5 Printed wiring boards shall be suitable for direct support of live parts in accordance with the Standard for Printed Wiring Boards, UL 796.

3.6 Metal oxide surge arrestors connected to the medium voltage line shall comply with IEEE C62.11 or IEC 60099-4 and shall have voltage ratings no less than the maximum voltage at which the arrestor is applied.

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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:

ANSI Z535 Series, *Safety Alerting Standards*

ASTM E230/E230M, *Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

IEC 61800-5-1, *Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy*

IEEE 4, *Techniques for High Voltage Testing*

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

NFPA 70, *National Electrical Code*

UL 50, *Enclosures for Electrical Equipment, Non-Environmental Considerations*

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

UL 248 Series, Fuses

UL 347, *Medium Voltage AC Contactors, Controllers, and Control Centers*

UL 489, *Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures*

UL 508, *Industrial Control Equipment*

UL 508A, *Industrial Control Panels*

UL 746C, *Polymeric Materials – Use In Electrical Equipment Evaluations*

UL 796, *Printed Wiring Boards*

UL 810, *Capacitors*

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

UL 969, *Marking and Labeling Systems*

UL 1077, *Supplementary Protectors for Use in Electrical Equipment*

UL 1562, *Transformers, Distribution, Dry-Type – Over 600 Volts*

UL 60950-1, *Information Technology Equipment – Safety – Part 1: General Requirements*

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UL 61800-5-1, *Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy*

5 Units of Measurement

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

RATING

6 General

6.1 Power conversion equipment shall be rated according to:

a) Input.

1) Voltage.

2) Maximum current.

3) Number of phases.

4) Frequency.

b) Output.

1) Voltage.

2) Full load current or maximum horsepower.

3) Number of phases.

4) Base frequency and frequency range (applies only to alternating current outputs).

6.2 Power conversion equipment shall also be rated with the following:

a) Short circuit current rating.

b) Maximum voltage.

c) Control voltage.

d) Impulse test voltage (expressed in kilovolts).

e) Dielectric withstand voltage.

6.3 Ratings of equipment covered by this standard are based on normal service conditions as defined in Section 2.1 of the Standard for Medium Voltage AC Contactors, Controllers, and Control Centers, UL 347. Section 2.2 of UL 347 provides additional guidance when equipment is used in special service conditions.

CONSTRUCTION

7 General

7.1 Equipment covered by these requirements shall be constructed as to provide for compliance with the rules for installation and use of such equipment as given in the National Electrical Code, NFPA 70.

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8 Enclosure

8.1 General

8.1.1 In addition to the following, the enclosure construction requirements of UL 50 and UL 50E, apply. If there is a conflict between the requirements in this standard and UL 50 or UL 50E, the requirements in this standard apply.

8.1.2 Enclosures shall be metallic and built to the requirements of UL 50 and UL 50E. External parts of the equipment may be of insulating material, provided that medium-voltage parts are completely enclosed by grounded metallic partitions or grounded shutters. These metallic partitions or shutters shall meet the thickness requirements of UL 50 and UL 50E. Excepted are inspection windows complying with 8.3. The enclosure shall comply with the rod entry test of Section 44.

8.1.3 A nonmetallic plug or other closure assembled as part of the enclosure shall be considered acceptable if evaluated in accordance with UL 50 and UL 50E.

8.1.4 Enclosures shall be supplied with a bottom plate unless marked in accordance with 47.24.

8.1.5 Equipment shall be substantially complete when shipped by the manufacturer with necessary bus splices, instructions, and hardware for field connecting to provide a completed control center.

8.1.6 Single vertical sections and vertical sections shipped assembled together shall be designed with provisions for lifting, handling, storage, and installation.

8.2 Exterior doors, covers, and similar parts of enclosures

8.2.1 A part of the enclosure, such as a door or cover, shall be provided with means, such as latches, locks, interlocks, or screws, for firmly securing it in place.

8.2.2 If bare live parts are exposed by the opening of such doors or covers, means requiring the use of a tool to open them or provision for locking them shall be provided to secure them in the closed position. If parts operating above 600 V are exposed by the opening of covers or doors, a warning marking shall also be provided in accordance with 47.26.

8.2.3 Doors shall be provided with a latch or with a captive fastener. Such fasteners shall be located or used in multiples so as to hold the cover closed over its entire length. A door more than 1220 mm (4 ft) long on the hinged side shall have at least a two-point latch operated by a single knob or handle, or shall have two or more separate latches or captive fasteners.

8.2.4 Doors and hinged panels of compartments containing medium-voltage components that can be opened without the use of a tool other than a key shall be mechanically interlocked in accordance with Section 16.

8.2.5 Covers of compartments containing medium-voltage components shall be bolted closed.

8.2.6 Where a door must be opened for maintenance of equipment or removal of drawout elements, low-voltage energized uninsulated live parts mounted on the door shall be effectively guarded or enclosed, to provide protection against unintentional contact.

8.2.7 All doors and hinged panels shall be capable of being opened to a minimum of 90 degrees from the closed position.

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8.2.8 Low-voltage compartments required to be opened during normal operation, thus exposing bare live parts, shall have:

a) Doors hinged such that the door will not come off inadvertently, and

b) Barriers installed to prevent inadvertent contact with bare live parts during normal operation.

NOTE: The replacement of fuses is not considered a normal operation with respect to controllers, but the resetting of overload devices, repeated adjustment of timers or switches, etc., are considered normal operations.

8.3 Inspection windows

8.3.1 A transparent material covering an observation opening and forming a part of the enclosure shall:

a) Be of clear safety-type glass or wire-reinforced glass or another clear material found suitable with respect to flammability and UV resistance in accordance with UL 746C, Standard for Polymeric Materials – Use in Electrical Equipment Evaluations;

b) Be secured in such a manner that it cannot be removed without tools; and

c) Meet the requirements of impact and pressure tests for viewing panes specified in Section 45.

8.4 Ventilation openings

8.4.1 When provided, ventilation openings shall comply with 8.4.2 – 8.4.10.

8.4.2 A ventilating opening shall not be employed in an enclosure unless the conditions of use necessitate such ventilation and the equipment complies with all the tests in this standard when the equipment under test includes the specified ventilation openings.

8.4.3 Any ventilation opening in the top of the enclosure shall be covered by a hood or protective shield spaced above the opening to prevent the entry of water or objects falling vertically downward, both with and without any cooling system or fans operating.

8.4.4 Ventilation openings, including perforations, louvers, and openings protected by means of wire screening, expanded metal, or a perforated cover, shall comply with the rod entry test specified in Clause 6.207 of the Standard for Medium Voltage AC Contactors, Controllers, and Control Centers, UL 347.

8.4.5 Barriers shall be provided behind all ventilating openings into medium-voltage compartments. The barrier shall be effectively secured in place and shall be positioned such that a straight line (of zero diameter) may not be drawn from any point outside of the equipment, through the ventilation opening, to any insulated or uninsulated live part. Removable ventilation filters shall not be considered as barriers to meet this requirement.

8.4.6 The diameter of the wires of a screen shall not be less than 1.3 mm (0.050 in) if the screen openings are 320 mm^2 (0.497 in^2) or less in area, and shall be not less than 2.06 mm (0.081 in) thick for larger openings.

8.4.7 Perforated sheet steel and sheet steel employed for expanded metal mesh shall be not less than 1.07 mm (0.042 in) thick for mesh openings or perforations 320 mm^2 (0.497 in^2) or less in area, and shall be not less than 2.03 mm (0.080 in) thick for larger openings.

8.4.8 When ventilation is accomplished by one or more blowers within the enclosure that provide a positive intake and exhaust, the ventilation openings shall be located such that the exhaust air is not directed toward the area occupied by the equipment operator. The area occupied by the operator is

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defined to be an area 30 in (762 mm) wide, centered on any operator control, display, or disconnect handle, and extending from the bottom of the equipment to a height of 78 in (2 m).

8.4.9 When equipment incorporates a blower motor, it shall comply with 39.3.

8.4.10 When provided with filter(s) for ventilation openings, the construction shall comply with 39.4 and with (a) or (b) below:

a) The filter(s) shall be located such that it cannot be replaced without opening an interlock in accordance with Section 16, Interlocking, or

b) The filter(s) shall be located so that the filters may be replaced without operating an interlock. During any period of filter replacement, including with a filter access cover open and no filter installed, the construction shall comply with 8.4.2 through 8.4.7.

8.5 Environmental rating related enclosure requirements

8.5.1 The requirements of Section 5.102.210 of the Standard for Medium Voltage AC Contactors, Controllers, and Control Centers, UL 347, apply to all enclosures intended for outdoor use. The Driven Rain Test of Section 6.203.1 of the Standard for Medium Voltage AC Contactors, Controllers, and Control Centers, UL 347 is not required for type 4 and type 6 enclosures which meet the requirements of UL 50E, as the requirements are to obtain a watertight enclosure as verified by the Hosedown Test and the Submersion Test of UL 50E respectively. For all other enclosures, the driven rain test is required. When conducting the driven rain test on an enclosure with forced ventilation, the driven rain test shall be conducted with the ventilation system operating, and repeated with the ventilations system off. When an enclosure is marked with an enclosure type number, it shall comply with 8.5.2.

8.5.2 Other than as noted in 8.5.3, when marked with an enclosure type number, an enclosure shall comply with the requirements of the Standard for Electrical Equipment, Environmental Considerations, UL 50E, as they apply to the type number or numbers that are marked on the enclosure. When provided with forced ventilation, the environmental tests required for the type number(s) marked on the enclosure shall be conducted with the ventilation system operating, and repeated with the ventilation system off.

8.5.3 An enclosure complying with the Driven Rain Test of the Standard for Medium Voltage AC Contactors, Controllers, and Control Centers, UL 347, is not required to comply with the Rain Test of the Standard for Electrical Equipment, Environmental Considerations, UL 50E, but shall comply with all other requirements for the enclosure type number that is marked on the enclosure.

8.6 Protection against corrosion

8.6.1 Enclosures shall be designed so that aluminum will not contact a concrete mounting pad when installed in accordance with the manufacturer's instructions.

8.6.2 Ferrous metals shall be suitably protected against corrosion as required by the Standard for Enclosures for Electrical Equipment, Non-Environmental Considerations, UL 50, and the Standard for Enclosures for Electrical Equipment, Environmental Considerations, UL 50E.

9 Arrangement of Components

9.1 Arrangement of devices in assemblies shall be such that individual components can perform their intended function without adversely affecting the operation of other components in the assembly.

9.2 Gas discharged during operation of interrupting devices shall be so directed as not to endanger personnel or impinge on other components of a controller.

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9.3 External operating handles and control devices shall comply with 9.4 through 9.6.

9.4 Control, instrument, switch, and operator handles or external handles and pushbuttons shall be located in accordance with the following:

a) Pushbuttons, control switch handles, and transfer switch handles shall be located in a readily accessible location at an elevation above the mounting surface not in excess of 2 m (79 in).

b) Operating handles requiring more than 222 N (50 lbf) to operate shall not be higher than 1.7 m (66 in) in either the open or closed position.

c) Operating handles for infrequently operated devices, such as reset devices, drawout fuses, fused voltage transformer or CPT primary disconnects, and bus transfer switches, need not comply with (a) and (b) above.

9.5 In determining compliance with 9.3, measurements shall be made from the mounting surface to the center of the handle grip with the handle in its highest possible position. If the handle grip is not clearly defined, the center of the handle grip shall be considered to be at a point 76 mm (3 in) in from the end of the handle.

9.6 If the mechanism of a switching device is such that operation of a remote or automatic tripping device will permit sudden movement of an operating handle, the motion of the handle shall be restricted or the handle shall be guarded.

10 Guarding and Accessibility of Live Parts

10.1 When access is required to a compartment that contains energized medium-voltage parts, barriers shall be provided to:

a) Prevent unintentional contact with energized parts;

b) Prevent tools or other equipment from being dropped on energized parts; and

c) Protect against contact with live parts of adjacent functional units.

10.2 Any barrier intended to be removed during routine maintenance or servicing (such as barriers required to be removed for replacement of fuses or the examination of contacts) shall be marked in accordance with 47.25.

11 Grounding and Bonding

11.1 The requirements of Section 5.3 of the Standard for Medium Voltage AC Contactors, Controllers, and Control Centers, UL 347, apply.

11.2 Within the low voltage compartment, a wire binding screw intended for the connection of a field-installed equipment grounding conductor shall have a green colored head that is hexagonal, slotted, or both.

11.3 Within the low voltage compartment, a pressure wire connector intended for connection of a field-installed equipment grounding conductor shall be plainly identified, such as being marked "G," "GR," "GRD," "Ground," "Grounding". The symbol ⏚ (IEC Publication 417, Symbol 5019) shall not be used alone unless the symbol is defined in the installation instructions provided with the equipment.

11.4 Insulated grounding and bonding conductors shall be identified by the color green with or without one or more yellow stripes. Insulated grounding and bonding conductors 6 AWG or larger may have black

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insulation, if the conductor is identified by green paint or tape applied at each end of the conductor. No other leads shall be so identified.

12 Protective Devices

12.1 Other than as noted in 12.5, equipment shall include coordinated protection that automatically interrupts overcurrents occurring in the driven motor, and in the motor-circuit conductors, both internal and external to the equipment itself. Protective devices shall open all ungrounded conductors of the protected circuit. When fuses provide this protection, there shall be a fuse in each ungrounded conductor of the circuit.

NOTE – In configurations involving cascaded power cells, the conductors between the internal transformer secondaries and the associated power cells are not considered motor-circuit conductors.

12.2 Motor overload protection shall be provided over the rated operating frequency range of the equipment by one of the following means:

a) Mechanical or electronic overload relay that complies with Section 13, Overload Relays; or

b) Solid state overload protection that complies with the Solid State Motor Overload Protection Test, 38.1 and is subjected to the requirements in Section 53, Burn-In and Diagnostic Tests.

12.3 Other than as noted in 12.5, in addition to the motor overload protection required by 12.2, branch circuit overcurrent protection shall be provided in the input circuit by one of the following:

a) A circuit breaker of suitable type and ratings. The circuit breaker may sense the fault current by means of integral or external sensing elements.

b) Fuses of suitable type and rating, placed in each ungrounded conductor.

12.4 The branch circuit overcurrent protection required by 12.3 shall not automatically reclose the circuit.

12.5 The branch circuit overcurrent protection required by 12.3 may be omitted when the equipment is marked, in accordance with 47.7, to indicate the specific overcurrent protection that shall be provided in the installation.

12.6 Polyphase controllers shall be provided with input phase loss protection. This protection shall prevent the controller from providing a single phase output to the motor terminals for more than 30 seconds. This protection shall comply with the single phase test requirements of 39.2.

12.7 Equipment shall comply with one of the following:

a) Be provided with motor load and speed sensitive overload protection with thermal memory retention, that complies with 38.2, 38.3, and 38.4,

b) Be provided with a means to accept and act upon a signal from a thermal sensor or switch imbedded in the motor or from an external protective relay, and be marked in accordance with 48.7, or

c) Have no provisions for motor overtemperature protection and be marked in accordance with 48.8.

12.8 When equipment is provided with current limiting protection that causes the output current to be limited to a specific current regardless of any increase in loading of the controlled motor, the protection shall comply with 39.5.

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12.9 Equipment shall be provided with over speed protection. When a controller is provided with overspeed protection incorporating feedback, the protection shall operate to prevent over-speed upon loss of the feedback signal.

12.10 When equipment is provided with input phase reversal protection, the protection shall operate on the reversal of the phase rotation in a polyphase circuit to cause and maintain the interruption of power in all of the circuit until the phase reversal has been corrected and the protection has been manually reset. The protection shall comply with 39.7.

12.11 Equipment for controlling a synchronous AC motor shall not incorporate over current protection in a motor field supply circuit, unless such protection also operates to remove all power from the motor.

12.12 Equipment for controlling a DC motor shall not be provided with field supply circuit protection unless the equipment incorporates a detector that senses loss of field current or voltage and prevents over-speed upon field loss.

12.13 Opening of a single fuse in a three phase circuit shall not result in application of single phase conditions to the motor for more than 30 seconds. The equipment shall comply with 39.2.

12.14 Fuses may be used in parallel in medium voltage circuits when all of the following conditions are met:

a) The fuses in parallel have identical ratings;

b) The fuses are installed in a common mounting with electrical connections that divide the current equally; and

c) The equipment is marked in accordance with 47.31.

13 Overload Relays

13.1 Section 12 applies only when equipment is provided with a discrete overload relay.

13.2 The overload relay shall be of the ambient compensated type and shall comply with the requirements for overload relays as detailed in the Standard for Industrial Control Equipment, UL 508.

13.3 Equipment that incorporates an overload relay with removable overload relay current elements that is used with a current transformer shall be marked in accordance with 47.9, unless it is so interlocked that the motor cannot be energized with the overload relay current element either removed or open.

13.4 Equipment incorporating an overload relay with removable overload relay current elements shall be provided with instructions for selection of the proper element.

13.5 Equipment incorporating an adjustable overload relay shall be provided with instructions for such adjustment.

14 Isolating Means

14.1 Other than as noted in 14.12, a controller shall be provided with an externally-operable, gang-operated, power circuit isolating means with position indication that complies with 14.4 – 14.11.

14.2 For equipment with an input voltage rating exceeding 1000 V, the isolating means shall be one of the following:

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