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An American National Standard

Standard Specification for Insulation Monitors for Shipboard Electrical Systems [Metric][1]

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1. Scope

1.1 This specification covers two (2) types of electrical system insulation monitoring devices.

1.1.1 Type I is an AC device intended as a permanently installed unit for use in the detection of ohmic insulation faults to ground in active AC ungrounded electrical systems up to 1000 VAC, having DC components up to 1500 VDC.

1.1.2 Type II is a DC device intended as a permanently installed unit for use in the detection of ohmic insulation faults to ground in DC ungrounded electrical systems up to 1500 VDC.

1.2 *Limitations*—This specification does not cover devices that are intended for operation in AC ungrounded systems without DC components.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 The following precautionary caveat pertains only to the test methods portion, Section 7 of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *UL Standard:*

UL STD 840 Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment[2]

2.2 *IEC Standards:*[3]

IEC 255-5 Insulation Tests for Electrical Relays

IEC 364-4-41 Electrical Installations of Buildings/ Protection for Safety/Protection Against Electrical Shock

2.3 *Military Standard:*

MIL-STD-1399 (NAVY) Section 300A Interface Standards for Shipboard Systems; Electrical Power, Alternating Current[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *AC or DC ungrounded electrical system, n*—a system that has no intentional connection to ground and can continue to perform normally if one conductor becomes connected to ground.

3.1.2 *measuring signal, n*—the output signal from the insulation monitor that is superimposed between the AC or DC ungrounded system to be monitored and ground.

3.1.3 *response value, n*—the adjustable or preset set-point value of the system insulation resistance at which an insulation monitor will provide an alarm indication.

3.1.4 *system leakage capacitance, n*—the total capacitance to ground of the system including all connected consumers.

3.1.5 *touch voltage, n*—the voltage appearing during an insulation fault, between simultaneously accessible parts. This term is used only in connection with protection against indirect human contacts, that is, no direct human contact with a live conductor. The International Electrotechnical Commission (IEC) limits the maximum prospective touch voltage which can be maintained indefinitely to 50 VAC rms or 120 V ripple-free DC.

4. Ordering Information

4.1 Orders for monitoring devices under this specification shall state the following information:

4.1.1 Type and quantity.

4.1.2 Nominal system voltage and frequency (for AC system).

4.1.3 Input supply voltage.

4.1.4 Response value/set-point range expressed in K-Ohms.

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[2] Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, http://www.ul.com.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, Attn: NPODS.

4.1.5 ASTM designation and year of issue.

4.1.6 System leakage capacitance or data from which an estimate of its magnitude can be determined.

4.1.7 Special requirements such as Test/Reset buttons, ohmmeters, visual indicators, memory fault retention, and so forth.

5. Materials and Manufacturing Methods

5.1 The materials and manufacturing methods used shall be such that the resulting products will conform to the properties and characteristics prescribed in this specification.

6. Performance Requirements

6.1 *Response of Insulation Monitor to a Step Input* —The insulation monitor measures the combined parallel resistance to ground from all power or circuit conductors. The time to respond to a step change in the actual resistance to a value less than or equal to 50 % of the desired response value shall be governed by the expression:

$$t\,(s) \leq 100 + 40\,(R_I \times C_s) \quad (1)$$

where

R_I = internal resistance of monitor, ohm, and
C_s = total system capacitance, farad.

For example,

$$t = 124\ s\ if\ R_I = 120\,000\ ohm\ and\ C_s = 5 \times 10^{-6}\ farad$$

6.2 *Measuring Signal Voltage Limits*— The peak value of the measuring signal shall under all operating conditions be limited to a magnitude deemed acceptable by applicable safety standards for the intended use. The peak value of the measuring signal shall be less than the touch voltage limits: 120 VDC ripple-free and 50 VAC rms.

6.3 *Internal Impedance and Internal Resistance*—The AC internal impedance and DC internal resistance shall be at least 30 ohms per volt nominal system voltage but in either case shall not be less than 12 K-Ohms.

6.4 *Response Tolerance*—The response tolerance of the monitor shall not exceed 0 to +50 % of the upper value of the set point range when measured at a room temperature of 25 ± 5°C (72 ± 9°F), with an input supply voltage 80–115 % of its nominal value and with a system leakage capacitance equal to the value at which the monitor is calibrated (1 µfd minimum).

6.5 *Working Range of System Voltage and Frequency* —The insulation monitor shall perform as specified when operating with a system voltage of 0–115 % nominal over the frequency range 50–400 hz.

6.6 *Self-Test*—The insulation monitor shall include a built-in test device or be equipped with connection provisions for a separate device that shall be furnished with the equipment which can verify the proper functioning for the monitor.

6.7 *Output Relay*—The insulation monitor shall have provisions for an external (remote) audible or visual alarm to operate when the insulation resistance value falls below the set-point value, or a remote indication of the insulation resistance value of the ungrounded system, or both. Built-in relay contacts for connection to an external alarm shall have a continuous rating of at least 4 amperes at 250 VAC. The break capacity shall be at least 2 amps at 250 VAC (0.7 power factor) and 0.3 amps at 120 VDC.

6.8 *Built-In Display of Insulation Resistance*—If provisions are made to indicate (display) the current insulation resistance level, then the manufacturer shall provide information as to the accuracy of this indication during normal operating conditions.

6.9 *Clearance and Creepage Distances*— The insulation monitor shall have protective spacings through air (clearance) and over surface (creepage) as stated in UL STD 840 for the intended maximum circuit voltage.

6.10 *Impulse Voltage Withstand Tests*— The insulation monitor shall meet the IEC 255-5 Class III Impulse Voltage Withstand Test Requirements.

7. Operating Environment

7.1 The insulation monitor shall reliably function over an ambient temperature range of 0 to 50°C (32 to 122°F) and at a relative humidity of up to 95 %. Storage temperatures of −20 to +60°C (−4 to 140°F) shall not damage the insulation monitor.

8. Test Methods

8.1 *Conformance Test*—Conformance testing of insulation monitors shall be performed to confirm that the response tolerances stipulated are not exceeded and that the requirements of Section 6 are met.

8.1.1 *Response Value Tests*—The measuring devices used for testing shall enable a slow stepless or step-by-step change of the simulated insulation resistance and shall allow the connection of artificial system leakage capacitances. To simulate the system leakage capacitance, capacitors with an isolation resistance of 100 times the desired response value and with a tolerance of +10 % maximum shall be used. On testing, the resistance shall be decreased slowly and the insulation monitor's response shall be observed. For testing the response value, the test arrangement with its insulation resistance level and its own capacitance must be considered.

8.1.1.1 An insulation monitor with adjustable response shall be tested at the beginning, mid and end points of its range. These tests shall be done without connected capacitances. The test resistor must be decreased slowly to ensure that a static response value is read. If the measuring principle is dependent on the system leakage capacitance, the tolerances must be tested in accordance with 6.4. This test is done by increasing the test capacitance step by step to the value at which the monitor was calibrated.

8.1.2 *Testing of Response Time*—At a system leakage of 1 µfd, there shall be a step change in the insulation level from nearly infinity to 50 % of the derived response value. The time for the output relay to react shall be measured.

8.1.3 *Testing of Peak Voltage*—Peak voltage measurements are taken to confirm that the requirements for 6.2 are met. The voltmeter's internal resistance should have a minimum value not less than 20 times the DC internal resistance of the measuring circuit.

8.1.4 *Testing of Input Impedance or Resistance:*

8.1.4.1 *Testing the AC Internal Impedance*— The AC internal impedance specified in 6.3 is verified without any input

supply voltage, with an rms milliammeter and with an external power supply wired between the linked measuring terminals and the ground terminal. The power supply must have an AC output rated at nominal voltage, nominal frequency, a harmonic distortion of less than 5 % and internal impedance of under 10 ohms. The monitor's internal impedance is calculated as follows:

$$Z_r = \frac{Nominal\ System\ Voltage}{AC\ rms\ Current} \quad (2)$$

8.1.4.2 *Testing the DC Internal Resistance*— The external power supply must have a DC output rated at nominal system voltage. The monitor's internal resistance is calculated as follows:

$$R_r = \frac{Nominal\ System\ Voltage}{DC\ Current} \quad (3)$$

8.1.5 *Testing of Built-in Meters*—If indication instruments are built into the insulation monitor, they must be checked so that they comply with the response tolerances laid down in 6.8.

8.1.6 *Testing the Impulse Voltage Withstand Capabilities* —These tests will follow the procedure outlined in IEC 255-5 Class III.

8.2 *Routine Tests*—Each monitor must undergo a test during production to prove that the insulation monitor functions correctly.

8.2.1 *Testing of Response Value*—Routine tests should be performed at room temperature 25 ± 5°C (72 ± 9°F) with rated input supply voltage. The insulation monitor must comply with the requirements of 6.4.

8.2.1.1 The response of the insulation monitor is to be tested at the beginning and end points of the range if it has a steplessly adjustable response value.

8.2.2 *Testing of Self-Test Function*— The internal and external test buttons must be checked according to 6.6. The built-in test device's proper functioning must be verified.

8.2.3 *Testing of Built-in Meters*—If the insulation monitor has built-in indication meters, they must be checked so that they comply with the response tolerances according to 6.8. The test should be performed at room temperature with rated input supply voltage.

8.2.4 *Voltage Test*—A voltage test is performed on the monitor to verify that the monitor is able to withstand an AC test voltage equal to twice the nominal systems voltage plus 1000 V for a period of one second without breakdown or flashover. The test voltages shall be applied directly to the terminals. Unless obvious, the independent circuits are those which are so described by the manufacturer.

8.2.4.1 Link all terminals of each independent circuit. Note that circuits having the same rated insulation voltage may be connected together when conducting the test in accordance with 8.2.4.3(*c*).

8.2.4.2 Link all terminals of open-contact[2] circuits.

8.2.4.3 Apply test potential: (*a*) between linked independent circuits; (*b*) between linked-independent circuits and linked open-contact circuits; (*c*) between linked independent circuits and exposed conductive parts.

8.2.5 *Verification of Markings, Labels and Manuals* —Visual examination should verify appropriate markings as specified in Section 9.

9. Product Marking and Equipment Manual

9.1 The following data shall be included on all enclosures for insulation monitors:

9.1.1 Name of manufacturer.

9.1.2 Type of monitor.

9.1.3 Connection diagram.

9.1.4 Input supply voltage.

9.1.5 Nominal supply voltage and frequency (for AC systems).

9.1.6 Response value or response range.

9.1.7 Test resistance value.

9.1.8 Serial number or year of production.

9.2 Manufacturer's equipment manual shall provide the following information in addition to the above requirement.

9.2.1 Description of operation.

9.2.2 AC internal impedance or DC internal resistance.

9.2.3 Connection diagram. Clearly identify where the connections are to be made to the equipment being monitored.

9.2.4 Nominal value of measuring signal.

9.2.5 Maximum measurement current.

9.2.6 Nominal contact voltage and current ratings for integral relays per 6.7.

9.2.7 A note advising that system leakage capacitance may influence the measurement.

9.2.8 A note advising that only one monitor may be connected per galvanic circuit and that one monitor must be disconnected when two ungrounded systems containing independent monitors are coupled together.

10. Keywords

10.1 AC electrical systems; DC components; DC electrical systems; electrical insulation monitoring; electrical systems; ohmic insulation faults