METRIC

NOTICE OF CHANGE

MIL-STD-2223
NOTICE 1
9 September 1994

MILITARY STANDARD

TEST METHODS FOR INSULATED ELECTRIC WIRE

TO ALL HOLDERS OF MIL-STD-2223:

1. THE FOLLOWING METHODS ARE TO BE ADDED:

NEW METHODS	DATE
3006 - WET ARC-PROPAGATION RESISTANCE	9 September 1994
3007 - DRY ARC-PROPAGATION RESISTANCE	9 September 1994
3008 - HIGH-FREQUENCY SPARK	9 September 1994

2. RETAIN THIS NOTICE PAGE AND INSERT BEFORE THE TABLE OF CONTENTS.

3. Holders of MIL-STD-2223 will verify that additions indicated above have been entered. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the Military Standard is completely revised or canceled.

Custodians:
Army - CR
Air Force - 85
Nasa - NA
Navy - AS

Preparing Activity:
Navy - AS
(Project 6145-2051)

Review activities:
Army - AR

METHOD 3006

WET ARC-PROPAGATION RESISTANCE

1. PURPOSE. The wet arc-propagation resistance test for wire insulation provides an assessment of the ability of an insulation to prevent damage in an electrical environment. In service, electrical arcs may originate from a variety of factors including insulation deterioration, faulty installation, and chafing, and may be further induced by water or other fluids which create conductive paths. It has been documented that results of an arc-propagation test may vary slightly due to the method of arc initiation; therefore a standard test method must be selected to evaluate the general arc-propagation resistance characteristics of an insulation. This test method initiates an arc by dripping salt water over pre-damaged wires which creates a conductive path between the wires. The arc propagation resistance is defined by the length of arc-propagation damage along the pre-damaged wires and by the extent of damage to all adjacent wires which are initially undamaged. The test also evaluates the ability of the insulation to prevent further arc-propagation when the electrical arc is re-energized. The power supply, test current, circuit resistances, and other variables are optimized for testing 20 gauge wires. The use of other wire sizes may require modifications to the test variables.

2. TEST EQUIPMENT

a. A transparent screen to protect laboratory personnel from molten metals, UV radiation, and other debris that may be ejected from the test specimen.

b. A variable speed, peristaltic pump or suitable other device and a hypodermic needle or burette. The apparatus should be able to deliver the electrolyte solution at a rate of 100 ± 10 mg (0.0035 ± 0.00035 ounces) per minute (8 to 10 drops of 3 percent sodium chloride solution) to the test specimen. An alternative means of delivery is acceptable.

c. A mechanical device for supporting the test bundle in free air in a horizontal position.

d. An electrolyte solution made by dissolving 3 ± 0.5 percent by weight of sodium chloride ($NaCl$) in distilled water.

e. A three phase wye connector power supply, grounded at wye, derived from a rotary machine or solid state power source of not less than 20 KVA rating, delivering 208 volts line-to-line at 400 Hz.

f. MS3320-7.5 (7.5 Amp) and MS25244-50 (50 Amp) protective circuit breakers.

g. Variable load and fixed load resistors.

h. MIL-T-43435 (Type V) lacing tape.

3. TEST SAMPLES. A test sample shall consist of 15 bundles of wire. Each bundle is composed of seven wires approximately 20.3 - 40.6 cm (8 - 16 inches) in length. A minimum of 21.3 meters (70 feet) is required. It is recommended that 20 gauge wire be use for the test.

4. TEST PROCEDURE

4.1 Preparation of bundles. Conduct a 2500 volt Wet Dielectric test on 100 percent of the wire in accordance with the Wet Dielectric test procedure described in MIL-STD-2223 method 3005 before the arc-propagation resistance test is performed. Discard any failed sections of wire. Cut seven wire segments 20.3 - 40.6 cm (8 - 16 inches) in length for each of the 15 bundles. Clean the cut wires using a cloth saturated with isopropyl alcohol. Strip both ends of five of the seven wire segments. Use these stripped ends for making electrical connections. These five wire segments will be called "Active Wires". The two unstripped wire segments will be called "Passive Wires". Using a sharp blade, cut a square groove completely around (360 degrees) the insulation of two of the active wires at their midpoints to expose the conductor. The width of the exposed conductor should be between 0.5 mm and 1.0 mm (0.0197 and 0.03941 inch). Form the bundle by laying the seven wire segments straight and geometrically parallel. Assemble the wires to form the six-around-one configuration shown in Figure 1. The two pre-damaged wires should be placed in the A1 and B1 positions and care should be taken to ensure that there is a longitudinal distance of 6.0 mm to 6.5 mm (0.2362 to 0.2560 inch) as measured between the stripped window of the two exposed conductors. The two passive wires correspond to the D1 and D2 components shown in Figure 1. Use MIL-T-43435 lacing tapes to hold the test bundle together. Clean the assembled bundle using a cloth saturated with isopropyl alcohol prior to installation in the fixture.

4.2 Electrical connection. Connect the test bundle to the power supply and circuit resistance using the schematic circuit shown in Figure 2. Connect one end of each active wire to the appropriate phase of the power supply as shown in Table I. Use an MS3320-7.5 (7.5 Amp) circuit breaker and a circuit resistance in series with each of the active wires. Use the circuit resistance values shown in Table II. Connect the other end of the five active wires under test to variable resistive loads. Adjust the resistance to limit the current flowing through each wire to 1 ± 0.2 Ampere. Protect the test circuits with MS25244-50 (50 Amp) circuit breakers connected on the supply side of the test set up.

TABLE I. Electrical connection.

Wire Identification	Power Supply	Layer
A1	Phase A	Top
B1	Phase B	Top
C1	Phase C	Middle
A2	Phase A	Middle
B2	Phase B	Middle
D1	None	Lowest
D2	None	Lowest

TABLE II. Circuit resistance.

Test Number	Circuit Resistance (ohm)
1	0.0
2	0.5
3	1.0
4	1.5
5	2.0

4.3 Initiation of test. Test three bundles for each of the five circuit resistances. Using the mechanical supports, mount the test bundle in a draft-free location so that the wires with the exposed conductors are upper most. Adjust the flow of the electrolyte to 8-10 drops per minute. Position the hypodermic needle to drop the electrolyte into the groove between the wires with the exposed conductor. Position the tip of the needle so that the vertical distance of the tip is 150 mm (5.91 inch) above the specimen. Position the protective screen to shield the operator from ejecting objects or UV radiation. Close all circuit breakers. Allow the electrolyte to flow. Apply three phase 400 Hz power.

5. RESULTS. Use one of the following conditions to conduct and complete the test.

5.1 If circuit breakers in any of the phases A2, B2, or C1 trips at any time during the test, wait 3 minutes and disconnect power. Conduct a 1000 volt Wet Dielectric test on wires A2, B2, C1, D1 and D2 in accordance with the Wet Dielectric procedure of MIL-STD-2223 method 3005. Record the number of wires which fail. Measure and record the total length of physical damage to each wire (including phase A1 and B1 wires) in inches.

5.2 If either phase A1 or phase B1 circuit breaker trips at any time during the test, disconnect the power and identify the phase of the tripped circuit breaker. Wait 3 minutes. Reset the circuit breaker, apply power and continue the test. Continue the test for eight hours or until either phase A1 or phase B1 circuit breaker has tripped twice. CAUTION: DO NOT RESET A CIRCUIT BREAKER THAT TRIPS TWICE. Conduct a 1000 volt, Wet Dielectric test on wires A2, B2, C1, D1 and D2 in accordance with the Wet Dielectric test of MIL-STD-2223 method 3005. Record the number of wires which fail. Measure and record the total length of physical damage to each wire (including phase A1 and B1 wires) in inches.

5.3 If the conductor(s) of phases A1 and B1 wires erode without tripping phase A1 or phase B1 circuit breakers (as may be indicated by an open circuit indicator), continue the test for a total of 8 hours or until the test endpoints of 5.1 or 5.2 occur. Conduct a 1000 volt Wet Dielectric test on wires A2, B2, C1, D1 and D2 in accordance with the Wet dielectric procedure of MIL-STD-2223 method 3005. Record the number of wires which fail. Measure and record the total length of physical damage to each wire (including phase A1 and B1 wires) in inches.

5.4 Circuit breakers should be periodically tested to assure they still meet the overload trip requirements of the applicable military specification (MS) sheet. Circuit breakers outside their overload trip limits should be replaced.

6. INFORMATION REQUIRED IN THE INDIVIDUAL SPECIFICATION. Specifications shall list minimum number of wires which must pass the dielectric test after the bundle has been energized, and also the maximum allowable length of physical damage to the individual wires in the bundle.

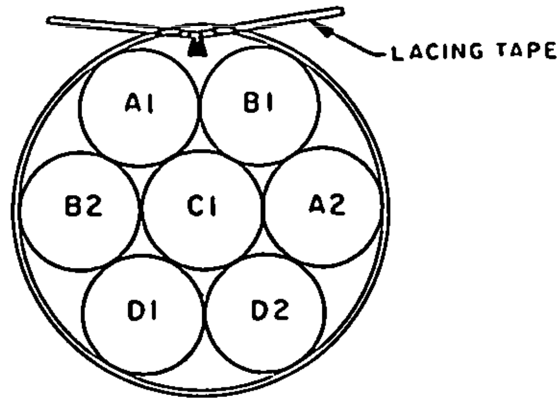

FIGURE 1. Bundle Configuration.

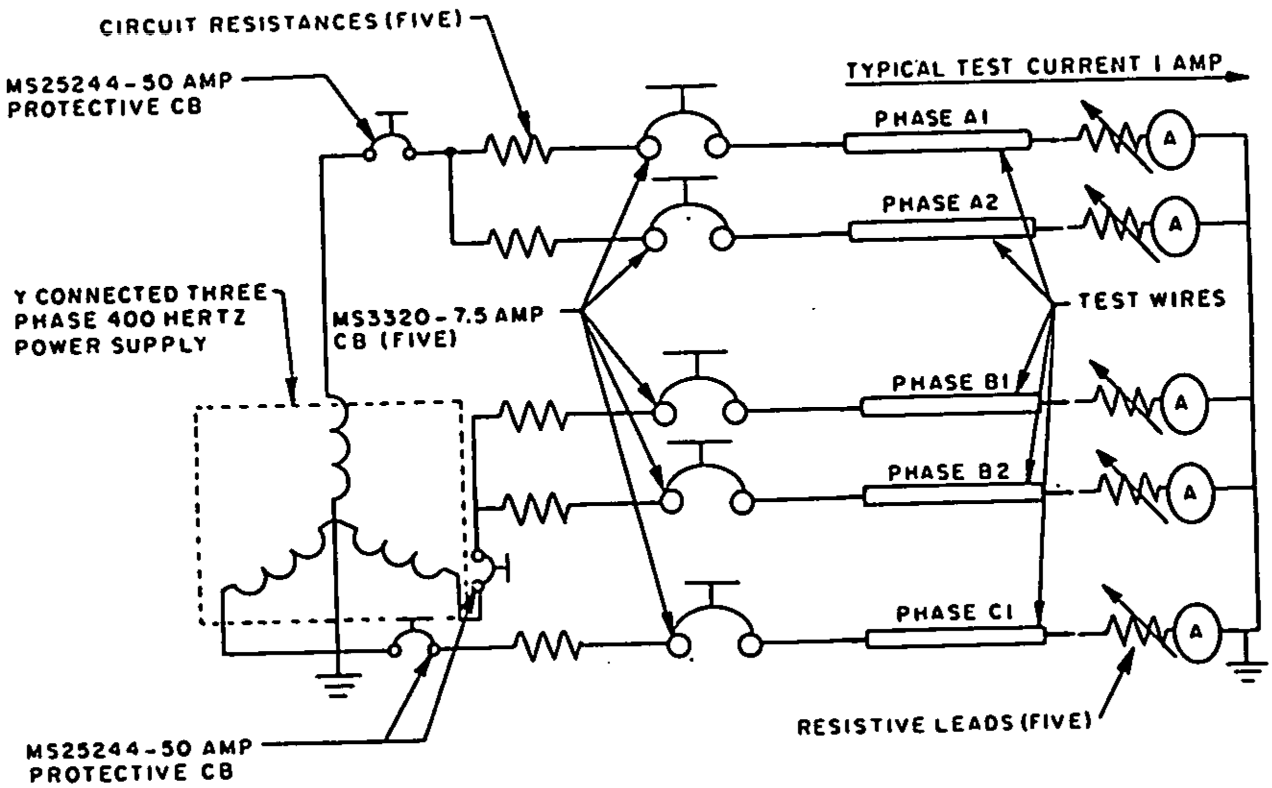

FIGURE 2. Electrical Connection

METHOD 3007

DRY ARC-PROPAGATION RESISTANCE

1. PURPOSE. The dry arc-propagation resistance test for wire insulation provides an assessment of the ability of an insulation to prevent damage in an electrical arc environment. In service, electrical arcs may originate from a variety of factors including insulation deterioration, faulty installation, and chafing. It has been documented that results of an arc-propagation test may vary slightly due to the method of arc initiation. Therefore a standard test method must be selected to evaluate the general arc-propagation resistance characteristics of an insulation. This test method initiates an arc with a vibrating blade. The arc-propagation resistance is defined by the length of arc-propagation damage along the wires in contact with the blade and by the extent of damage to all adjacent wires undamaged by the vibrating blade. The test also evaluates the ability of the insulation to prevent further arc-propagation when the electrical arc is re-energized. The power supply, test current, circuit resistances and other variables are optimized for testing 20 gauge wires. The use of other wire sizes may require modification of other test variables.

2. TEST EQUIPMENT

a. An abrader blade made from 6061-T6 aluminum material. Use a grit size 60 grinding wheel or 60 grit sanding belt to sharpen the blade. A typical abrader blade is shown in Figure 1. Use the blade sharpening fixture shown in fixture shown in Figure 2.

b. A transparent screen to protect laboratory personnel from molten metals, UV radiation, and other debris that may be ejected from the test specimen.

c. An oscillating mechanism to which the abrader blade is connected. The oscillating mechanism shall provide a stroke of 3.81 cm (1.50 inches) at a frequency of 0.5 ± 0.05 cycles per second.

d. A test fixture which includes a test block to hold the wire at right angles to the abrading blade. The block is made from 6061-T6 aluminum.

e. A three phase wye connected power supply, grounded at wye, derived from a rotary machine or solid state power supply of not less than 20 KVA rating, delivering 208 volts line-to-line at 400 Hz.

f. A mechanical stop constructed of stainless steel.

g. MS3320-7.5 (7.5 Amp) and MS25244-50 (50 Amp) protective circuit breakers.

h. Variable load and fixed load resistors.

i. MIL-T-43435 (Type V) lacing tape.

j. MS25281 plastic clamps.

3. TEST SAMPLES. A test sample shall consist of 15 bundles of wire. Each bundle is composed of seven wires and shall be of sufficient length, 35.6 cm (14 inches) minimum, to allow the bundle to be installed in the test fixture. A minimum of 37.3 meters (122.5 feet) of wire is required. It is recommended that 20 gauge wire be used for the test.

4. TEST PROCEDURE

4.1 Preparation of bundles. Conduct a 2500 volt Wet Dielectric test on 100 percent of the wire in accordance with the Wet Dielectric test procedure described in MIL-STD-2223 method 3005 before the arc propagation resistance test is performed. Discard any failed sections of wire. Cut seven wire segments at least 35.6 cm (14 inches) in length for each of the 15 bundles. Clean the cut wires using a cloth saturated with isopropyl alcohol. Strip both ends of five of the seven wire segments. Use these stripped ends for making electrical connections. These five wire segments will be called "Active Wires". The two unstripped wire segments will be called "Passive Wires". Form the bundle by laying the seven segments straight and geometrically parallel. Assemble the wires to form the six-around-one configuration shown in Figure 3. Use MIL-T-43435 lacing tapes to hold the test bundle together. Clean the assembled bundle using a cloth saturated with Isopropyl alcohol prior to installation in the test fixture.

4.2 Bundle installation. A test fixture shall be used to hold the wire bundle in place perpendicular to the abrader blade. Details of a suggested test fixture are shown in Figure 4. Before installation, the wire bundle shall be tied with MIL-T-43435 lacing tape at .635 cm (.25 inch) on each side of where the abrader blade is to be applied; then secured to the test fixture. The wire bundle is clamped with MS25281 plastic clamps at two points on the fixture at a minimum distance of 15.24 cm (6.0 inches). The clamp points are equidistant from the point of application of the abrader. The slide bolt allows the adjusting screw to move the holding plates snugly against the bundle. Ensure that the active wires A1 and B1 are parallel with the top plane of the test fixture, and that the passive wires D1 and D2 are in complete contact with the base of the test fixture. The bundle must not be allowed to move while the abrader blade is cutting wires A1 and B1. The test fixture shall contain an adjustable mechanical stop, which may be set to allow for various penetration depths of the vibrating blade.

4.3 Electrical connection. Connect the test bundle to the power supply and circuit resistance using the schematic circuit shown in Figure 5. Connect one end of each active wire to the appropriate phase of the power supply as shown in Table I. Use an MS3320-7.5 (7.5 Amp) circuit breaker and a circuit resistance in series with each of the active wires. Use the circuit resistance values shown in Table II. Connect the other end of the five active wires under test to variable resistive loads. Adjust the resistance to limit the current flowing through each wire to 1.0 ± 0.2 Ampere. Protect the test circuits with MS25244-50 (50 Amp) circuit breakers connected on the supply side of the test set up. Connect the abrader blade to the neutral of the generator. Connect the generator neutral to ground.

TABLE I. Electrical connection.

Wire Identification	Power Supply	Layer
A1	Phase A	Top
B1	Phase B	Top
C1	Phase C	Middle
A2	Phase A	Middle
B2	Phase B	Middle
D1	None	Lowest
D2	None	Lowest

TABLE II. Circuit resistance.

Test Number	Circuit Resistance (ohm)
1	0.0
2	0.5
3	1.0
4	1.5
5	2.0

4.4 Initiation of test. Test three bundles for each of the five circuit resistances. Install the oscillating mechanism which may use a reciprocating arm. or vertical and horizontal precision linear ball slides (a suggested ball slide apparatus is shown in Figure 6). Adjust the mechanical stop to ensure that the abrader blade penetrates into the A1 and B1 wires a distance of 0.87 times the radius of the seven wire bundles. Close all circuit breakers. Apply a nominal load of 250 grams (0.551 pounds) to the abrader at the point of contact with one wire. Adjust the blade to ensure that the major plane of the blade lies perpendicular to the longitudinal axis of the bundle. Apply the abrader blade on the test bundle. Position the protective screen to shield the operator from ejecting objects and UV radiation. Apply three phase 400 Hz power. Actuate the abrader. Allow the abrader blade movement to continue.

5. RESULTS. Use one of the following conditions to conduct and complete the test.

5.1 If the abrader cuts through A1 and B1 wires without tripping phase A1 or phase B1 circuit breakers, stop the abrader movement. Disconnect the power.

5.2 Conduct the 1000 volt Wet Dielectric test on wires A2, B2, C1, D1 and D2 in accordance with the Wet Dielectric procedure of MIL-STD-2223 method 3005. Record the number of wires which fail. Measure and record the total length of physical damage to each wire (including phase A1 and B1 wires) in inches.

5.3 If a circuit breaker in any of the phases A2, B2 or C1 trips at any time during the test, stop the abrader and disconnect the power. Perform tests as listed in 5.2.

5.4 If either phase A1 or phase B1 circuit breaker trips at any time during the test, stop the abrader. Disconnect the power and determine if the conductor of wires A1 or B1 are open. If both wires are open, conclude the test by performing tests as listed in 5.2. If wire A1 or wire B1 are not open, wait 3-4 minutes, reset the circuit breaker and restart the abrader and then immediately re-apply the power. Continue the test until either phase A1 or phase B1 circuit breaker has tripped a second time, phases A1 and B1 are open, or the blade movement is stopped by the mechanical stop. CAUTION: DO NOT RESET A CIRCUIT BREAKER THAT TRIPS TWICE. Perform the tests as listed in 5.2. Use a new abrader blade edge for each test bundle, if any blade damage is present, or if circuit breakers A1 or B1 trip during the test.

5.5 Circuit breakers should be periodically tested to assure they still meet the overload requirements of the applicable military specification (MS) sheet. Circuit breakers outside their overload trip requirements should be replaced.

6. INFORMATION REQUIRED IN THE INDIVIDUAL SPECIFICATION. Specifications shall list minimum number of wires which must pass the dielectric test after the bundle has been energized, and also the maximum allowable length of physical damage to the individual wires in the bundle.

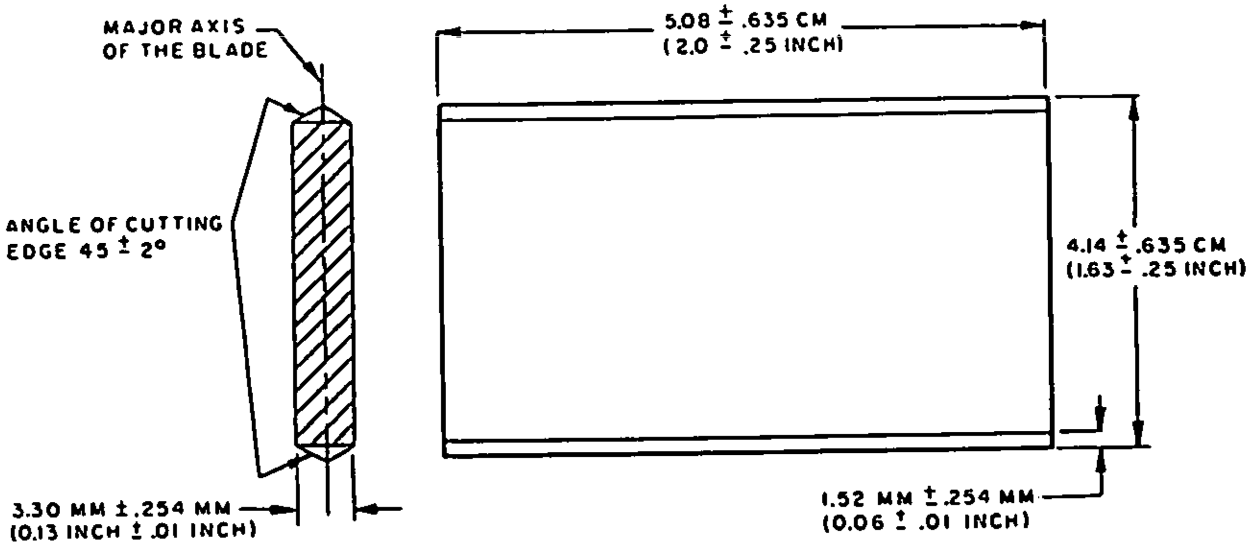

FIGURE 1. Blade.

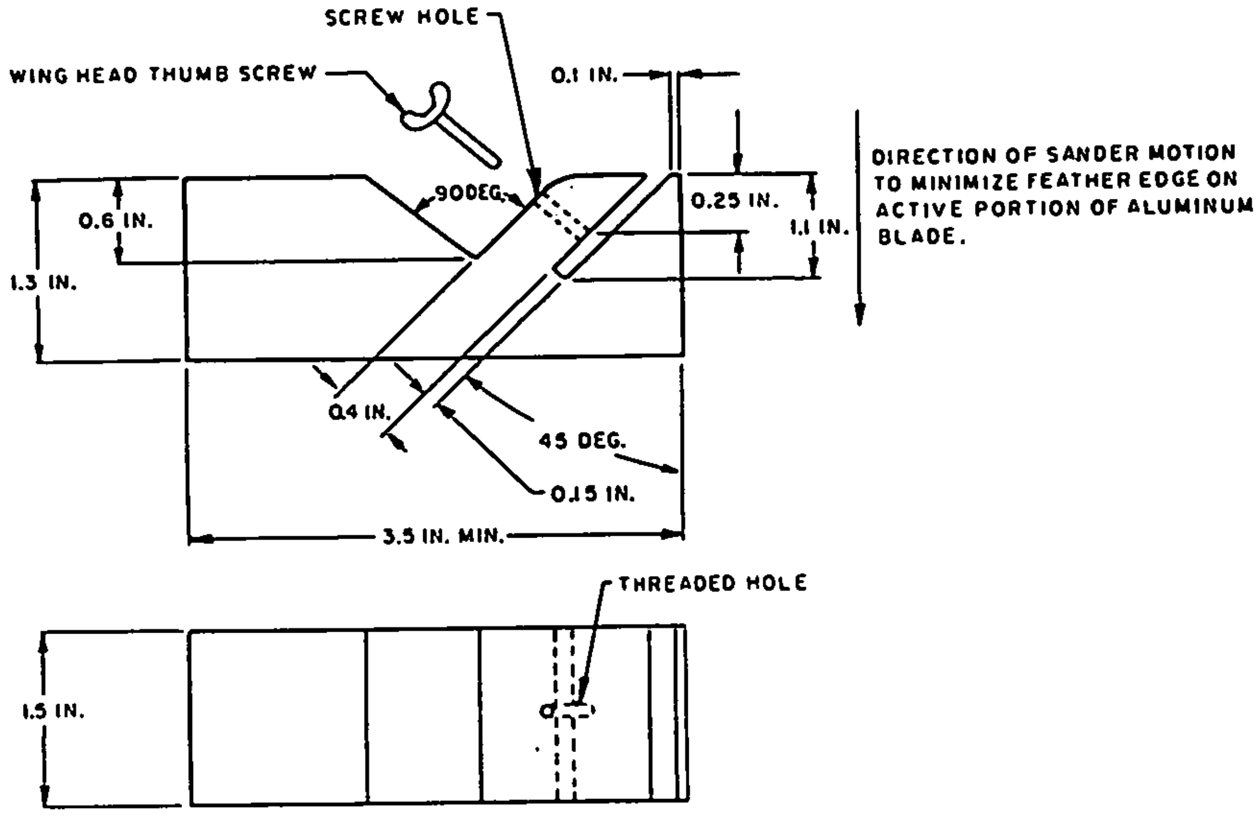

FIGURE 2. Aluminum blade sharpening fixture.

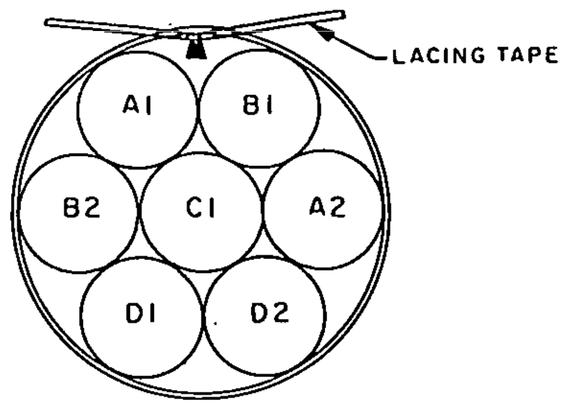

FIGURE 3. Bundle configuration.

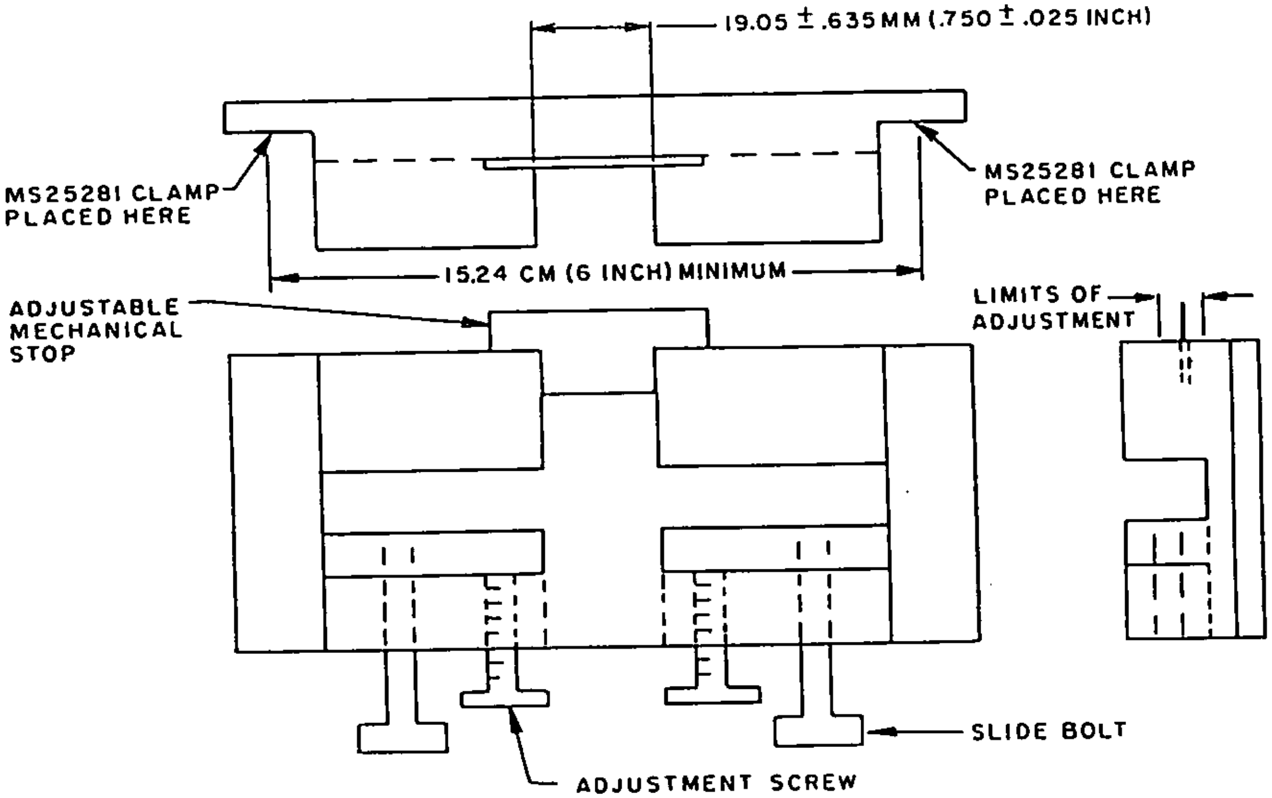

FIGURE 4. Test fixture.

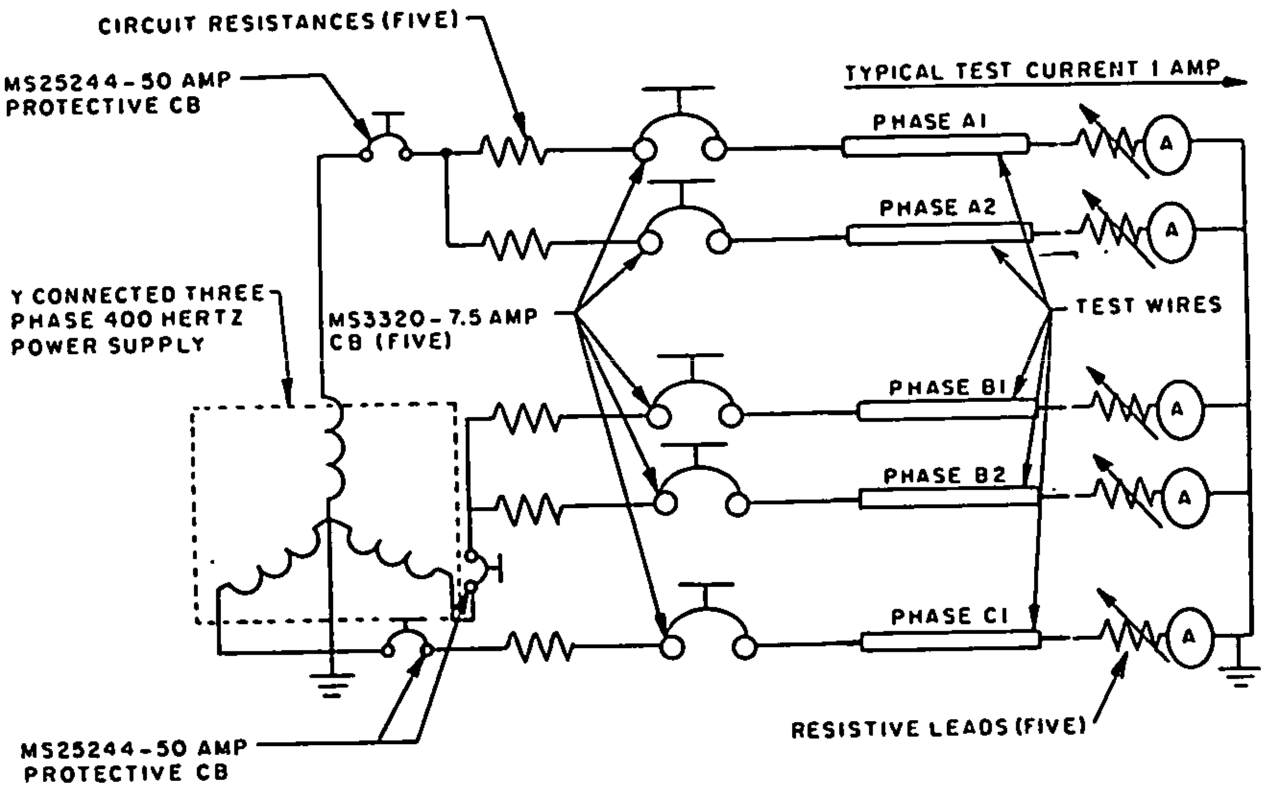

FIGURE 5. Electrical connection.

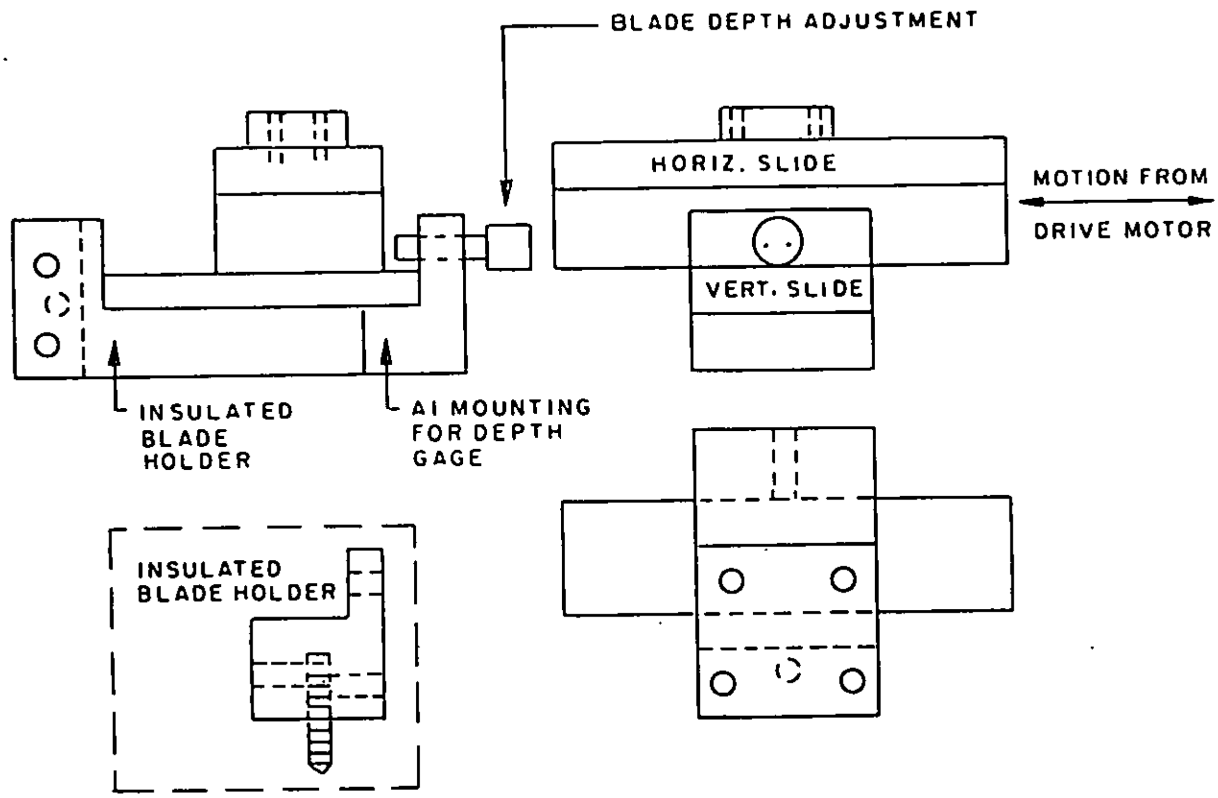

FIGURE 6. Ball slide blade fixture.

METHOD 3008

HIGH-FREQUENCY SPARK

1. PURPOSE. This method detects and removes insulation defects in finished wires. The test is primarily used as a 100 percent screening test at final packaging. but may be used as an in-process test or as an incoming inspection test by the user. Because of possible damage in handling. damage caused by repeated high-frequency spark testing. and variations in test parameters. comparisons between producer's and customer's test results are not significant. The High-Frequency Spark Test is considered to be an alternative method to the Impulse Dielectric Test: it is preferred to a 100 percent wet dielectric test since faults can be located and removed during final spooling without subjecting the wire to immersion in water. which is potentially detrimental.

2. TEST EQUIPMENT

a. Electrode - The electrode consists of a bead chain construction that will give intimate metallic contact with the wire insulation surface. The chain must be suspended in a U- or V-shaped trough having a width approximately 40 mm (1.5 in.) greater than the diameter of the largest wire that is tested. The chain must have a length appreciably greater than the depth of the enclosure so that the beads will droop below the wire under test. The electrode assembly consists of an array of approximately 1.6 mm (0.0625 in) diameter stainless steel bead chains suspended approximately 2.0 mm (0.08 in.) apart perpendicular to the direction of the wire movement and spaced approximately 2.5 mm (0.10 in.) apart parallel to the direction of the wire movement. The electrode length must be chosen so that at the speed being used. the wire will be subjected to no less than a total of 6 positive and negative crests of the supply voltage (the equivalent of 3 complete cycles) nor more than a total of 1200 positive or negative wave crests (the equivalent of 600 complete cycles) at any given cross section. Only one electrode will be connected to the power supply transformer. The electrode must be kept free of water and foreign matter: it must be provided with an earth grounded metal screen or an equivalent guard to provide protection for the operating personnel. Broken chains must be promptly replaced.

b. Power Supply - Any 3000-Hz sinusoidal generator which meets the requirements of c. through g. shall be used.

c. Waveform - The waveform of the voltage applied to the electrode head shall consist of a 2500 ± 1000-Hz sine wave. the amplitude of which shall not change more than ± 2 percent as the line voltage varies ± 15 volts from the nominal. Unless otherwise specified, the alternating voltage (root mean square) shall be the voltage called for in the applicable specification sheet. The ratio of the peak value to the root mean square value of the voltage shall be no less than 1.35 nor more than 1.48 under any load condition.

d. Regulation - The current which the equipment can deliver to a purely capacitive load shall be no less than 40 milli-Amperes (mA). The current that can be delivered to a purely resistive load shall be no less than 4 mA. When the load consists of a capacitance passing a current of 10 mA in parallel with a resistance passing a current of 1 mA, the voltage at the test load shall not change more than 5 percent between no-load and full-load conditions.

e. Instrument Voltmeter - An average indicating voltmeter capable of operating accurately at a frequency of 4000-Hz and calibrated to read root mean square values shall be provided. It shall continuously indicate the potential on the electrode. This a-c (root mean square) voltmeter shall have an accuracy tolerance of not more than ± 3 percent at the specified potentials after calibration as specified in 2.1, and shall be energized by a metering winding unity coupled to the high-voltage secondary winding.

f. Failure Detection Circuit - There shall be a failure detection circuit to give a visual or audible indication, or both, of insulation failure. In addition, the electrode head must be de-energized on detected faults, and the drive mechanism stopped. The system shall be sufficiently sensitive so that a fault is indicated at 2000 volts when the electrode is arced to the ground through a needle spark gap in series with the detection circuit for a duration of 0.001 seconds or less.

NOTE - A test set for checking sensitivity may be constructed using a turnable with a grounded metal plate at its periphery; rotated to move the plate past a 0.13 mm (0.005 in.) phosphor bronze wire, positioned normal to the plate's surface, in 0.001 seconds. The wire shall be spaced 0.25 mm (0.01 in.) from the plate, and connected electrically to the output voltage of the apparatus for the duration of a single pass.

g. Response After Failure Detection - The stability and recovery of the generator, and associated detection circuitry, shall be such that the waveform and regulation meet the requirements for the power supply and will maintain the set test potential 0.040 seconds after failure detection.

2.1 Calibration of equipment. Calibrate the instrument's voltmeter periodically by comparison with an external electrostatic voltmeter, with or without auxiliary circuitry, having a ± 1 percent full-scale accuracy. The measurements shall be made in the upper two-thirds of the standard voltmeter scale. In performing the calibration, connect the standard voltmeter to the electrode head directly. Adjust the voltage generator until the reading on the standard voltmeter is the specified potential, at which point the reading on the instrument's voltmeter shall be observed and recorded. Repeat this calibration for each potential at which the equipment is intended to operate. Calibration will include a determination of the waveform with the wire to be tested in the electrode. The waveform must comply with paragraph 2c.

3. TEST SAMPLES. Test samples shall consist of 100 percent of the finished wire.

4. TEST PROCEDURE. Thread the wire through the electrode and ground the conductor at one, or preferably, both ends. Energize the electrode to the specified potential and, after final adjustment of the voltage with the wire in the electrode head, pass the wire from the pay-off spool through the electrode onto the take-up spool at a speed not exceeding that used in 2a to determine the electrode length. Cut out or mark for later removal, all sections of wire that cause the detector to trip, along with at least 2 in. of wire on each side of the failure. The point of failure can be located by passing the wire back through the head. If the detector does not trip again, it can be assumed that the indication was false. Every effort shall be made to test the entire length, including ends, of the wire when stringing up new lengths, in accordance with this procedure. Remove all ends or other portions of the wire not tested. For final testing of wire, or when specified in product or purchase specification, dielectric failures, untested portions of wire, or portions that have been exposed to fewer or more than the specified number of pulses may be marked by stripping the insulation or by any other suitable method of marking as specified in the product or purchasing specification in lieu of being cut out of the length.

5. RESULTS. Report if 100 percent of the wire has been subjected to the high-frequency spark test and certify that all faults detected were removed or marked as required.

6. INFORMATION REQUIRED IN THE INDIVIDUAL SPECIFICATION. Specifications shall list the root mean square (rms) voltage to be used.