

Chapter E4

Test for Electrical Wire Used in Designated Fire Zones

E4.1 Scope

E4.1.1 This test method is intended for use in determining the resistance of high-temperature electrical wire used in designated fire zones to damage due to flame and vibration according to the requirements of FARs 25.863, 25.865, 25.867, 25.1201, 25.1203, and 25.1359.

E4.1.2 This test method generally follows MIL-W-25038E. The method is used predominantly in the United States and by most wire and cable manufacturers. ISO/DIS 2685.2 is a similar test procedure and is used by Aerospatiale in France and by the Civil Aviation Authority in Great Britain.

E4.2 Definitions

E4.2.1 Ignition Time

Ignition time is the length of time the burner flame is applied to the specimen. In this test, the ignition time is 5 minutes.

E4.2.2 Wire

A single insulated electrical conductor.

E4.2.3 Designated Fire Zone

A region of the aircraft, such as engine and auxiliary power unit compartments, designated to require fire detection and extinguishing equipment and, as appropriate, the use of materials that are fire resistant or fireproof.

E4.2.4 Fire Resistant

Per FAR Part 1, (found in Subchapter A—Definitions, Part I—Definitions and Abbreviations) “with respect to fluid carrying lines, fluid system parts, wiring, air ducts, fittings, and powerplant controls means the capacity to perform the intended functions under the heat and other conditions likely to occur when there is a fire at the place concerned.”

E4.2.4.1 Electrical wire is demonstrated to be fire resistant by meeting the requirements of this 5-minute test.

E4.2.5 Firewall

A structure designed to prevent a hazardous quantity of air, fluid, or flame from exiting a designated fire zone in which a fire has erupted and causing additional hazard to the aircraft.

E4.2.6 Fire Zone Wire

A wire installed in a designated fire zone.

E4.3 Apparatus

E4.3.1 Test Fixture

A test fixture, such as shown in figure E4-1, will be provided. The fixture will include a provision for mounting above the test burner.

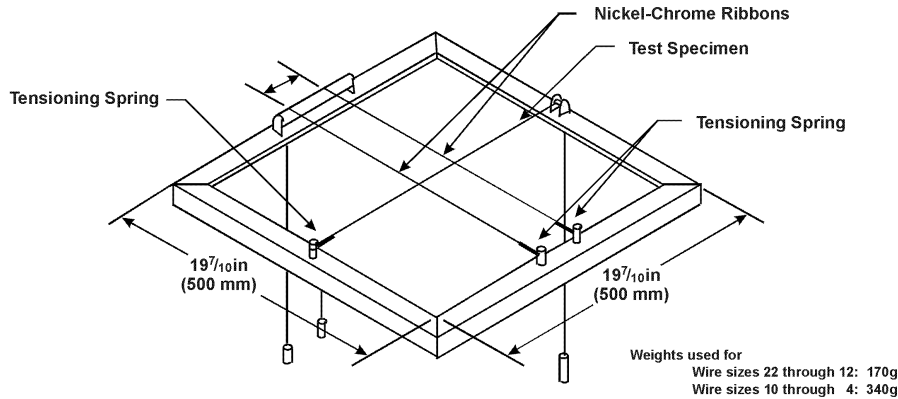


Figure E4-1. Firezone Electrical Wire Test Setup

E4.3.2 Test Burner

A test burner, such as shown in figure E4-2, will be provided. The burner will include provisions for introducing air premixed with the gas fuel and for introducing secondary air into the burner flamelets.

NOTE: See SAE AS-8028 for burner details.

E4.3.2.1 Burner Fuel

Propane gas of 99 percent purity will be used for the burner fuel.

E4.3.2.2 Plumbing for Gas Supply

The necessary gas connections, tubing, pressure regulators, and gauges will be provided.

E4.3.3 Vibration Source

A means will be provided to vibrate the test fixture vertically at 33 Hz with a total excursion of 0.14 inch (3.5 mm).

E4.3.4 Thermocouple

A 22-gauge ANSI (Type K) Chromel-Alumel thermocouple or equivalent, as shown in figure E4-3, will be provided to measure the temperature of the burner flame. In addition, a device to continually monitor the thermocouple output within an accuracy of 5 percent will be provided.

E4.3.5 Ammeter

An ammeter will be provided that measures a current of at least 2A within an accuracy of 5 percent.

E4.3.6 Ohmmeter

An ohmmeter will be provided to measure resistance within an accuracy of 5 percent of full scale.

E4.3.7 Power Source

A power supply will be provided that will deliver 2A at 115V AC, 400 Hz or 60 Hz.

E4.3.8 Nickel-Chrome Ribbons

Two nickel-chrome ribbons that are 0.010 by 0.059 by 23.6 inches (0.25 by 1.5 by 600 mm) will be provided (see figure E4-1).

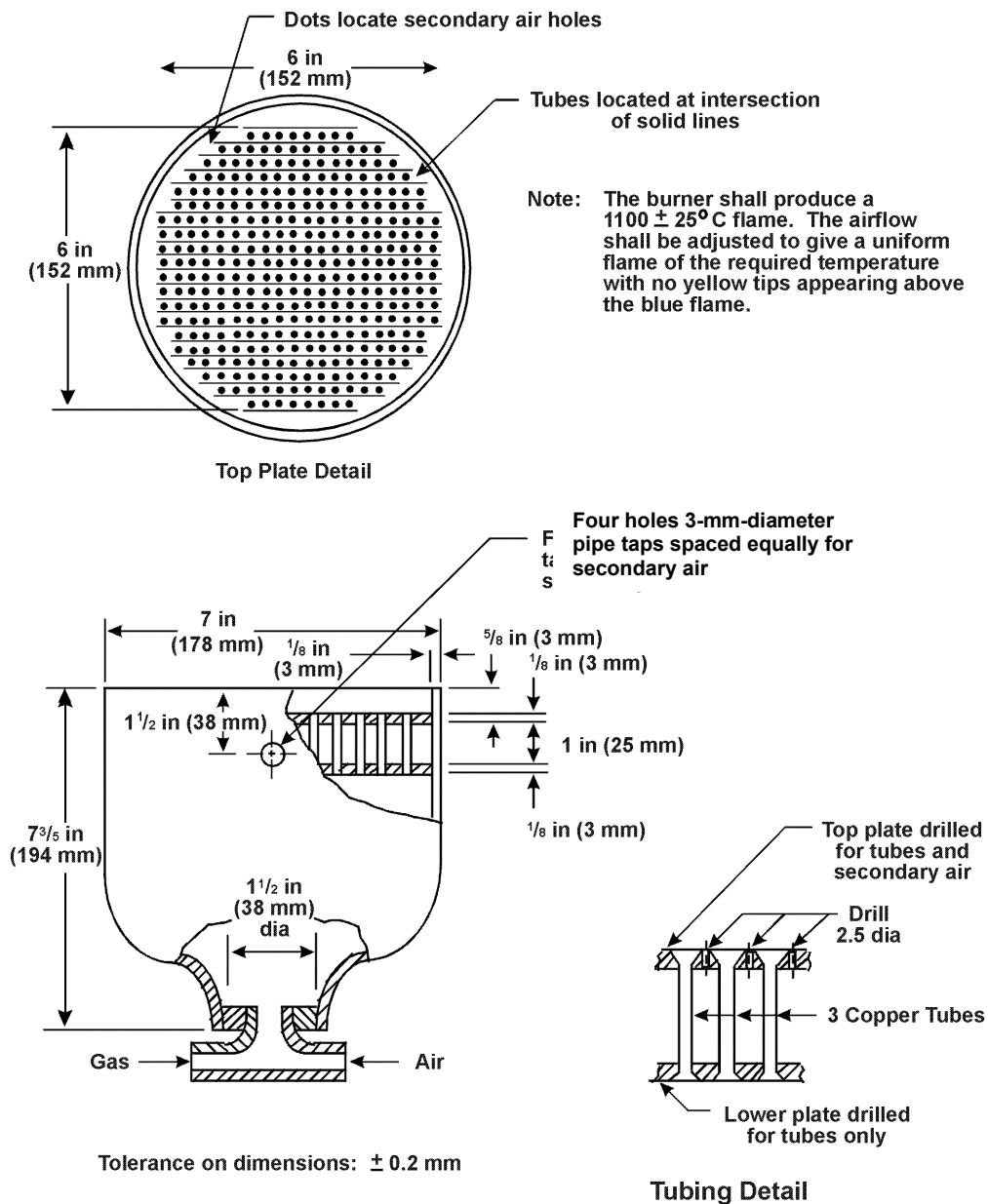


Figure E4-2. Burner Details

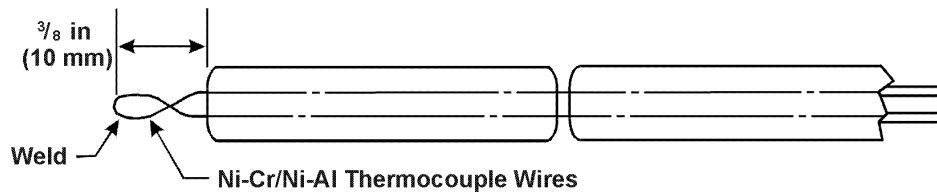


Figure E4-3. Thermocouple Details

E4.3.9 Weights

Weights are required to tension the wire over the test fixture. Suggested weights are 12 ounces (340 g) for wire sizes 4 through 10 and 6 ounces (170 g) for wire sizes 12 through 22.

E4.3.10 Reagents and Materials

The following materials found in the fire zone of intended use may be necessary to condition the specimens prior to the test (NOTE: The reagents needed for conditioning vary, depending on the airframe manufacturer):

E4.3.10.1 Aviation fuel such as JP-4 or JP-5 or per MIL-G-5572

E4.3.10.2 Lubricating oil per MIL-L-6082, Grade 1100

E4.3.10.3 Hydraulic fuel per MIL-H-5606

E4.3.11 Timer

A stopwatch or other device, calibrated and graduated to 1 second, will be used to measure the time of application of the burner flame.

E4.4 Test Specimens

E4.4.1 Specimen Length

Specimens will be 24 inches (610 mm) in length.

NOTE: ISO/DIS 2685.2 calls out test specimens that are 30 inches (750 mm) long. MIL-W-25083 calls out test specimens that are 24 inches (600 mm) long. The difference in length does not affect test results.

E4.4.2 Specimen Number

Twelve test specimens will be prepared unless otherwise specified. Three specimens will be tested for each condition: no conditioning, conditioning in aviation fuel, conditioning in hydraulic fuel, and conditioning in lubricating oil (see section E4.5.1).

E4.5 Conditioning/Preparation of Test Specimens

E4.5.1 Test Conditions

Each wire type will be tested without being exposed to any contaminating fluid and after being exposed to each of the fluids described in section E4.3.10. Three test specimens will be used for each of the test conditions.

NOTE: All current industry specifications require only one specimen for each fluid. However, testing three specimens for each fluid will provide a greater degree of confidence in results.

E4.5.1.1 Immerse three test specimens in each test fluid for the times and temperatures shown in table E4-1. Wipe the test specimens with a clean cloth after removing them from the fluids.

Table E4-1. Specimen Immersion Information

Specimen No.	Test Fluid	Immersion	
		Time (hr)	Temp (°C)
1	Mil-G-5572 (grade 100/130)	24	23
	JP-5	24	23
	JP-4	24	23
2	50% JP-4 and 50% MIL-L-6082	24	23
3	MIOL-L-6082	24	121
4	Skydrol 50084/L04 (aero)	24	23
5	Ethylene Glycol (aero)	24	121

E4.5.1.2 Locate the point on the wire specimen that will be located directly above the center of the burner when the wire specimen is placed on the test stand. Mark a 7-inch (178-mm) -long section with this point in its center by placing a wire band around the specimen 3 1/2 inches (89 mm) on each side of this point. In addition, place an outer wire band around the test specimen 4 inches (102 mm) outside each of these two bands.

NOTE: The wire band consists of one turn of AWG 30 or smaller wire.

E4.5.2 Store each set of test specimens in a separate airtight container until the time of the test.

E4.6 Calibration

E4.6.1 Position the thermocouple as shown in figure E4-3, 1 inch (25 mm) above the center of the burner top plate, as shown in figure E4-4.

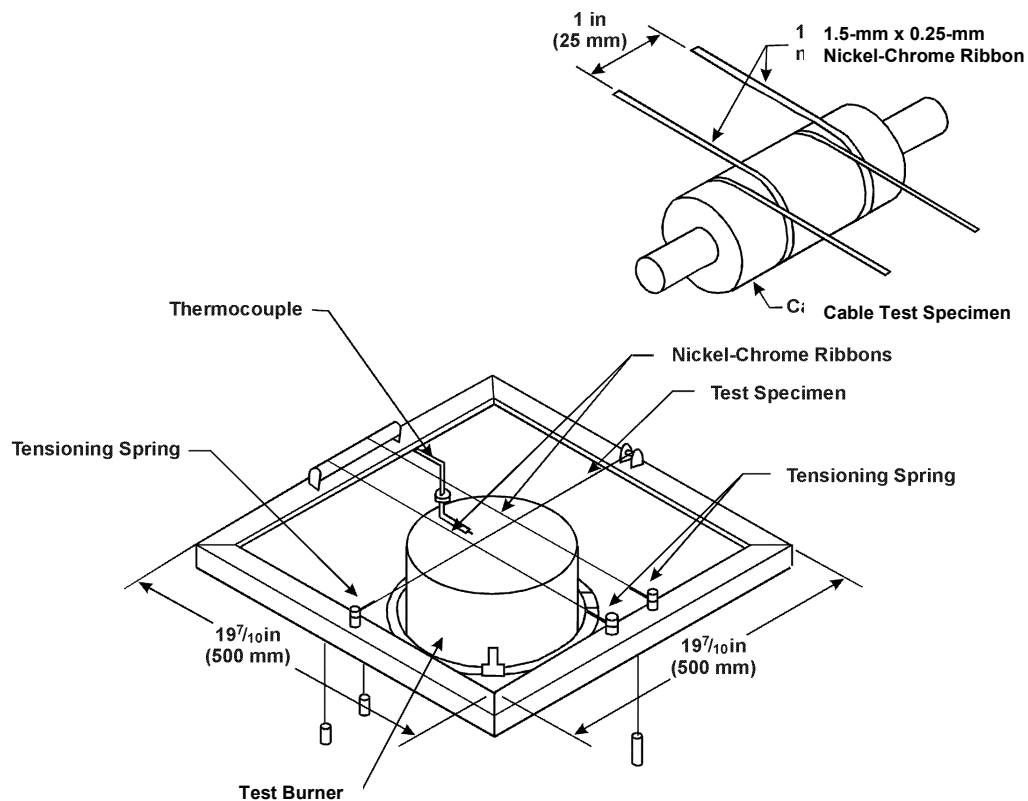


Figure E4-4. Fire Zone Electrical Wire Test Setup—Top View

E4.6.2 Ignite the burner and adjust the fuel, air, and secondary air to the burner to obtain a nonoxidizing, nonreducing flame with no yellow tips at a temperature of $2,000^{\circ} \pm 50^{\circ}\text{F}$ ($1,093^{\circ} \pm 28^{\circ}\text{C}$). Stabilize the flame for 5 minutes.

E4.6.3 Turn off the burner after the flame is properly adjusted.

E4.7 Procedure

E4.7.1 Test Setup

Position the test specimen 1 inch (25 mm) above the burner top plate. Place the center 7-inch (178-mm) section of the specimen above the center of the burner (see figure E4-4).

E4.7.1.1 Position the two nickel-chrome ribbons at a distance of 1 inch (25 mm) apart, as measured at the center 7-inch (178-mm) section of the ribbons and perpendicular to the test specimen. Clamp one end of each of the nickel-chrome ribbons to the test fixture. Wrap the nickel-chrome ribbons around the wire and tension with weights. Lock the wires at the pulley or clamp them to the test fixture. See figure E4-4 for details.

E4.7.1.2 Connect the conductor and the nickel-chrome ribbons as shown in figure E4-5.

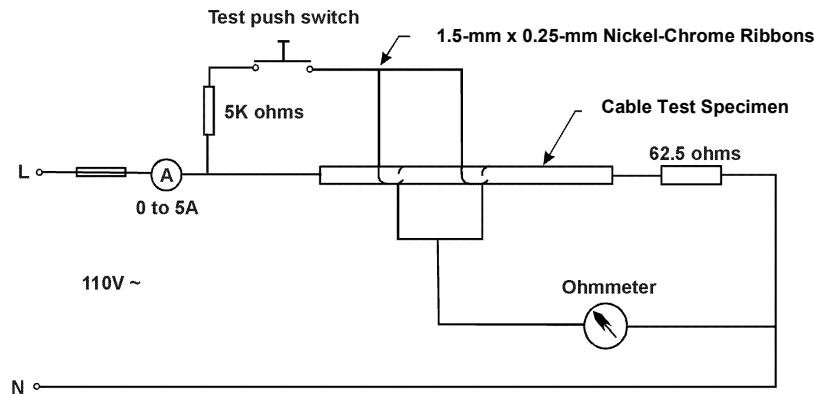


Figure E4-5. Electrical Connections

E4.7.1.3 Insert a shorting bar between the conductor and the nickel-chrome ribbons. Adjust the ohmmeter to zero in this position.

E4.7.1.4 Start the vibration using a frequency of 33 Hz and a vertical amplitude of 0.014 inch (3.5 mm).

E4.7.2 Test Procedure

Start the vibration using a frequency of 33 Hz and a vertical amplitude of 0.014 inch (3.5 mm).

E4.7.2.1 Simultaneously start the timer and apply the ignited burner to the specimen.

E4.7.2.2 Monitor the flame temperature for the duration of the test. Adjust the secondary air continually as necessary to keep the flame and the temperature within the limits specified in section E4.6.2.

E4.7.2.3 Monitor and record the insulation resistance shown by the ohmmeter for the duration of the test, starting at 7.5 seconds after the test begins. In addition, record the lowest resistance shown by the ohmmeter during the test.

E4.7.2.4 Monitor and record the current in the conductor during the test with the ammeter.

E4.7.2.5 Turn off the burner and the vibration, in that order, at the end of the 5-minute test period.

NOTE: Monitoring the conductor has been added in addition to the requirements found in MIL-W-25038. This is done in both the firewall connector test procedure MIL-STD-1344 Test Method and the ISO/DIS 2685.2 test procedure for wire. The integrity of the conductor would be as important as the integrity of the insulation if the wire were faced with an in-flight fire situation.

E4.8 Report

E4.8.1 Material Identification

Fully describe the wire type being tested. Include manufacturer, manufacturer's product designation, manufacturer's part number, specification callout (if applicable), insulation type, conductor size, and material.

E4.8.2 Insulation Integrity

Report whether the insulation flakes or falls off the conductor.

E4.8.3 Insulation Resistance

Report the insulation resistance at 7.5 seconds into the test and the lowest resistance occurring during the test and the time of its occurrence.

E4.8.4 Flame Travel

Report whether flame travel on the wire extended beyond the outer marking bands.

E4.8.5 Conductor Amperage

Report the amperage carried through the conductor throughout the duration of the test.

E4.9 Requirements

The following acceptance criteria must be met by each specimen tested.

E4.9.1 Insulation Integrity

The insulation will not flake excessively or fall off the conductor.

E4.9.2 Insulation Resistance

The minimum insulation resistance of the wire under test will be at least 10,000 ohms for the duration of the test.

E4.9.3 Flame Travel

The flame travel on the insulation will not exceed beyond the outer bands.

E4.9.4 Conductor Amperage

The conductor will be able to carry a current of at least 2A throughout the duration of the test.