



# IPC-TM-650 TEST METHODS MANUAL

**1.0 Scope** This test method is designed to determine the degree of flame resistance of metal-clad or unclad laminate. It is intended for use on laminate of thicknesses 0.51 mm [0.020 in] and greater.

## 2.0 Applicable Documents

### IPC-TM-650

Method 2.3.6, Etching, Ammonium Persulfate Method  
Method 2.3.7, Etching, Ferric Chloride Method  
Method 2.3.7.1, Cupric Chloride Etching Method  
Method 2.3.7.2, Alkaline Etching  
UL-STD-94, Flammability

## 3.0 Test Specimens

**3.1 Size** Test specimens shall be  $127 \pm 0.64$  mm [ $5.0 \pm 0.025$  in] in length and  $12.7 \pm 0.51$  mm [ $0.5 \pm 0.020$  in] in width by the thickness being tested. Edges shall be smoothed after cutting; any radius imparted to the corners shall not exceed 1.27 mm [0.05 in].

**3.2 Quantity and Sampling** Specimens may be taken parallel to either grain direction, unless otherwise specified. Five specimens shall be prepared for each condition required. Reserve sets of five specimens should also be prepared in the event a retest is necessary.

## 4.0 Apparatus or Material

**4.1 Test Chamber** A laboratory hood, totally enclosed, with a heat-resistance glass window for observing the test, shall be used. The exhaust fan shall be turned off during the test, but may be turned on periodically to clear out the fumes between tests.

**4.2 Specimen Holder** Clamping device adjustable for vertical positioning of the test specimen shall be provided within the test chamber so that the specimen will hang with its length in a vertical position approximately coincident with the central vertical axis of the test chamber.

**4.3 Laboratory burner** A Bunsen or Tirrill Burner shall be used having a tube length of 101.6 mm [4.0 in] and an inside diameter of 9.4 mm [0.370 in]. The burner shall not be

Number <b>2.3.10</b>	
Subject <b>Flammability of Laminate</b>	
Date <b>12/94</b>	Revision <b>B</b>
Originating Task Group <b>MIL-P-13949 Test Methods Task Group (7-11b)</b>	

equipped with end attachments.

**4.4 Gas supply** The gas supply shall be regulated and metered for uniform flow. The standard gas shall be Technical Grade methane. Natural gas or other fuel gases such as butane, propane and acetylene may be used, provided they have a nominal heat content of 1000 BTU per cubic foot. Technical grade methane shall be used for referee testing.

**4.5 Timer** Stopwatch or other suitable timing device with a precision of 0.5 seconds minimum.

**4.6 Desiccator** Desiccation chamber capable of maintaining an atmosphere of less than 30% RH at 23°C [73°F].

**4.7** Conditioning oven of circulating draft type capable of maintaining  $125 \pm 2$ °C [ $257 \pm 3.6$ °F].

**4.8** Thin steel scale or template for gauging flame height.

**4.9** Etching system capable of removing metal-cladding from the laminate.

**4.10** Cutting and edge smoothing apparatus such as shears, diamond blade saw, or other equipment, and sanding or routing equipment for smoothing.

## 5.0 Procedure

**5.1 Specimen Preparation** Metal-clad laminates shall be completely etched using standard industry practices (see IPC-TM-650, Methods 2.3.7, 2.3.7.1, or 2.3.7.2). Unclad laminates shall be tested in the as-is condition. Specimens shall be cut to size and the edges smoothed, in accordance with 3.1.

## 5.2 Specimen Conditioning

**5.2.1** Specimen sets shall be conditioned prior to testing by exposure to standard laboratory conditions of  $23 \pm 2$ °C [ $73 \pm 3.6$ °F] and relative humidity of  $50 \pm 5$ % for 24 hours minimum.

**5.2.2** If specified, a second set of specimens shall be conditioned for  $24 \pm 2$  hours at a temperature of  $125 \pm 2$ °C

IPC-TM-650		
Number <b>2.3.10</b>	Subject <b>Flammability of Laminate</b>	Date <b>12/94</b>
Revision <b>B</b>		

[257 ± 3.6°F], then cooled in a desiccator for 4 hours minimum prior to testing.

**5.2.3** Reserve sets of specimens may also be conditioned concurrently for failure verification purposes.

### 5.3 Preparation for Testing

**5.3.1 Adjustment of Test Flame** The burner is ignited and adjusted to produce a blue flame 19 mm [0.75 in] high. The correct flame is obtained by adjusting the gas supply and the air ports of the burner until a blue flame with a yellow-tipped outer cone 19 mm [0.75 in] high is produced. The air supply is increased slightly by opening the air ports only until the yellow tip just disappears and completely blue inner and outer flame cones are formed. The flame is remeasured for correct height. The procedure is repeated as necessary until all conditions are met. The burner tube is vertical during adjustment and testing. (See 6.2, 6.3, and 6.4.)

**5.3.2 Specimen Mounting** Each specimen is mounted in the test fixture with its longitudinal axis vertical. The clamp used shall cover no more than the upper 6.4 mm [0.25 in] of the specimen. The vertical position of the test fixture/specimen assembly is adjusted so that the lower end of the specimen is 9.5 mm [0.375 in] above the top of the burner tube.

### 5.4 Measurement

**5.4.1** The test flame is placed centrally under the lower end of the specimen for 10 ± 0.5 seconds. The burner is withdrawn from the specimen. If active combustion ceases prior to the specimen being completely consumed, the test flame is to be immediately placed under the specimen for an additional 10 ± 0.5 seconds, then withdrawn as before.

**5.4.2 Evaluation and Report** Steps 5.5.1, 5.5.2, and 5.5.3 shall be performed for each test condition.

**5.5 Recording Data** The following data is to be observed and recorded.

**5.5.1** Duration of specimen burning to the nearest second after the first test flame application for each specimen.

**5.5.2** Duration of specimen burning to the nearest second after the second test flame application for each specimen.

**5.5.3** Duration of specimen burning plus glowing to the nearest second after the second test flame application for each specimen, only if required by the specification.

**5.5.4** If any specimen burns up to the holding clamp on any ignition.

### 5.6 Calculation

**5.6.1** Calculate the total specimen burning time and the average burning time based on ten ignitions per set of five specimens.

**5.6.2** Calculation of the glowing time for each specimen, if required by the specification.

**5.7 Report** The material shall be reported as out of compliance for one or more of the following test results, unless otherwise specified.

**5.7.1** More than one specimen per set burns up to the holding clamp on any ignition.

**5.7.2** More than one specimen per set burns for a period of time longer than allowed by the specification for a single specimen.

**5.7.3** The total specimen burning time or the average specimen burning time as applicable exceeds the maximum allowed by the specification and is beyond the tolerance specified in 5.5.4.

**5.7.4** More than one specimen glows for a period of time greater than allowed by the specification (when applicable).

**5.8 Retest** If only one specimen per set fails to comply with the requirements, the reserve set of specimens shall be tested. In the case of total or average specimen burning time, the reserve set shall be tested only if these calculated values exceed the specification maximum by five seconds or less. All specimens from the reserve set shall comply with the requirements.

### 6.0 Notes

**6.1** Most laminates covered by this test method do not drip molten or flaming material, and therefore provisions for this evaluation have not been described. If necessary, refer to UL-STD-94.

**6.2** The inside of the burner barrel should be cleaned frequently. Specimen combustion by-products can collect around and inside the barrel tip. These deposits can be

IPC-TM-650		
Number <b>2.3.10</b>	Subject <b>Flammability of Laminate</b>	Date <b>12/94</b>
Revision <b>B</b>		

flushed out during burner ignition and flame adjustment resulting in a false yellow flame tip. Proper flame adjustment becomes very difficult.

**6.3** When the flame is correct and the specimens end is at the proper height above the burner 9.5 mm [0.375 in], the inner blue cone of the flame will just meet the end of the specimen. The specimen will then be ignited by the hottest area of the flame.

**6.4** Accurate centering of the flame under the specimen is essential for consistent testing.

**6.5 Desiccator Conditions** The Test Methods Task Group determined that a great majority of test laboratories are unable to consistently hold the Relative Humidity in a desiccator to less than 20%. Based on data from participating company lab management, the lowest practically feasible RH for use with the affected IPC Test Methods is 30% maximum.