Designation: F 520 – 97

Standard Test Method for Environmental Resistance of Aerospace Transparencies[1]

This standard is issued under the fixed designation F 520; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers determination of the effects of exposure to thermal shock, condensing humidity, and simulated weather on aerospace transparent enclosures.

1.2 This test method is not recommended for quality control nor is it intended to provide a correlation to actual service life.

1.3 *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 *ASTM Standards:*

D 1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics[2]

F 521 Test Methods for Bond Integrity of Transparent Laminates[3]

G 23 Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials[4]

G 26 Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials[4]

G 53 Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type for Exposure of Nonmetallic Materials[4]

3. Summary of Test Method

3.1 Two types of test specimens, duplicating the aerospace transparent enclosure design, are subjected to thermal shock, condensing humidity, and artificial weathering. Edge sealing may be used if representative of the design.

3.1.1 Type A specimens are used to determine the effect of environmental exposure on electrical and optical properties.

3.1.2 Type B specimens are used to determine the effect of environmental exposure on bond integrity.

4. Significance and Use

4.1 This test, when applied to aerospace transparencies of either monolithic glass/plastic or laminated combinations, is a measure of the ability of the transparency to withstand the effects of artificially induced environments. The test may be used on configurations employing electrically conductive coatings, and also to evaluate the integrity of noncoated materials.

4.2 The resistance of the transparent enclosure to environmental effects may vary appreciably depending on the size, geometry, material of construction, coating integrity, coating density, and other factors.

5. Test Specimens

5.1 Each Type A specimen shall be a 250 by 250-mm (9.8 by 9.8-in.) cross section of the design and shall contain, as applicable, surface coatings of operational, electrically conducting coating systems complete with bus bars, braids, and temperature sensors.

5.1.1 Type A test specimens shall have a fully operational coating system, when applicable, with an average resistivity consistent with the average resistivity of the representative design. Reproduction of multiphase electrical circuits is not required for these test specimens since this type of circuitry is only a design technique used to accommodate limited voltage resources at installation.

5.2 Each Type B test specimen shall be 50 by 50 mm (2 by 2 in.) and shall be of a cross section consistent with the edge configuration of the representative design. Type B test specimens are not intended to be operational electrically, but they shall be representative of the average resistivity of the design.

6. Preparation of Test Specimens

6.1 Prepare a minimum of three Type A specimens for each design configuration. If the design contains an electrically activated coating, only one temperature sensor per specimen is required.

6.2 Prepare a minimum of five Type B specimens for each design configuration. Prepare the specimen in such a manner as to produce smooth edges and corners to prevent chipping during testing. Polish at least one edge of each specimen to allow inspection of the internal bonded surfaces during tensile loading. Do not apply edge sealant to the specimens.

6.3 Condition all test specimens by exposing them to not less than 40 h at 23 ± 2°C (73.4 ± 3.6°F) and 50± 5 % relative humidity.

---

[1] This test method is under the jurisdiction of ASTM Committee F-7 on Aerospace and Aircraft, and is the direct responsibility of Subcommittee F 07.08on Transparent Enclosures and Materials.

Current edition approved April 10, 1997. Published August 1997. Originally published as F 520 – 77. Last previous edition F 520 – 77 (1989).

[2] *Annual Book of ASTM Standards,* Vol 08.01.

[3] *Annual Book of ASTM Standards,* Vol 15.03.

[4] *Annual Book of ASTM Standards,* Vol 14.02.

7. Procedure

7.1 *Visual Examination*—Carefully examine Type A and Type B specimens for any signs of material or manufacturing defects. A microscope or magnifying lens, dark background, and cross lighting may be used, as appropriate, to assist in the identification and classification of visible defects.

7.2 *Optical Tests*—Measure each Type A specimen for luminous transmittance and haze in accordance with Procedure B of Test Method D 1003. Make at least two measurements, one in the center and one near the edge, on each specimen. Six measurements are preferred. If greater than 1 % variation exists, prepare a template from polyester film or other suitable material to record these locations for indexing and correlation to readings to be taken after environmental exposure.

NOTE 1—Paragraphs 7.3-7.6 are applicable to systems using electrically conductive coatings.

7.3 *Electrical Tests*:

7.3.1 *Bus Bar-to-Bus Bar Resistance*—Measure each Type A specimen for bus bar-to-bus bar resistance. Take precautions to minimize the effects of variable contact resistance. Record results and repeat the measurement after environmental exposure prior to application of over-voltage power.

7.3.2 *Sensing Element*—Test the sensing elements for open or shorted circuits by applying an electrical potential of 10 rms volts ac for a minimum period of 1 min. Follow by measuring resistance in both directions. Measure the resistance of the sensing elements at a specified temperature to assure conformance to the temperature resistance ranges certified by the element manufacturer.

7.3.3 *Electrical Insulation*—Test the electrical insulation by measuring leakage current on each test specimen. Apply an alternating current potential of either 1500 or 2500 V rms (depending upon the design application) at 50 or 60 Hz for a period of 1 min between the following:

(1) each sensor lead and each heater lead;

(2) each sensor lead and metal insert or spacer;

(3) each heater lead and the metal insert or spacer;

(4) each heater lead and metal strip placed in contact with the edge of the glass panel; test the entire edge of the glass panel;

(5) each anti-ice and defog heater lead.

Leakage current in excess of 1.5 mA at 1500 V rms or 2.5 mA at 2500 V rms is objectionable. Monitor the current during a preliminary low voltage application and terminate the test if the current leakage exceeds the allowable amount prior to full voltage application. Determine the resistance and decide whether to proceed to full voltage in conformance with the test procedure.

7.3.4 Monitor the current during gradual application of a d-c voltage. Current in excess of 5 µA is objectionable. If the current exceeds 5 µA dc before 500 V dc is reached, suspend the test and determine the resistance before deciding whether to continue. Gradually apply and remove the potential at no greater rate than 500 V rms/s.

7.3.5 *Electrically Conductive Coating Test*—Test each Type A specimen for electrically conductive coating uniformity by energizing with the same level of controlled power as proposed in the design while viewing between polarized plates. Identify all detectable coating hot spots during this heat-up cycle. These thermally induced stress concentrations are generally characterized by a "butterfly" shape and are to be noted for later specimen evaluation.

7.3.6 *Overvoltage Test*—Subject each of the electrical heating circuits of Type A specimens to the application of an overvoltage of 150 % maximum operating voltage for the circuit. Apply this voltage to the power leads for a minimum of 5 s. After no less than a 2-min wait, apply the same voltage for a minimum of 5 s, observing the sample in a darkened room with specific emphasis being on the bus bars for signs of arcing.

7.3.7 *Bond Integrity Test*—Test individual Type B specimens in accordance with Test Methods F 521.

7.4 Specimens that fail due to some obvious, nonrepresentative defect shall be disqualified and retests conducted.

7.5 *Environmental Exposure*:

7.5.1 *Artificial Weathering*—Expose test specimens to artificial weathering in accordance with one of the two standards listed below.

7.5.1.1 *Practice G 53 for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials*—Use UVB-313 bulbs and a cycle of 7 h UV followed by 5 h condensation, all at a constant temperature of 120°F. Apply the cycle continuously for 168 h (1 week) to simulate 1 year of equivalent natural exposure.

7.5.1.2 *Practice G 26 for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials*—Use a cycle of 102 min of light followed by 18 min of spray in accordance with Test Method A of Practice G 26.

NOTE 2—Practice G 53 and Practice G 26 have both been shown to produce acceptable accelerated weathering results. Practice G 53 is used most extensively in the Transparency Community due to its simplicity, ease of use and low operational costs. Practice G 26 is preferred by some organizations for its flexibility in tuning the wavelength of the light source and its ability to provide more energy throughout the UV spectrum. Both practices have been included to enhance the applicability of the test method.

NOTE 3—Accelerated weathering results may only be compared for samples exposed using the same practice. Comparison of test results obtained using different practices may result in erroneous conclusions, particularly when comparing the relative performance of different materials.

7.5.2 *Humidity*—Expose the test specimens to 10 cycles of condensing humidity in a chamber with a controlled temperature of 49 ± 3°C (120 ± 5°F) and relative humidity of 95 to 100 %. Water used to maintain the humidity shall not contain more than 200 ppm total solids. Each cycle shall be a 24-h exposure in the condensing humidity chamber and an 8-h exposure to ambient temperature and humidity.

7.5.3 *Thermal Shock*—Place the test specimen in an oven at a temperature of 71°C (160°F) and leave until stabilized at 71°C (160°F) as determined by a thermocouple attached to the specimen face. After the temperature has stabilized, transfer the specimen as rapidly as possible (within 3 min) to a chamber maintained at − 54°C (−65°F). Let the specimen stabilize at − 54°C (−65°F) and as rapidly as possible return it to the

oven at 71°C (160°F). After each − 54°C (−65°F) cold soak, and while the specimen is stabilized at − 54°C (−65°F), energize the conductive coating on Type A specimens using the design watt density until the temperature at the sensor stabilizes. Then switch off the power and place the specimen in the 71°C (160°F) oven. Repeat this for two cycles unless specified otherwise.

7.6 Upon completion of environmental exposure in accordance with either 7.5.1, 7.5.2, 7.5.3, or any combination thereof, allow all specimens to return to ambient conditions and examine them for signs of delamination, cracking, spalling, or other deterioration.

7.7 Repeat tests 7.1-7.4.

8. Report

8.1 The test report shall include the following:

8.1.1 A complete and detailed identification of the materials and configurations tested, including type, source, manufacturer's code or serial number, face ply materials, interlayer description, coatings, principal dimensions of all panels tested, and previous history,

8.1.2 Results of all visual examinations including (if obtained) photographs and photomicrographs,

8.1.3 Luminous transmittance, haze measurements, and location diagram (if necessary) to describe results,

8.1.4 Test results in accordance with Test Method F 521,

8.1.5 Bus bar-to-bus bar resistance of Type A specimen before and after environmental exposure,

8.1.6 Results of applied standard, controlled energizing current, and overpower voltage tests, and

8.1.7 The practice used for artificial weathering and appropriate details required by the report section of the practice.

8.1.8 All other results required by the individual test procedures, referenced herein, where these are applicable.

9. Precision and Bias

9.1 *Precision and Bias—Visual Examination*:

9.1.1 No statement is made concerning either precision or bias for this portion of the test method since the result merely states whether there is conformance to the criteria for success specified in the procedure.

9.2 *Precision and Bias—Optical Tests*:

9.2.1 The precision and bias of the portion of the test method measuring haze and luminous transmittance are as specified in Test Method D 1003.

9.3 *Precision and Bias—Electrical Tests*:

9.3.1 No statement is made concerning either precision or bias for the following portions of the test method since the result merely states whether there is conformance to the criteria for success specified in the procedure: Bus Bar-to-Bus Bar Resistance, Sensing Element, Electrical Insulation, Electrically Conductive Coating Test, Overvoltage Test.

9.4 *Precision and Bias—Bond Integrity Test*:

9.4.1 The precision and bias of the portion of the test method measuring bond integrity are as specified in Test Method F 521.

9.5 *Precision and Bias—Environmental Exposure*:

9.5.1 No statement is made concerning either precision or bias for this portion of the test method since the result merely states whether there is conformance to the criteria for success specified in the procedure.

10. Keywords

10.1 environmental resistance; humidity; thermal shock; transparency; transparency coating; weathering