



Standard Test Method for Hail Impact Resistance of Aerospace Transparent Enclosures¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers the determination of the impact resistance of an aerospace transparent enclosure, hereinafter called windshield, during hailstorm conditions using simulated hailstones consisting of ice balls molded under tightly controlled conditions.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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.* For specific hazard statements see Section 7.

2. Terminology

2.1 Definitions:

2.1.1 *damage, n*—any modification in visual properties or integrity of a windshield as a result of hail impact including scratches, crazing, delamination, cracks, or shattering.

2.1.2 *ice ball, n*—a frozen mass of water, with filler, that simulates a natural hailstone in weight, size, and toughness.

2.1.3 *impact angle, n*—the angle between the ice ball flight path and the target normal.

2.1.4 *sabot, n*—a plastic device for protecting the ice ball while in the launch tube. One type of sabot (see Fig. 1) consists of a split polycarbonate rod containing a central cavity for holding the ice ball. Each sabot half is designed to assure aerodynamic separation from the ice ball after ejection from the launch tube.

3. Summary of Test Method

3.1 The test method involves launching a series of ice balls of specified sizes at a sample windshield at a designated velocity and angle and in a specified pattern. Requirements are specified for the ice ball, test specimen, procedure, and data acquisition. The ice ball is photographed in flight to verify its integrity.

3.2 Requirements are specified for a particular apparatus and test procedure, but options are permitted for certain areas. However, it must be possible to demonstrate that the options used result in an ice ball impacting the test panel with the same size, consistency, and velocity as with the specified apparatus and procedure. Following are areas where options are allowed:

3.2.1 *Ice Ball Mold Material.*

3.2.2 *Launcher*—Any type of launcher is allowable as long as the iceball reaches the test specimen intact at the correct speed. The use of sabots and sabot material and geometry are optional.

3.2.3 *Method of Determining Ice Ball Integrity.*

3.2.4 *Ice Ball Speed Measurement*, optional as long as accuracy standards are met.

3.2.5 *Test Specimen Sizes*—Those given are minimum.

3.2.6 *Safety*—Safety must satisfy the safety standards of the test facility being used.

4. Significance and Use

4.1 This test method shall be used to determine the hail impact resistance of windshields for acceptance, design, service, or research purposes. By coupling this method with the installed angle and velocity of a specific aerospace vehicle, design allowables, criteria, and tolerances can be established for that vehicle's windshield.

5. Apparatus

5.1 The facilities and equipment required for the performance of this test procedure include a suitable firing range equipped with an ice ball mold, a launcher, blast deflector, sabot trap, velocity measuring system, test specimen holder, and a camera with strobe lights to verify ice ball integrity. Ancillary equipment required for this test include test

¹ This test method is under the jurisdiction of ASTM Committee F07 on Aerospace and Aircraft and is the direct responsibility of Subcommittee F07.08 on Transparent Enclosures and Materials.

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