



Designation: E3192/E3192M – 20

Standard Practice for Soft Armor Conditioning by Tumbling¹

This standard is issued under the fixed designation E3192/E3192M; 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 practice applies only to the conditioning of soft body armor via temperature, humidity, and tumbling exposure prior to ballistic resistance testing.

1.2 This practice is intended for soft armor for law enforcement applications, and its purpose is to subject test items to conditions intended to provide some indication of the test item ability to withstand conditions of heat, moisture, and mechanical wear (folding and abrasion) that might be encountered during wear.

1.2.1 This practice is not intended for soft armor to be used in military applications.

1.3 In this practice, “other standards and specifications” and “unless specified elsewhere” refer to documents that require the use of this practice. Purchasers and other users are responsible for the “other standards and specifications” and for specifying any requirements that supersede those of this practice.

1.4 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This practice is under the jurisdiction of ASTM Committee E54 on Homeland Security Applications and is the direct responsibility of Subcommittee E54.04 on Personal Protective Equipment (PPE).

Current edition approved April 1, 2020. Published April 2020. Originally approved in 2019. Last previous edition approved in 2019 as E3192/E3192M – 19. DOI: 10.1520/E3192_E3192M-20.

2. Referenced Documents

- 2.1 *ASTM Standards*:²
E3005 Terminology for Body Armor

3. Terminology

3.1 The following terms from Terminology E3005 are applicable: *body armor*, *conditioning*, *controlled ambient*, *soft armor*, and *test item*.

3.1.1 Within this standard, the definition for *controlled ambient* from Terminology E3005 applies to any direct or indirect reference to controlled ambient, superseding referenced standards that may have a different definition.

4. Significance and Use

4.1 U.S. Department of Justice standards for assessing the performance of ballistic-resistant torso body armor require conditioning of soft armor test items prior to ballistic testing.

4.2 This practice method may be applicable for certification testing or for research and development testing.

4.3 This practice has only been evaluated for ballistic-resistant body armor and has not been assessed for applicability to any other type of protective system.

5. Test Item Preparation

5.1 The number of test items to be conditioned at one time shall be specified in other standards and specifications.

5.2 Test items shall be conditioned at controlled ambient for at least 24 h prior to this procedure. This may be achieved in a controlled laboratory environment, or if conditions in the laboratory deviate from those specified, a chamber may be used to create these conditions.

5.3 The test items shall be stored flat prior to and following this procedure.

NOTE 1—Stacking of test items is permitted.

6. Laboratory Configuration and Equipment

6.1 Environmental Chamber:

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

6.1.1 The environmental chamber shall be capable of achieving and maintaining the required temperature and humidity within the specified tolerances for the duration of the conditioning procedure.

6.1.2 The environmental conditioning temperature shall be $65\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ [$149\text{ }^{\circ}\text{F} \pm 3.6\text{ }^{\circ}\text{F}$].

6.1.3 The environmental conditioning relative humidity shall be $80\% \pm 5\%$.

NOTE 2—It is highly recommended that the water used for humidity generation be relatively free from impurities and chemicals, have a pH in the range of 6.5 to 7.2, and have water resistivity of no less than 150 000 ohm cm. This can be achieved using distillation, demineralization, reverse osmosis, or deionization.

6.2 Tumbling Apparatus:

6.2.1 A rotating drum shall be used to generate the tumbling action and shall have a rotation rate of 5.0 ± 1.0 rpm. The drum rotation rate may be varied within the given tolerance to achieve the necessary number of rotations.

6.2.2 The drum shall be constructed from stainless steel.

6.2.3 The drum shall meet the following dimensional requirements:

6.2.3.1 Internal diameter: $832\text{ mm} \pm 6\text{ mm}$ [$32\frac{3}{4}\text{ in.} \pm \frac{1}{4}\text{ in.}$]

6.2.3.2 Internal depth: $651\text{ mm} \pm 6\text{ mm}$ [$25\frac{5}{8}\text{ in.} \pm \frac{1}{4}\text{ in.}$]

6.2.3.3 The drum shall have four fins (that is, ribs) running the full depth of the drum spaced at nominally 90° intervals about the circumference. Each fin shall be $114\text{ mm} \pm 3\text{ mm}$ [$4\frac{1}{2}\text{ in.} \pm \frac{1}{8}\text{ in.}$] high. The top edge of each fin shall be rounded with a diameter of $19\text{ mm} \pm 3\text{ mm}$ [$\frac{3}{4}\text{ in.} \pm \frac{1}{8}\text{ in.}$]. The base of each fin shall not be thinner than 19 mm [$\frac{3}{4}\text{ in.}$] and shall not be wider than 76 mm [3.0 in.].

6.2.3.4 The drum shall have smooth inner surfaces with no sharp edges, no rough spots, and no burrs.

6.2.4 The drum shall have sufficient openings such that the air inside the drum remains within the specified tolerances for temperature and humidity. The openings shall be in the front or back walls or both, unless the drum is perforated. Fig. X1.1 in Appendix X1 shows a simple sketch of the drum orientation and how it may be configured.

NOTE 3—The drum wall may or may not be perforated.

6.2.5 The drum shall have a rotation counter.

6.2.6 The tumbling apparatus shall be configured to allow viewing of the contents of the drum (for example, a viewing port or a camera).

6.3 Environmental chamber and tumbling apparatus monitoring.

6.3.1 The monitoring equipment shall include measurement and recording device(s), independent from the chamber and tumbling apparatus controllers.

6.3.2 The monitoring equipment shall provide and allow documentation of temperature and relative humidity measurements inside the environmental chamber.

6.3.2.1 Unless otherwise specified, when an analog recording system is used, measure and document the temperature and relative humidity continuously. When a digital recording system is used, measure and document the temperature and relative humidity at intervals of 10 min or less.

6.3.3 The laboratory shall monitor and document:

- (1) Time and date at beginning and for each time the rotation count is recorded,
- (2) Temperature,
- (3) Relative humidity,
- (4) Rotation rate, and
- (5) Rotation count.

6.3.4 The humidity chamber shall be designed in a manner that minimizes condensation coming into contact with the test items to the extent possible.

7. Conditioning Procedure

7.1 Duration of Procedure:

7.1.1 The conditioning procedure duration shall be $240\text{ h} \pm 1\text{ h}$.

7.1.2 The drum shall be rotated through $72\ 000 \pm 1500$ complete rotations during the conditioning procedure.

7.1.3 Fig. 1 shows acceptable conditioning procedure end points given the combination of time and drum rotation. The procedure is complete and may be stopped when time and drum rotation fall within the box shown in Fig. 1.

7.2 Allowed Interruption:

7.2.1 The conditioning procedure may be interrupted if any of the following occurs:

7.2.1.1 The temperature or humidity becomes out of tolerance.

7.2.1.2 There is an equipment failure.

7.2.1.3 Test items are observed to be not tumbling (for example, test items stuck to the drum walls or trapped at the front or back of the drum).

(1) If any test item is trapped between the rotating and static portions of the drum, then that test item shall be removed from the drum and inspected. Any damage to that test item shall be documented, and the test item shall be marked to indicate that it is not to be subjected to ballistic testing. That test item shall then be flattened and returned to the drum to keep the load in the drum constant.

7.2.2 If an interruption is warranted, stop the tumbling and follow the guidance of Section 8 to shut down the apparatus. Open the drum to gain access to the test items, and follow the guidance of Section 9 to sort and stack test items.

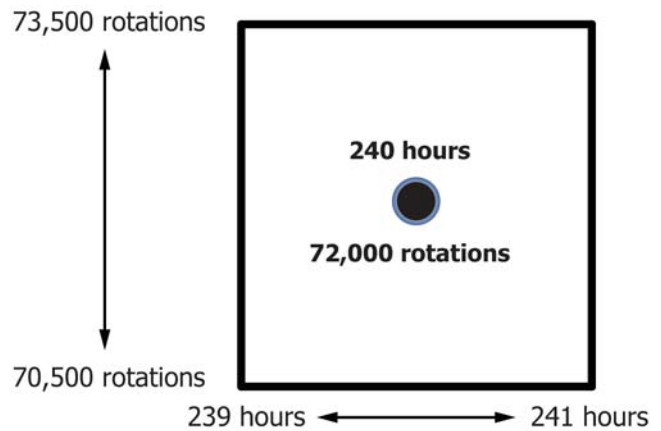


FIG. 1 Criteria for the End of the Conditioning Activity