



Standard Specification for Protective Headgear Used in Martial Arts¹

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1. Scope

1.1 This specification covers performance requirements for head protection used for training and competition in martial arts such as karate, wushu, and taekwondo, where normal contact between participants may be repeated, but is limited to a level that is not intended to produce injury. These activities typically take place in indoor or outdoor environments where the temperature is moderate. This specification recognizes the desirability of a lightweight and streamlined construction, and ventilation; however it is a performance specification, and is not intended to restrict design.

1.2 All testing and requirements of this specification shall be in accordance with Test Methods F1446, except where noted in this specification.

1.3 Partial utilization of this standard is prohibited. Any statement of compliance with this specification shall be a certification that the product meets all of the requirements of the specification in its entirety. A product that fails to meet any one of the requirements of this specification is considered to have failed the specification, and shall not be distributed or sold with any indication that it meets parts of the specification.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 The following safety caveat applies to the chemical, mechanical, or physical, or a combination thereof, test methods described herein and is meant specifically for those performing the tests (in an effort to provide them with notice to take the appropriate precautions when conducting the tests): *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.*

¹ This specification is under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and is the direct responsibility of Subcommittee F08.53 on Headgear and Helmets.

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2. Referenced Documents

2.1 *ASTM Standards*:²

F1446 Test Methods for Equipment and Procedures Used in Evaluating the Performance Characteristics of Protective Headgear

3. Terminology

3.1 See Test Methods F1446.

4. Significance and Use

4.1 The purpose of this specification is to provide reliable and repeatable test methods for the evaluation of protective headgear for martial arts training and competition. Injuries resulting from accidentally hard hand-to-head impacts, foot-to-head impacts, and head-to-ground impacts may be decreased in severity and, in some cases, prevented. No headgear can protect against all impacts, foreseeable or not. Forces resulting from strikes to the head due to kicks, punches, and falls are not well understood. The mechanism of possible injury is not addressed in this specification.

5. Certification

5.1 See Test Methods F1446.

6. Apparatus

6.1 *Test Headforms*—Headforms to be used for the stability and falling impact tests in this specification are as defined in Test Methods F1446. The appropriate size headform shall be selected for the headgear to be tested. For the striking impact tests in this specification, it is acceptable to use the appropriate size Hybrid III head- and neck-forms.

6.2 *Stability Test Instruments and Equipment*—Stability test instruments and equipment shall be in accordance with the requirements of the roll-off test described in Test Methods F1446.

6.3 *Falling Impact Test Instruments and Equipment*—Impact test instruments and equipment for falling impact shall

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.

be in accordance with the requirements of Test Methods F1446, using the flat anvil described in Test Methods F1446.

6.4 *Striking Impact Instruments and Equipment*—All tests for striking impact shall be performed with a Hybrid III headform and neck. A tri-axial accelerometer capable of measuring impact of at least 1000-G and frequencies greater than 3 kHz, mounted at the center of mass of the headform, shall be used to measure the resultant acceleration of the headform. The headform and neck are to be rigidly connected at the neck to a 25-kg steel mass, and suspended head-down on a flexible joint. The striker shall be an aluminum tube with a length of 500 ± 5 mm from its pivot point to the strike point, extend an additional 50 ± 5 mm beyond the strike point, and have an external diameter of 80 ± 5 mm. The mass of the tube shall be 4.5 ± 0.2 kg, uniformly distributed along its length. The striker shall be loaded with a spring or a falling mass, such that when the striker is rotated back and released, it rotates forward toward the headform and strikes it at the designated points. No force is to be applied to the striker by the spring or falling mass once the striker rotates forward beyond the initial impact point, however, the striker must be free to rotate forward after impact. Rotating the striker further backwards before releasing it can increase the striking speed. The terminal speed impact shall be measured within 100 mm of the point of free rotation. A schematic diagram of a typical striking impact tester is shown in Fig. 1.

7. Samples for Testing

7.1 Conditions and attachments in accordance with Test Methods F1446.

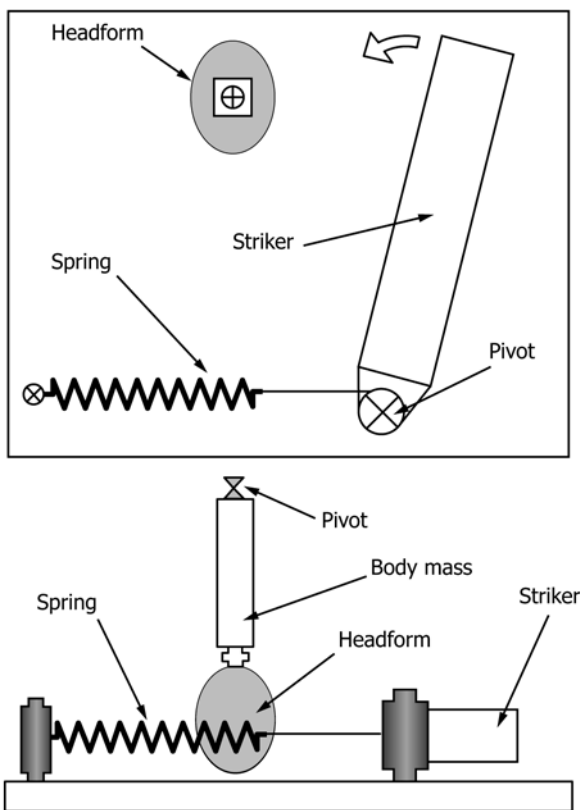


FIG. 1 Striking Impact Test.

7.2 *Number of Samples*—A test normally requires seven samples of each size. All testing may be done on two size groups only if the material, material thickness, and construction of all the sizes are the same, that is, differing in coverage area only. If only two size groups are tested, the sizes must represent the largest and smallest sizes that will fit the appropriate headform. If the material, material thickness, or construction is different between each size, then all sizes must be tested.

8. Calibration and Standardization

8.1 See Test Methods F1446.

9. Conditioning Environments

9.1 See Test Methods F1446. The ambient temperature and water immersion environments shall be used.

9.2 The following modified high temperature environment shall be used. The sample shall be kept in a 47 to 53°C environment for 4 to 24 h. The sample shall then be kept in a 35 to 40°C environment for 4 to 24 h. Testing must begin within 1 min after removal from this final conditioning environment. Before further testing, the headgear must be returned to the final conditioning environment within 3 min, or be reconditioned for 5 min for each minute it is out of the final conditioning environment beyond the allowed 3 min.

10. Test Schedule

10.1 One sample from each size group to be tested will be inspected according to the schedule listed in Test Methods F1446.

10.2 Two headgear will be assigned to the ambient conditioning environment. Two headgear will be assigned to each of the other two conditioning environments.

10.3 Testing will be performed in the following order:

- 10.3.1 Retention test,
- 10.3.2 Low-energy falling impact test,
- 10.3.3 High-energy falling impact test,
- 10.3.4 Low-energy striking impact test, and
- 10.3.5 High-energy striking impact test.

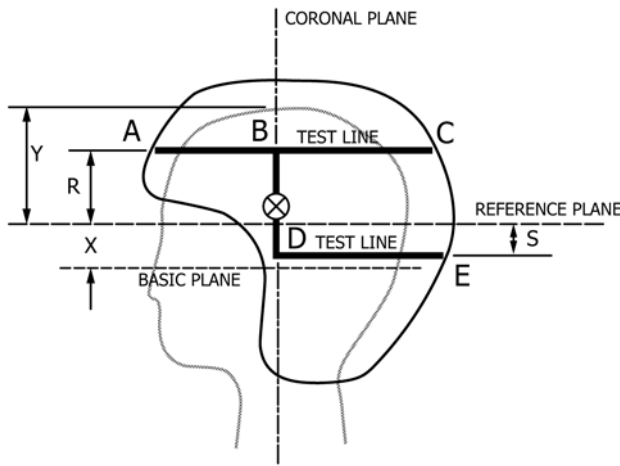
10.4 Testing must be complete 30 min after initial removal from the conditioning environment. Once testing has begun on a sample, all tests on that sample must be completed within 3 min. For each minute, or fraction thereof, this time limit is exceeded, the sample must be returned to the conditioning environment for an additional 5 min.

11. Test Methods

11.1 *Reference Marking*:

11.1.1 Place the headgear on the appropriate headform in accordance with Test Methods F1446. Pre-load with a ballast of 5 kg.

11.1.2 Draw lines A-B-C-D-E on the headgear as shown in Fig. 2. This represents the test line for impact in the frontal, temporal, and occipital directions. Lines A-B-C and D-E are parallel to the reference and basic planes. Line B-D is



ASTM Headform Size	X mm	Y mm	R mm	S mm
A	24.0	89.7	38.0	7.0
E	26.0	96.0	39.0	8.0
J	27.5	102.5	41.0	8.0
M	29.0	107.0	41.0	8.0
O	31.0	110.0	42.0	9.0

FIG. 2 Marking the Test Line

co-planar with the coronal plane. The center of impact may be selected to be anywhere on or between the test lines.³

11.2 Configuration:

11.2.1 In general, the headgear shall be constructed to reduce the acceleration of the wearer’s head and to remain on the wearer’s head during and after impact. The headgear shall also include the following features.

11.2.2 Openings—The headgear shall be designed so that the ears have a connection to the environment to enable the wearer to hear, as well as to prevent air pressure damage caused by blows to the ear. There shall also be an alternate air path for relieving pressure to the ears in case a blow to the ear seals all of the connections. This alternate air path shall be constructed such that a rigid 6-mm diameter rod can pass unobstructed from each ear to the environment.

11.2.3 External Surface—The headgear must be cushioned externally to prevent injury to the striking implement, presumably a foot, hand, or another part of the body. The external surfaces of the headgear, including any exposed hard buckles or fasteners, shall be cushioned with the equivalent of at least 6 mm of a material with a maximum durometer hardness of 40 on the Shore A scale.

11.3 Materials:

11.3.1 See Test Methods F1446.

11.4 Labels and Warnings:

11.4.1 Each headgear shall be labeled in accordance with Test Methods F1446.

11.4.2 Each headgear shall also have instructions indicating that the headgear is designed to be used for martial arts training and competition. It should also inform the user that it is not designed to protect against possible trauma resulting from full contact strikes to the head. It is designed to provide protection from light and incidental impacts that may occur while engaging in martial arts training and competition where normal contact between participants is limited to a level that is not

intended to produce injury. While headgear is designed to decrease the chance of having a head injury or decrease its severity, no headgear can prevent all head injuries.

11.4.3 Each headgear shall also have instructions for method and frequency of self-inspection for damage, and for disposal after a period of time.

11.5 Projections:

11.5.1 Any internal projections must be in accordance with Test Methods F1446.

11.5.2 External Projections—Any external rigid projections that can contact the striker during impact shall be protected by means of cushioning. Verify that if projections are present, they are protected. Projections may not extend beyond the exterior surface more than 25 mm.

11.6 Vision—Vision testing is defined in Test Methods F1446. The vision shall be unobstructed through an angle of 105°, minimum, on either side of the midsagittal plane. The vision shall be unobstructed through an angle of 25°, minimum, upward from the reference plane. The vision shall be unobstructed through an angle of 45° downward from the basic plane. These angles are shown in Fig. 3.

11.7 Stability (Roll-off) Test—Roll-off testing is defined in Test Methods F1446. The drop-mass shall be 2 ± 0.1 kg and the drop height shall be 600 ± 10 mm. One sample of the headgear conditioned to the ambient environment will be used for this test.

11.8 Low-Energy Falling Impact Test— This test consists of three sequential impacts, on the same headgear at the same location, with less than 1 min between each impact. Four different sites will be tested on the same headgear.

11.8.1 Performance Requirements—The maximum acceleration measured during any impact, cannot exceed 100-G. In addition, the retention system must remain intact and the headgear must remain on the headform during impact testing.

11.8.2 Test Details—The impact testing shall be performed in accordance with the procedures in Test Methods F1446 unless otherwise noted.

³ The Hybrid III 50th percentile male head corresponds to ASTM headform size J.

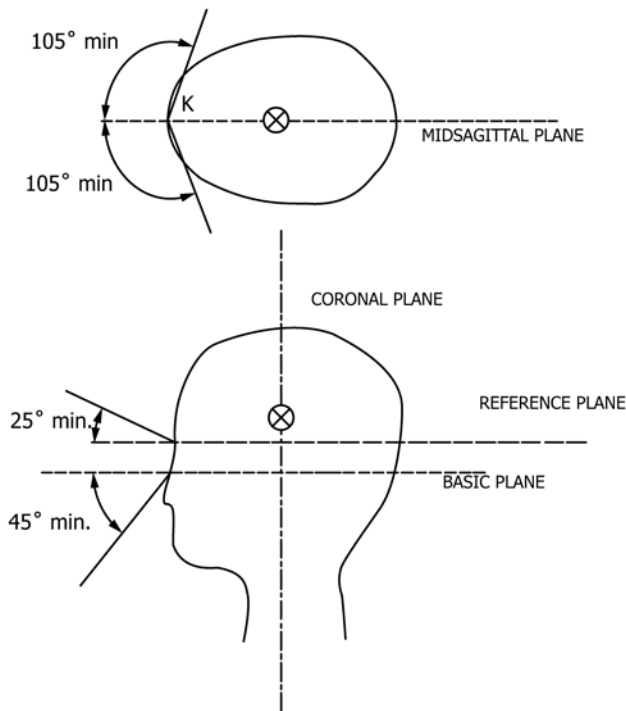


FIG. 3 Vision requirements

11.8.2.1 Four impact sites will be defined by the test technician and should represent the sites with the greatest risk of failure. The sites shall be centered anywhere on or between the test lines.

11.8.2.2 The headgear shall be dropped onto the flat anvil. The impact shall achieve an impact velocity of 3.0 ± 0.15 m/s. Measure the resulting acceleration time history of the headform.

11.8.2.3 Reposition the headgear as necessary and repeat the drop within a 1-min time frame for a total of three drops at each site.

11.8.2.4 Repeat the testing for each impact site and each environmental condition, for a total of 36 impacts.

11.9 *High-Energy Falling Impact Test*—This test consists of a single impact at four different sites on the same headgear. This test is possibly destructive, thus the headgear should be inspected for damage according to the manufacturer’s instructions for self-inspection. Damaged headgear shall not be used for any other tests.

11.9.1 *Performance Requirements*—The maximum acceleration measured during impact cannot exceed 300-G. In addition, the retention system must remain intact and the headgear must remain on the headform during impact testing.

11.9.2 *Test Details*—The impact testing shall be performed in accordance with the procedures of Test Methods F1446 unless otherwise noted.

11.9.2.1 Four impact sites will be defined by the test technician and should represent the sites with the greatest risk of failure. The sites shall be centered anywhere on, or between, the test lines.

11.9.2.2 The headgear shall be dropped on to the flat anvil. The impact shall achieve an impact velocity of 4.0 ± 0.2 m/s. Measure the resulting acceleration time history of the headform.

11.9.2.3 Repeat the testing for each impact site and each environmental condition, for a total of twelve impacts.

11.10 *Low-Energy Striking Impact Test*—This test consists of three sequential impacts with less than one minute between each impact. The impacts shall be on the same headgear at the same site for four different sites.

11.10.1 *Performance Requirements*—The maximum acceleration measured during any impact cannot exceed 50-G. In addition, the retention system must remain intact and the headgear must remain on the headform during impact testing.

11.10.2 *Test Details*—The impact testing shall be performed with the apparatus specified in Section 6.

11.10.2.1 Four impact sites will be defined by the test technician and should represent the sites on the frontal, occipital, and temporal areas (on both sides of the headform) with the greatest risk of failure. Each test shall be centered on or between the test lines.

11.10.2.2 Prior to each test, position and secure the headgear on the test headform as in accordance with Test Methods F1446.

11.10.2.3 The striker shall be rotated backwards, extending the spring, and released so that the striker impacts the headform. The impact shall achieve an impact velocity of 5 ± 0.3 m/s. Measure the resulting acceleration time history of the headform.

11.10.2.4 Reposition the headgear as necessary and repeat the impact within a 1-min time frame for a total of three strikes.

11.10.2.5 Repeat the testing for each environmental condition and each impact site, for a total of 36 impacts.

11.11 *High-Energy Striking Impact Test*—This test consists of one impact on the same headgear at four different sites. This test is possibly destructive, thus the headgear should be inspected for damage according to the manufacturer’s instructions for self-inspection. Damaged headgear shall not be used for any other tests.

11.11.1 *Performance Requirements*—The maximum acceleration measured during impact cannot exceed 150-G. In addition, the retention system must remain intact and the headgear must remain on the headform during impact testing.

11.11.2 *Test Details*—The impact testing shall be performed with the apparatus specified in Section 6.

11.11.2.1 Four impact sites will be defined by the test technician and should represent the sites on the frontal, occipital, and temporal areas (on both sides of the headform) with the greatest risk of failure. Each test shall be centered on or between the test lines.

11.11.2.2 Prior to each test, position and secure the headgear on the test headform as per Test Methods F1446.

11.11.2.3 The striker shall be rotated backwards, extending the spring, and released so that the striker impacts the headform. The impact shall achieve an impact velocity of 8 ± 0.5 m/s. Measure the resulting acceleration time history of the headform.

11.11.2.4 Repeat the testing for each environmental condition and each impact site, for a total of twelve impacts.

11.12 *High and Low Speed Errors*—If the impact speed for any impact test exceeds the specified maximum test speed, and the resultant headform acceleration is below the allowable G level for that nominal speed, the data for that test is considered acceptable for that nominal speed. If the impact speed for any impact test is below the specified minimum test speed, and the resultant headform acceleration exceeds the allowable G level

for that nominal speed, the data for that test is considered acceptable for that nominal speed.

12. Reporting

12.1 Reporting shall be in accordance with the requirements of Test Methods **F1446**.

13. Keywords

13.1 headgear; helmet(s); karate; martial arts; protective headgear; taekwondo; wushu

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