



Standard Test Methods for Equipment and Procedures Used in Evaluating the Performance Characteristics of Protective Headgear¹

This standard is issued under the fixed designation F1446; 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.

INTRODUCTION

These test methods specify equipment and procedures used for testing protective headgear. Individual ASTM performance standards (standard specifications) will use these procedures and equipment. Test conditions, pass-fail criteria, and other performance requirements will be specified in the individual performance standards, tailored to the needs of a particular activity (for example, bicycling, skateboarding, skiing, etc.).

These test methods were developed using resources in medical, scientific, mechanical engineering, human factors, and biomechanical fields. However, it is recognized that it is not possible to write a protective headgear performance standard that will result in headgear that can protect against injury or death in all accidents. It is also recognized that serious injury or death can result from both low- and high-energy impacts, even when protective headgear is worn.

These test methods incorporate aspects of other recognized headgear performance standards. They draw from work done by others where appropriate for these test methods. These standards are referenced within this standard test method. It should be noted that these test methods specify laboratory tests of completed headgear to measure its ability to reduce head acceleration during use and other selected parameters.

1. Scope

1.1 These test methods cover laboratory equipment, procedures, and basic requirements pertinent to testing protective headgear. Deviations or additions, or both, to these test methods will be specified, as required, in individual ASTM performance standards.

1.2 *Requirements*—The protective headgear is to be tested under specified environmental conditions for the following:

1.2.1 Impact attenuation (the limiting of head acceleration) of the protective headgear, and

1.2.2 Strength and stability of the retention system and its attachment to the protective headgear.

1.2.3 Special tests for particular protective headgear uses will be specified in the individual performance standards to be used in conjunction with these test methods.

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

1.4 *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.*

2. Referenced Documents

2.1 *ASTM Standard*.²

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

F2220 Specification for Headforms

2.2 *Federal Motor Vehicle Safety Standard*.³

218 S7.1.8 Motorcycle Helmets

¹ These test methods are under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and are the direct responsibility of Subcommittee F08.53 on Headgear and Helmets.

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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.

³ Available from National Highway Traffic Safety Administration (NHTSA), 400 7th St., NW, Washington, DC 20590.

TABLE 1 Table for Reference

Terms for Reference	Section	Items to Consider for Each Method
Chin Bar Rigidity	12.9	Types defined: impact velocity, nominal drop height
Conditioning Environments	10	Types defined: ambient, low temperature, high temperature, water immersion
Configuration	12.2	Standard requirement defined
Dynamic Retention Test	12.7.1	Types defined: mass of drop weight, drop height, extension pass/fail criteria
Headforms	7.1	Headforms to be used in all tests in Test Methods F1446
Impact Anvil	7.3.1	Types defined: flat, hemispherical, cylindrical, triangular hazard, curb-stone
Impact Attenuation Test	12.8	Types defined: number of impact sites, impact velocity and theoretical drop height, and maximum peak g value
Internal Projections	12.5.1	Standard requirement defined
Labeling	12.4	Standard labeling requirements defined
Materials	12.3	Standard requirement defined
Peripheral Vision	12.6.1	Standard method of pass/fail for horizontal vision defined
Reference Marking	12.1	Standard method of marking defined, define test lines
Reporting	13	Standard report format defined
Roll-Off Test (Helmet Stability Test)	12.7.2	Types defined: mass of drop weight, drop height, standard method of pass/fail defined
Samples for Testing	8	Criteria to be considered in selecting number of samples
Selecting the Correct Headform	7.1.1	Method defined
Test Schedule	11	Standard test schedule defined

2.3 SAE Standard:⁴

SAE J211 Recommended Practice for Instrumentation for Impact Tests—Requirements for Channel Class 1000

3. Reference Table

3.1 For references to these test methods, the standard terms for reference are listed in bold type in Table 1 with the items to consider for each method. For conditions and anvils, use the standard term listed in Table 1. Referring to section numbers in these test methods is not the recommended method for reference.

4. Terminology

4.1 Definitions:

4.1.1 *basic plane, n*—an anatomical plane (Frankfort Horizontal Plane) that includes the superior rim of the external auditory meatus (upper edge of the external openings of the ear) and the inferior margin of the orbit (the lowest point of the floor of the eye socket).

4.1.1.1 *Discussion*—The headforms are marked with the basic plane (see Figs. 1 and 2).

4.1.2 *coronal plane, n*—an anatomical plane perpendicular to both the basic and midsagittal planes and passing through the superior rims of the right and left auditory meatuses.

4.1.2.1 *Discussion*—The transverse plane corresponds to the coronal plane (see Figs. 1 and 2).

4.1.3 *field of vision, n*—angle of vision as measured on the reference headform (upward, downward, and peripheral).

4.1.4 *headform size selection, n*—helmets shall be tested on the appropriate test headform size(s), as determined by the testing laboratory. Helmets shall be tested on the largest and smallest size test headforms on which they fit. When multiple headform sizes are required, each test set of helmets will include at least one extent of coverage, vision test, retention

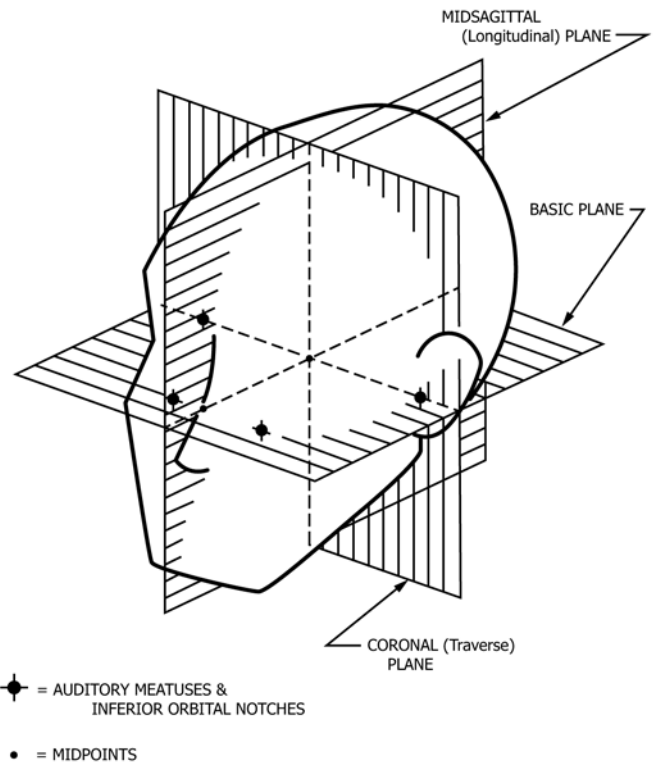


FIG. 1 Anatomical Planes

test, and impact test on each specified headform size. “Fit” means that it is not physically difficult to put the helmet on the larger headform and that the helmet’s comfort or fit-foam is partially compressed on the smaller headform. For helmets equipped with adjustable fit systems, the headform sizes are determined by the fit at the smallest and largest limits of the adjustment.

4.1.5 *helmet, n*—a protective device worn on the head in an effort to reduce or minimize injury to that portion of the head that is within an area above the test line (as defined in the individual performance standards).

⁴ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

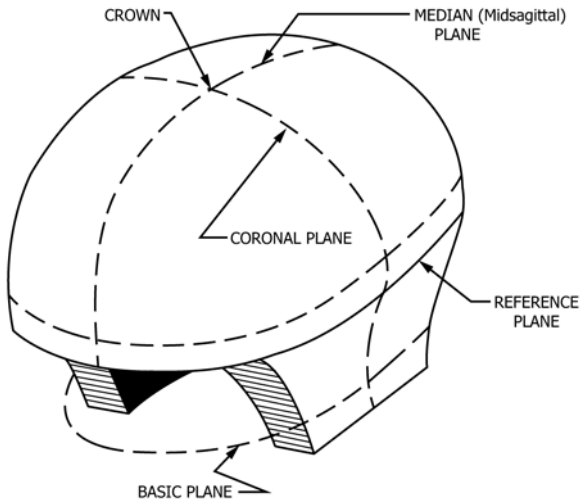


FIG. 2 Test Headform—Basic, Reference, and Midsagittal Planes

4.1.5.1 *Discussion*—A helmet of a given size is further defined as a combination of structure(s) making up the primary energy-absorption structure covering part of the wearer’s head. Each structural size is made up of a specific size energy-absorbing structure that may include an outer or inner hard shell, or both.

4.1.6 *helmet position index (HPI), n*—the vertical distance from the brow of the helmet to the basic plane, when the helmet is placed on a reference headform. The manufacturer shall specify the size of the headform and the vertical distance.

4.1.7 *helmet type, n*—a category of helmets which do not differ in basic construction components such as shell, energy-absorbing layer(s), retention system, or any other component that is tested.

4.1.7.1 *Discussion*—Difference in size alone does not constitute a different helmet type.

4.1.8 *midsagittal plane, n*—an anatomical plane perpendicular to the basic plane and containing the midpoint of the line connecting the notches of the right and left inferior orbital ridges and the midpoint of the line connecting the superior rims of the right and left external auditory meatus.

4.1.8.1 *Discussion*—The longitudinal plane corresponds to the midsagittal plane (see Figs. 1 and 2).

4.1.9 *modular elastomer programmer (MEP), n*—a cylindrical-shaped pad used as the impact surface for the spherical impactor.

4.1.10 *preload ballast, n*—a “bean-bag” filled with shot placed on the helmet to secure its position on the headform. The weight of the preload ballast shall be 5.0 ± 0.1 kg unless otherwise specified in the individual performance specification.

4.1.11 *projection, n*—any part of a helmet, internal or external, that extends beyond the faired surface and is likely to cause injury.

4.1.12 *protective headgear, n*—see **helmet**.

4.1.13 *reference headforms, n*—measuring headforms contoured in the same configuration as the test headforms sizes A, C, E, J, M, and O, as defined in Specification F2220.

4.1.13.1 *Discussion*—The reference headforms should include surface markings corresponding to the basic, coronal, midsagittal, and reference planes (see Figs. 1 and 2).

4.1.14 *reference plane, n*—a plane marked on the headforms at a specified distance above and parallel to the basic plane (see Fig. 3).

4.1.15 *retention system, n*—the complete assembly that secures the helmet, in a stable position, on the wearer’s head.

4.1.16 *shield, n*—optional equipment used in place of goggles to protect the eyes.

4.1.17 *size, n*—a combination of structure(s) making up the primary energy-absorption structure covering part of the wearer’s head.

4.1.17.1 *Discussion*—Each structural size is made up of a specific size energy-absorbing structure that may include an outer or inner hard shell, or both.

4.1.18 *spherical impactor, n*—a device made of low resonance material (for example, magnesium), aluminum alloy, or stainless steel that couples mechanically with the ball arm connector of the drop assembly in place of the impact test headform. When mounted, the device presents a spherically machined impact face with a radius of 73 mm on its bottom surface. All radii from the center of the curvature of the impact face to its outer edge shall from angles of no less than 40° with the downward vertical axis. The center of curvature shall be within 5 mm of the vertical axis drawn through the center of the ball arm. The mass and center of gravity of the drop assembly including the impactor shall meet the same requirements as those specified for the drop assembly incorporated with the test headforms (see 7.3.2), using the 5 ± 0.1 kg drop mass.

4.1.19 *test area, n*—the area of the helmet on or above a specified test line, subject to impact or penetration testing.

4.1.20 *test headforms, n*—test headforms that correspond to the physical dimensions defined in Specification F2220 as sizes A, C, E, J, M, and O. The weight of the drop assembly including the headform shall be 5.0 ± 0.10 kg unless a variable mass drop assembly configuration is specified. If a variable mass configuration is specified, then the weight of the drop assembly shall comply with the weight specifications presented in Table 2. The test headforms may include surface markings corresponding to the basic, coronal, midsagittal, and reference planes (see Fig. 2).

4.1.21 *test line, n*—a line drawn on the helmet as specified in the individual performance standards.

4.1.22 *visor (peak), n*—optional equipment for protection against sun or glare, and sometimes used as a rock or dirt deflector.

5. Significance and Use

5.1 The purpose of these test methods is to provide reliable and repeatable tests for the evaluation of various types of protective headgear. Use of these test methods in conjunction with the specific individual performance standards is intended to reduce the likelihood of serious injury and death resulting from impacts to the head sustained by individuals participating