



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

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INTRODUCTION

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

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. It is also recognized that protective headgear must be acceptable to the user and to the regulating associations or agencies requiring their use. Acknowledging these limitations, these test methods were developed using resources in medical, scientific, mechanical engineering, human factors, and biomechanical fields.

These test methods incorporate many aspects of other recognized headgear performance standards. They draw from work done by others where appropriate for these test methods. These standards may be referenced. It should be noted that this standard specifies a laboratory test of completed headgear to measure its ability to reduce head acceleration when impacting various shaped objects. It is known that headgear that performs well under these test methods will mitigate head injury in actual use (within its design limits).

1. Scope

1.1 These test methods describe 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 performance standard specifications.

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.

1.2.2 Strength of the retention system and its attachment.

1.2.3 Special tests for particular protective headgear uses will be specified in the individual standard specifications 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 These test methods incorporate or reference sections

of standards from the following U.S. and foreign standards organizations: DOT, ASTM, ANSI, Snell, E22, BSI, ASA, SP1, and CSA.

2.2 *ISO/DIS Standard*.²

6220-1983 Headforms for Use in the Testing of Protective Helmets

2.3 *Federal Motor Vehicle Safety Standard*.³

218 S7.1.8 Motorcycle Helmets

2.4 *SAE Standard*.⁴

J211 Recommended Practice for Instrumentation for Impact Tests—Requirements for Channel Class 1000, June 1980.

3. Terminology

3.1 *Descriptions of Terms Specific to This Standard:*

3.1.1 *basic plane*—an anatomical plane that includes the superior rims of the auditory meatuses (the upper edges of the external openings of the ears) and the notches of the interior orbital ridges (the bottom edges of the eye sockets). The ISO headforms are marked with a plane corresponding

² Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

³ Available from Department of Transportation, National Highway Traffic Safety Administration, Office of Vehicle Safety Standards, 400 7th St. S. W., Washington, DC 20590.

⁴ Available from Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.

¹ These test methods are under the jurisdiction of ASTM Committee F-8 on Sports Equipment and Facilities and are the direct responsibility of Subcommittee F08.53 on Headgear.

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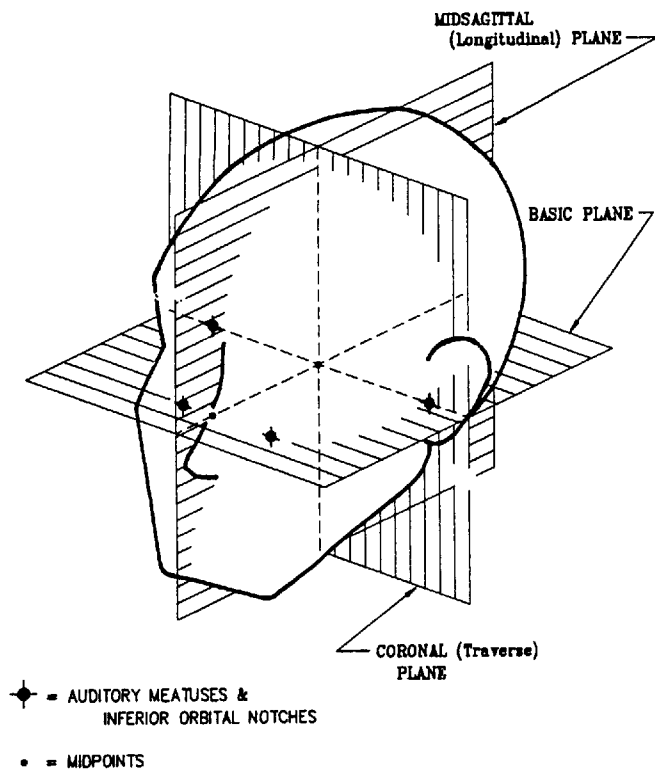


FIG. 1 Anatomical Planes

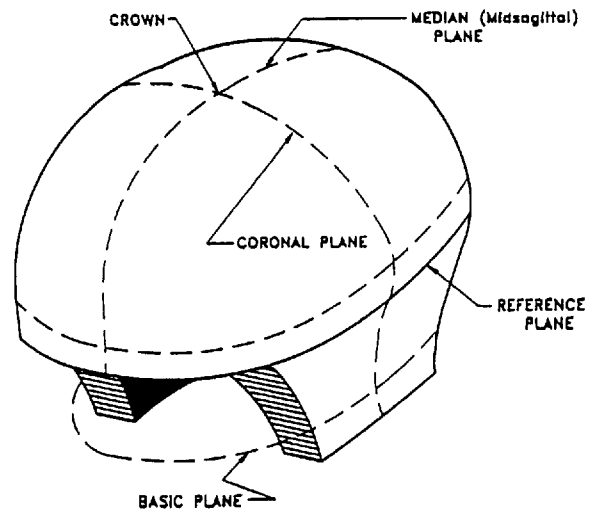


FIG. 2 ISO Headform—Basic, Reference, and Median Planes

to this basic plane (see Figs. 1 and 2).

3.1.2 *coronal plane*—an anatomical plane perpendicular to both the basic and midsagittal planes and containing the midpoint of a line connecting the superior rims of the right and left auditory meatuses. The ISO headforms are marked with a traverse plane corresponding to this coronal plane (see Figs. 1 and 2).

3.1.3 *extent of coverage*—the area of the head covered by the protective headgear being tested, as measured on a reference headform.⁵

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

3.1.5 *full-coverage (open-face) helmet*—a helmet that covers the entire area of the head except the face.

3.1.6 *full-face helmet*—a helmet that covers the entire area of the head and face except an eye opening.

3.1.7 *headform size selection*—helmets shall be tested on the appropriate test headform, or two sizes of the test headforms, as determined by the testing laboratory. Helmets shall be tested on the largest and smallest size test headforms on which they fit. If a smaller size of the same model fits the smaller headform, the larger helmet will be tested on the larger headform only. When two headform sizes are required, each test set of four helmets will include at least one peripheral test, impact test, and dynamic retention test on each specified headform size.

3.1.7.1 *Discussion*—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.

3.1.8 *headgear*—see *helmet*.

3.1.9 *helmet*—a protective device worn on the head in an effort to reduce or minimize injury to that portion of the head which is within a specified area of coverage (as defined in the individual performance specification), while participating in various activities where risk of head injury is recognized.

3.1.10 *helmet positioning index (HPI)*—the vertical distance from the brow of the helmet to the basic plane, when placed on a reference headform. The size of headform and vertical distance shall be specified by the manufacturer.

3.1.11 *modular elastomer programmer (MEP)*⁵—a cylindrical shaped pad used as the impact surface for the spherical impactor. The MEP is 6.0 in. (152 mm) in diameter, and 1.0 in. (25 mm) thick. It is affixed to the top surface of a flat, 0.25-in. (6.35-mm) thick aluminum plate. The durometer of the MEP is 60 ± 2 Shore A.

3.1.12 *midsagittal plane*—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 auditory meatus. The ISO headforms are marked with a longitudinal plane corresponding to this midsagittal plane (see Figs. 1 and 2).

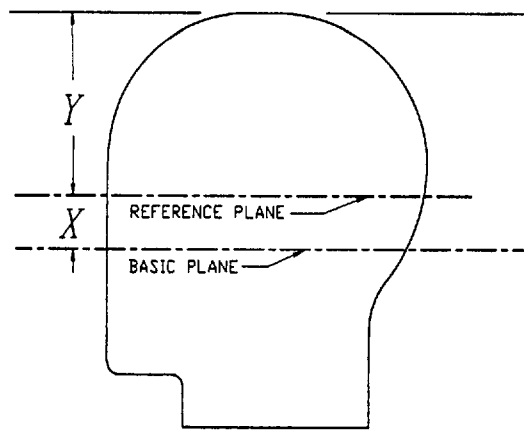
3.1.13 *preload ballast*—a “bean-bag” filled with lead shot placed on the helmet to secure its position on the headform. The weight of the preload ballast is specified in the individual standard specification.

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

3.1.15 *reference headforms*⁵—measuring headforms contoured in the same configuration as the test headforms A, E, J, M, or O defined in ISO/DIS 6220-1983. The reference headforms shall include surface markings corresponding to the basic, coronal, midsagittal, and reference planes (see Figs. 1 and 2).

3.1.16 *reference plane*—a plane marked on the ISO

⁵ Available from Research & Testing Company, 1415 Park Ave., Hoboken, NJ 07030.



HEADFORM	SIZE	X	Y
A	50	24	90
E	54	26	96
J	57	27.5	102.5
M	60	29	107

FIG. 3 Location of Reference Line

headforms at a specified distance above and parallel to the basic plane (see Fig. 3).

3.1.17 *retention system*—the complete assembly that secures the helmet in a stable position on the wearer's head.

3.1.18 *shield*—optional equipment used in the place of goggles to protect the eyes.

3.1.19 *spherical impactor*⁵—a 5.75-in. (146-mm) diameter aluminum sphere, weighing 4005 ± 5 g, specifically machined for mounting onto the ball-arm connector of the drop-test assembly. The impactor is used for systems check of the electronic equipment (see Section 17).

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

3.1.21 *test headforms*—test headforms defined in ISO/DIS 6220-1983 as Size A, E, J, M, and O. The test headforms shall include surface markings corresponding to the basic, coronal, midsagittal, and reference planes (see Fig. 2).

3.1.22 *test line*—a line drawn on the helmet as specified in the individual standard specification.

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

4. Significance and Use

4.1 The purpose of these test methods is to provide reliable and repeatable test methods for the evaluation of various types of protective headgear. Use of these test methods in conjunction with the specific individualized standard specifications should reduce the likelihood of serious injury and death resulting from impacts to the head sustained by individuals participating in sports, recreation, and other leisure activities in which protective headgear is worn.

5. Certification

5.1 These test methods permit self-certification. It is

recommended that each manufacturer employ an independent test laboratory at least annually to test each model and size of protective headgear.

6. Test Headforms

6.1 *General*—The surface of a headform above the reference plane is defined by ISO/DIS 6220-1983. The profile below the reference plane and the geometry of the mounting system is defined in ISO/DIS 6220-1983. Construction and materials are also specified in ISO/DIS 6220-1983. This procedure specifies four sizes of headforms—A, E, J, M, and O—for performing reference measurements, impact, dynamic retention, and penetration tests.

6.2 Since 6.1 was adopted, ISO Magnesium K1A headforms have become available as has an additional head Size O. Effective January 1, 1995, the magnesium headforms, including Size O, shall be used for testing. Until January 1, 1995, testing shall be done on existing composite headforms (Sizes A, E, J, and M).

7. Construction

7.1 *General*—The helmet shall be constructed to reduce the acceleration of the wearer's head and to remain on the wearer's head during impact. Optional devices fitted to the helmet shall be designed so that they are unlikely to cause injury in an accident.

7.2 *Projections*—Any internal rigid projections that can contact the wearer's head during impact shall be protected by some means of cushioning or force spreading.

7.3 *Retention System*—The retention system shall be designed and constructed to meet the requirements of Section 15 and any other requirements called for in the individual standard specification.

8. Materials

8.1 Materials used in the helmet shall be durable and resistant to exposure to sun, rain, cold, dust, vibration, perspiration, and products likely to be applied to the skin or hair. Materials known to cause skin irritation or disease cannot be used. Lining materials, if used, may be detachable for washing. If hydrocarbons, cleaning fluids, paints, or transfers and other additions will affect the helmet adversely, a warning shall be provided.

9. Labeling

9.1 Each helmet shall be marked in such a way that the following information is easily legible by the user and is likely to remain legible throughout the life of the helmet:

9.1.1 Model designation.

9.1.2 Name of manufacturer.

9.1.3 Month and year of manufacture.

9.1.4 A label that warns the user that no helmet can protect against all possible impacts, and that for maximum protection the helmet must be fitted and attached properly to the wearer's head in accordance with the manufacturer's fitting instructions.

9.1.5 A label that warns the user that the helmet may, after receiving an impact, be damaged to the point that it is no longer adequate to protect the head against further impacts, and that this damage may not be visible to the user. This label should also state that a helmet that has sustained