Designation: F 1045 – 9904

An American National Standard

Standard Performance Specification for Ice Hockey Helmets[1]

This standard is issued under the fixed designation F 1045; 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

Ice hockey is a contact sport with intrinsic hazards. The use of protective equipment will not eliminate all injuries but should substantially reduce the severity and frequency of injury. Participation in the sport of ice hockey by a player implies acceptance of some risk of injury. The goal is to minimize this risk.

This performance specification for head protective equipment has been prepared after consideration of head protection relative to the following principle risks: high-mass, low-velocity impact (various playing situations), and fit. This performance specification may be modified as other risks are identified.

Performance requirements were determined after consideration of state-of-the-art of helmet design and manufacture and the demands of the sport.

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[1] This performance specification is under the jurisdiction of ASTM Committee ~~F-8~~ F08 on Sports Equipment, and Facilities and is the direct responsibility of Subcommittee F08.15 on Ice Hockey.

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1. Scope

1.1 This performance specification[2] ~~sets~~ covers performance requirements for ice hockey helmets.

1.2 The intent of this performance specification is to reduce the risk of injury to the head without compromising the form and appeal of the game.

1.3 This performance specification covers: (~~1~~)*1)* performance tests for shock absorption properties of the complete helmet and strength and elongation of the chin strap and its attachment; and (~~2~~)*2)* requirements for ~~dimension~~ area of ~~the ear aperture.~~ coverage and penetration.

1.4 The values as stated in inch-pound units are to be regarded as the standard. The values in parentheses are given for information only.

1.5 The following precautionary caveat pertains only to the test methods portion, Section 12, of this performance specification: *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 *ASTM Standards:* [3]

F 513 Safety Specification for Eye and Face Protective Equipment for Hockey Players

F 2220 Specification for Headforms

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *retention system*:

3.1.1.1 *chin strap*—the chin strap, including a cup that covers the chin~~,~~ (see Fig. 1), is affixed to both sides of the helmet and secures the helmet to the head when a Type II full face protector is not worn with the helmet.

3.1.1.2 *neck strap*—the neck strap that secures the helmet to the head is affixed on both sides of the helmet and passes under the lower jaw in close proximity to the jaw and the neck. Where the helmet is worn with a Type II full face protector, the neck strap serves as the attachment of the helmet to the head.

NOTE 1—For a description of the Type II face protector, see the Types of Protectors Section in Safety Specification F 513.

3.1.2 *crown*—a point in the median plane that is equal chord lengths from the anterior and posterior intersections of the median and reference planes.

3.1.3 *drop height*—the vertical distance between the lowest point (impact point) of the elevated helmet and the apex of the impact surface.

3.1.4 *g* —the dimensionless ratio of the acceleration of the headform during impact to the acceleration due to gravity.

3.1.4.1 g_{max}—the maximum value of *g* encountered during impact.

3.1.5 *helmet*—the complete product, including the shell, liner, ~~and~~ chin strap, including the cup or neck strap, and associated attachment hardware, assembled with components supplied by the manufacturer. The helmet is intended to protect the wearer's head while participating in ice hockey.

3.1.6 *helmet position index (HPI)*—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.

3.1.7 *liner*—the material inside the shell for the purpose of shock absorption or comfortable fit, or both.

~~3.1.7 *reference index*—the manufacturer's recommended dimension from the lowest point of the helmet face opening to the basic plane of a reference headform, with both points located on the median plane of the helmet.~~

3.1.8 ~~*r*~~*Reference ~~p~~ Planes* :

3.1.8.1 *basic plane*—an anatomical plane that ~~is located at~~ includes the ~~level~~ superior rim of the external auditory meatus (upper edge of the external openings of the ear~~s~~) and the inferior margin of the orbit (the lowest point of the floor of the eye socket). The headforms are marked with the basic plane (see Figs. 2 and 3).

[2] This performance specification is subject to revision as indicated by subsequent injury statistics and subject to review at least every five years.

[3] 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,~~ ~~Vol 15.07~~*. Standards volume information, refer to the standard's Document Summary page on the ASTM website.

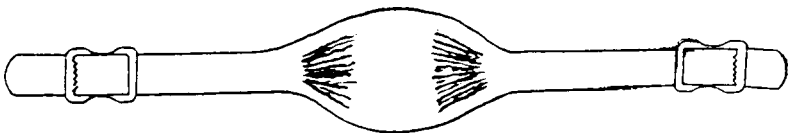


FIG. 1 Chin Strap (Includes a Chin Cup)

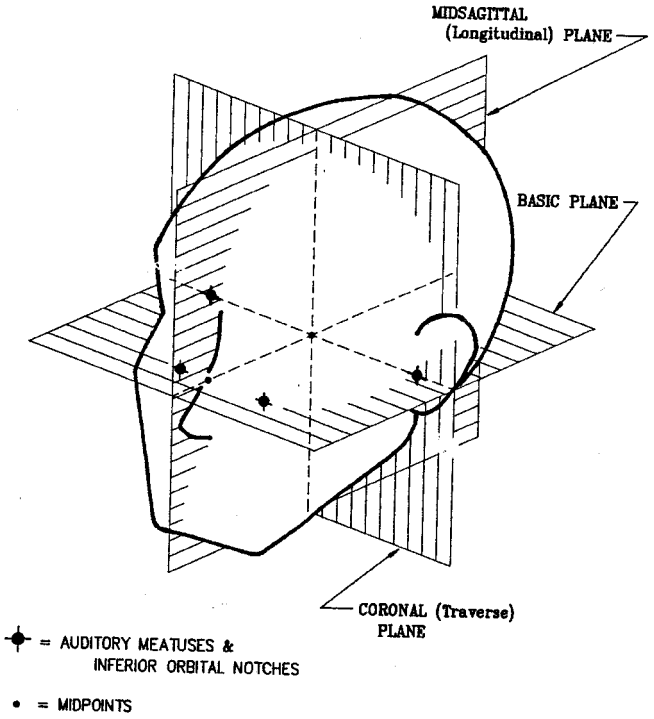


FIG. 2 Anatomical Planes

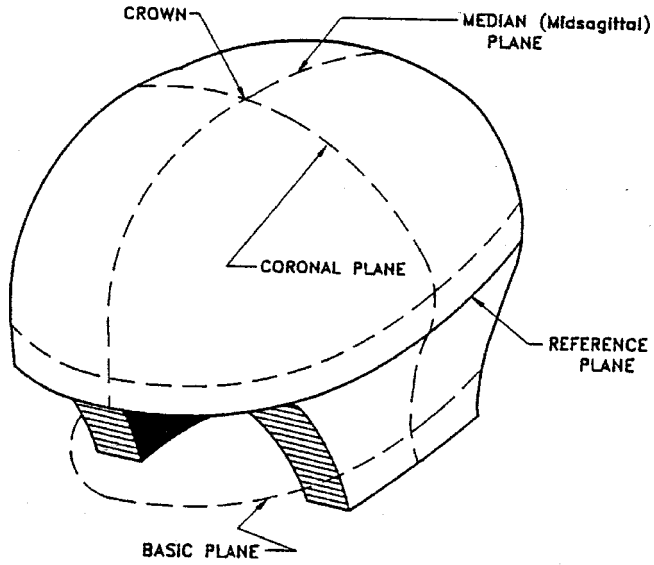


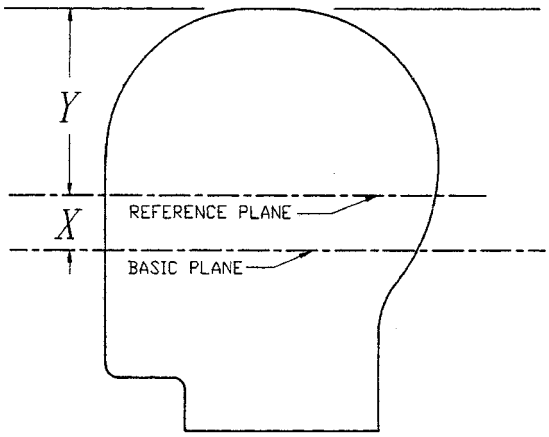
FIG. 3 Test Headform—Basic, Reference, and Misadgittal Planes

3.1.8.2 *coronal plane*—a vertical—an anatomical plane that is perpendicular to both the median basic and the reference midsagittal planes and passes passing through the crown superior rims of the right and left auditory meatuses. The transverse plane corresponds to the coronal plane (see Figs. 2 and 3).

3.1.8.3 *median**midsagittal plane*—a vertical—an anatomical plane that passes through the headform from front perpendicular to the basick plane and d containing the midpoint of thes 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 (. The longitudinal plane corresponds to the mid-saggittal plane (see Figs. 2 and 3).

3.1.8.4 *reference plane*—a plane that is located 2.36 in. (60 mm) marked on the headforms at a specified distance above and parallel to the basic plane (Size C headform). (see Fig. 4).

3.1.9 *shell*—the rigid outer material that gives the helmet its form.



HEADFORM	SIZE, mm	X, mm	Y, mm
A	500	24	90
E	540	26	96
J	570	27.5	102.5
M	600	29	107
O	620	30	110

FIG. 4 Location of Reference Line

4. General Requirements

4.1 *Materials*:

4.1.1 All materials used in the fabrication of helmets shall be known to be suitable for the intended application. For example, shell materials shall remain strong, semirigid, and firm, and shall not permanently distort during an exposure of at least 4 h to any temperature in the range from ~~0 ± 3.6~~ -27 to ~~122 ± 3.6°F (−18 ± 2 to 50 ± 2°C),~~ 32°C, nor shall the material be significantly affected by exposure to ultraviolet radiation, water, dirt, or vibration. All materials shall be rot-resistant. In addition, paints, glues, and finishes used in manufacture shall be compatible with the helmet shell and shock absorption system materials.

4.1.2 Materials coming into contact with the wearer's head shall not be the type known to cause skin irritation or disease, and shall not undergo significant loss of strength, flexibility, or other physical change as a result of contact with perspiration, oil, or grease from the wearer's hair.

4.1.3 Any material used in the construction of helmets shall not be adversely affected by ordinary household soap and water, mild household detergent, or cleaners recommended by the manufacturer.

4.2 *Helmet Assembly*:

4.2.1 Any optional devices fitted to the helmet shall be so designed that they are unlikely to cause any injury to the wearer or other participants during contact.

4.2.2 All edges shall be smooth and rounded and there shall be no rigid projections on the inside of the helmet that could come in contact with the wearer's head.

4.2.3 All external projections shall be smooth and adequately faired to other surfaces. Split or bifurcated rivets shall not be used.

4.3 ~~*Extent and Form*~~*Types of Protective Material*—All parts of Protectors:

4.3.1 *Type 1* —Head protectors that meet requirements for the ~~wearer's head covered by the~~ area of ~~the shell shall be protected at least to the minimum impact~~ coverage mentioned in 4.5.1.

4.3.2 *Type 2*—Head protectors that meet requirements ~~of 13.1 and 13.2. The extent of protection shall include at least all of~~ for the ~~hatched~~ area ~~shown~~ of coverage mentioned in ~~Fig. 4. The hatched~~ 4.5.2.

4.4 *Impact Test Protected Area*—The area ~~selected shall correspond with~~ above the ~~headform size with which the helmet is to be tested.~~

~~4.4 Except for ear apertures, the area around the ear~~ test line (see 12.2.5) shall be ~~completely covered by~~ considered the ~~helmet shell. No ear aperture shall have any dimension exceeding 1.5 in. (38 mm). The ear aperture shall be entirely surrounded by the helmet. This part of the helmet shall also have protective padding. The distance from the edge of the ear aperture to any edge of the helmet shall not be less than 0.8 in. (20 mm).~~ impact test protected area.

4.5 *Area of Coverage*— Area of coverage measurements shall be made with the protector mounted in accordance with the protector manufacturer's instructions on the headforms that correspond to the physical dimensions defined in Specification F 2220 as sizes A, E, J, or M. If a helmet size range, as identified by the manufacturer's instructions, is capable of fitting two different headforms, the larger headform shall be used.

4.5.1 *Type 1* —The extent of coverage shall include at least all of the area above line BCDEF as shown in Fig. 5. This area shall correspond with the headform size with which the protector is to be tested. No ear aperture shall have any dimension exceeding 38 mm (1.5 in.). The ear aperture shall be completely surrounded by the helmet. The distance from any edge of an ear aperture to any edge of the helmet shall not be less than 20 mm (0.8 in.).

4.5.2 *Type 2*—The extent of coverage shall include at least all of the area above line BCDGHEF as shown in Fig. 6. This area shall correspond with the headform size with which the protector is to be tested.

4.6 *Attachments*—The components of the fasteners for securing attachments to the shell shall be so attached that the degree of protection afforded the wearer by the protective padding or cushioning material of the helmet is not thereby reduced.

~~4.5.1 When a face protector is to be attached to the helmet, the manufacturer of the face protector shall supply a template designating the position on the helmet where holes should be bored for the attachment screws or bolts.~~

~~4.6~~

4.7 *Size of Helmets*—Helmets shall be sized in accordance with Table 1.

4.~~7~~8 *Chin Strap or Neck Strap*:

4.~~7~~8.1 The chin strap, including the cup, or the neck strap, shall be attached to the helmet so that the helmet remains in its normal position on the player's head during play and impact conditions.

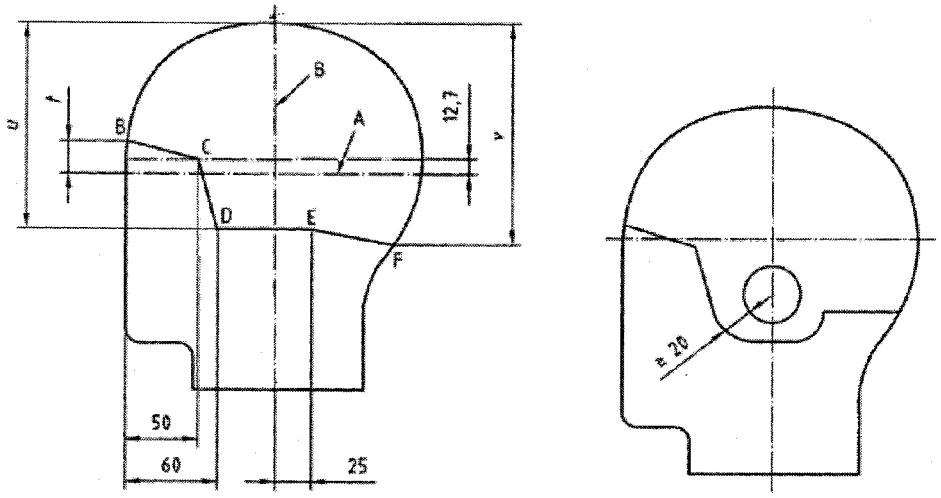
4.~~7~~8.2 The chin strap or the neck strap used in combination with the face protector shall satisfy the requirements in 3.1.1.

4.~~7~~8.3 The minimum width of the chin strap exclusive of the cup shall be 0.5 in. (13 mm).

5. Performance Requirements

5.1 *General*—Helmets shall be capable of meeting the requirements in this performance specification throughout their full range of adjustment. They shall be capable of meeting the requirements in Sections 11 and 12 at any temperature between ~~0 and 122°F (−18 and 50°C).~~ -27 to 32°C.

5.2 *Shock Absorption*—The helmet is mounted on a headform that is oriented in different positions and dropped at a specific velocity onto an impact surface. A linear accelerometer mounted at the center of gravity of the headform monitors the acceleration and the time history of impact that are recorded with appropriate instrumentation. Maximum acceleration and time duration data obtained by the specified procedures are intended to determine the shock absorption characteristics of the helmet.



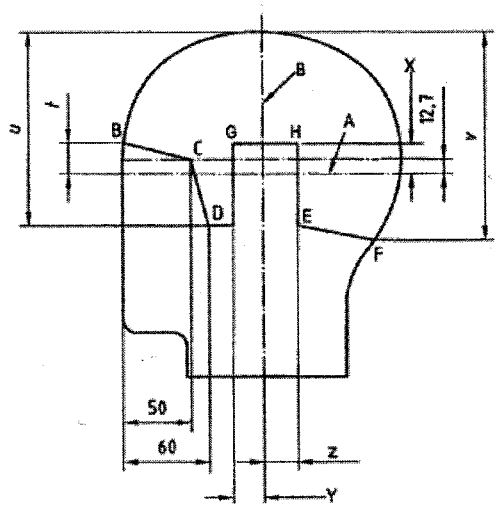
a) Minimum area b) Extended area

Headform code letter	Size: inside circumference of helmet mm	Distance mm		
		t	u	v
A	500	24	123	132
E	540	25	128	140
J	570	27	130	145
M	600	28	132	151

NOTE—A-Reference plane, B-Coronal plane

FIG. 5 Type 1–Area of Coverage

Dinensions in millimetres



C) Minimum area

Headform code letter	Size: inside circumference of helmet mm	Distance mm					
		t	u	v	x	y	z
A	500	24	123	132	—	—	—
E	540	25	128	140	18	30	50
J	570	27	130	145	20	40	55
M	600	28	132	151	20	45	55

NOTE 1—A-Reference plane, B-Coronal plane
NOTE 2—Dimension Y and Z are taken and must cover between the reference and the basic plane.
NOTE 3—A-Headform does not have Type 2 coverage.

FIG. 6 Type 2–Area of Coverage

TABLE 1 Hat Sizes and Head Fittings

NOTE 1—These are U.S. and Canadian hat sizes.

Hat Size	Circumference of Head	
	in.	mm
6	19	483
6⅛	19⅜	492
6¼	19¾	502
6⅜	20⅛	511
6½	20½	521
6⅝	20⅞	530
6¾	21¼	540
6⅞	21⅝	550
7	22	559
7⅛	22⅜	568
7¼	22¾	578
7⅜	23⅛	587
7½	23½	597
7⅝	23⅞	606
7¾	24¼	616
7⅞	24⅝	625
8	25	635

5.3 *Chin Strap*—When tested in accordance with 12.7, the force to separate the strap shall be not less than ~~11 lbf (50 N)~~ 50 N (11 lbf) nor more than ~~124 lbf (500 N)~~ 500 N (124 lbf) and the maximum displacement of the strap shall not exceed ~~1 in. (25 mm)~~ 25 mm (1 in.) at a load of ~~24 lbf (109 N).~~ 109 N (24 lbf). The requirements of 12.7 shall be met at ~~73°F (23°C).~~ ambient conditions.

5.4 *Penetration Resistance Test Requirements*—It shall not be possible to touch the test headform with the curved end of the test stick blade within the required area of coverage, excluding the ear opening.

6. Apparatus

6.1 *Shock Absorption Test:* The apparatus for the shock absorption test shall consist of the following:

6.1.1 *Guide Assembly*—The headform shall be attached to the free fall drop assembly carriage by an adjustable mounting that will allow impacts to be delivered to any prescribed point on the helmet (see Fig. ~~5~~ 7). The carriage shall be free to slide on vertical guides. If wires are used they must be placed under at least 190 lbf (845 N) tension (see 12.4 for guide assembly specifications and allowable weight of drop assembly).

6.1.2 *Recording Equipment*—The recording equipment shall meet the following criteria:

6.1.2.1 *Acceleration Transducer*—The linear accelerometer is mounted at the center of gravity of the combined test headform and carriage assembly with the sensitive axis aligned to within 5° of the vertical when the helmet and headform are in the impact position. This transducer shall be capable of withstanding a shock of 1000 *g* without damage and shall have a frequency response (variation ±1.5 %) over the range from 5 to 900 Hz.

6.1.2.2 *System Accuracy*—The impact recording system shall be capable of measuring shocks of up to 500 *g* peak acceleration with an accuracy of ±5 %.

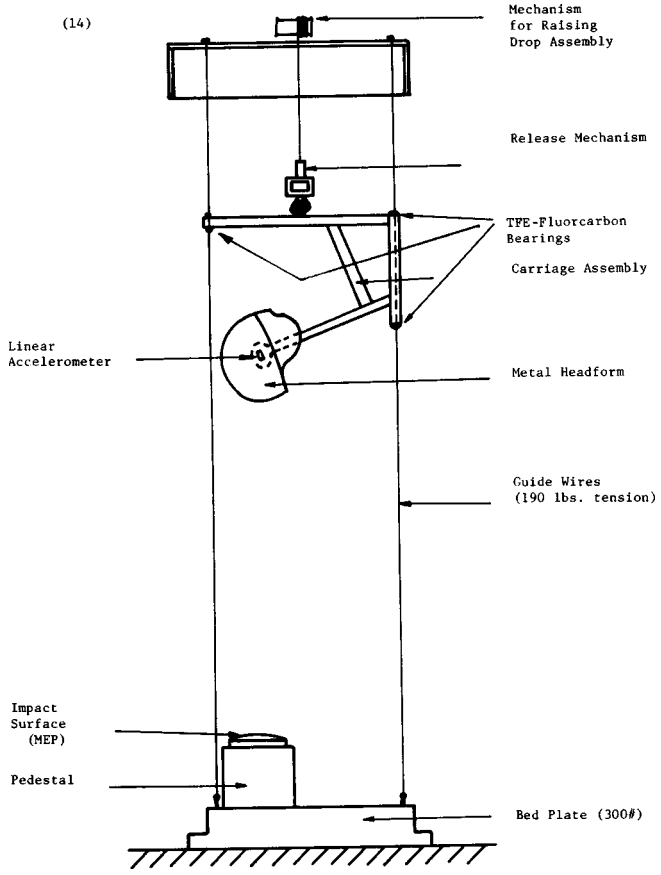
6.1.2.3 *Impact Recording*—The impact shall be recorded on single- or dual-trace storage oscilloscope with 0.1-mV to 20-V deflection factor, 1 to 5-ms sweep speed-division, and 500-kHz bandwidth.[4]

6.1.2.4 ~~*Headform*—Standard metal~~Test Headforms—Test headforms that correspond to the physical dimensions defined in ~~Table 2~~ Specification F 2220 as sizes A, E, J, and M. The weight of the drop assembly, including the headform, shall be 5.0 kg unless otherwise specified in the individual performance specifications. The test headforms shall include surface markings corresponding to the basic, coronal, midsagittal, and reference planes (see Figs. 2 and 3).

6.1.2.5 *Reference Headforms*—Measuring headforms contoured in the same configuration as the test headforms sizes A, E, J, and M, as defined in Specification F 2220. The reference headforms shall include surface markings corresponding to the basic, coronal, midsagittal, and reference planes (see Figs. 2-4).

6.1.2.6 *Impact Surface*—The impact surface shall be a *flat* modular elastomer programmer (MEP) 6 in. (152 mm) in diameter and 1 in. (25 mm) in thickness which is firmly fixed to the top surface of a flat anvil. The MEP required is a 60 ± 5 Durometer

[4] Equivalent instrumentation capable of recording, displaying, and providing a permanent record of the generated accelerometer shock signal will meet this requirement.



NOTE 1—Rail-guided drop assemblies are also permissible.

FIG. ~~5~~ 7 Schematic of Typical Drop Assembly

Shore A Hardness impact surface. The base shall consist of a rigid slab weighing at least 300 lb (136 kg). The top surface of this base may be used as the flat metal anvil if it is faced with a steel plate with minimum thickness of 1 in. (25 mm) and minimum top surface area of 1 ft ^{2} (0.09 m^2). If a detachable flat metal anvil is used it must have a top surface area of at least 45 in.^{2} (290 cm ^{2}). The MEP is mounted on an aluminum plate with a minimum thickness of 0.220 in. (6 mm) after grinding.

7. Sampling

7.1 Submit at least four specimen helmets for each size to be tested under the various conditions as described in Section 11~~,~~. One ambient conditioned sample sh~~r~~all be used for ~~conditioning~~ both impact testing and ~~one for~~ the ~~chin strap.~~ penetration and retention test.

8. Test Specimen

8.1 Test helmets without accessories.

9. Preparation of Apparatus

9.1 Turn on all electronic equipment and allow to warm-up for at least 30 min or as recommended by the manufacturer, whichever time is greater, prior to any testing.

10. Calibration and Standardization

~~10.1 Check~~

10.1 *Calibration*— Instrumentation used in the testing shall be calibrated to manufacturer's specifications on a periodic basis. The duration of the calibration cycle shall be no more than one year.

10.2 *Impact Attenuation Instrument System Check*—The system instrumentation shall be checked before and after each series of tests by ~~impacting~~ dropping the ~~Size C headform (see Table 2) on~~ spherical impactor onto the ~~crown without a helmet~~ MEP pad at an impact velocity of ~~14 ft/s (4.25 m/s) + 0/−2 %. This should produce a~~ g_{max} 5.44 m/s (±2 %). Impact velocity shall be measured during the last 40 mm of ~~375 ± 25 *g* with a time duration~~ free fall for each test. The weight of ~~3.1~~ the drop assembly (which is the combined weight of the instrumented spherical impactor and supporting assembly) for the drop test shall be 5 ± 0.~~3~~1 kg. Three such impacts, at intervals of 75 + 15 s, shall be performed before and after each series of tests. The peak acceleration obtained during impact shall be 389 ± 8 g. If the ~~50-*g* line.~~

~~10.2 Record at least three~~ average peak acceleration obtained in the post test impacts ~~as~~ differs by more than 5 % from the average peak acceleration obtained in ~~12.2~~ the pretest impacts, the following checks shall be made. Checks of the mechanical condition of the drop system and ~~12.3 immediately prior to~~ checks of the calibration of the instruments and ~~following each~~ transducers are required and all data obtained during that series of helmet tests ~~and record on the report form.~~ should be discarded.

10.3 If the maximum *g* or acceleration time history, or both, are not within the tolerance limits prior to test, adjust or repair the system as necessary.

10.4 If the means of the three peak acceleration values following the test series differ by more than 40 *g* from the mean of the initial calibration series, discard the entire test series.

11. Conditioning

11.1 Prior to testing, condition each helmet in one of the following ways:

11.1.1 *Ambient Temperature*—~~Condition one helmet for a period~~—The ambient condition of ~~not less than 4 h at~~ the test laboratory ~~conditions that~~ shall be ~~at~~ 18 to 22°C, with a ~~temperature of 70 ± 9°F (21 ± 5°C) and a~~ relative humidity of ~~50 ± 15 %. Record the temperature~~ 25 to ~~the nearest degree and the relative humidity~~ 75 %. The barometric pressure in all conditioning environments shall be 75 to ~~the nearest percent at the time of testing on the report form~~ 110 kPa. Helmets shall be conditioned in their environment for ~~each test series.~~ not less than 4 h.

11.1.2 *Low Temperature*—~~Condition the second helmet by exposing it to~~—The low temperature is at a temperature of ~~0 ± 3.6°F (−18 ± 2°C)~~ -23 to -27°C. Helmets shall be conditioned for a period of not less than 4 h nor more than 24 ~~h in a mechanically cooled apparatus.~~ h.

11.1.3 *High Temperature*—~~Condition the third helmet by exposing it to~~—The high temperature is at a temperature of ~~122 ± 3.6°F (50 ± 2°C)~~ 28 to 32°C. Helmets shall be conditioned for a period of not less than 4 h nor more than 24 h.

11.1.4 *Testing for Conditioned Specimens*— Complete all testing on helmets within 5 min after removal from the conditioning environment. Helmets may be returned to the conditioning environment in order to meet this requirement. Prior to the resumption of testing, specimens must remain in the conditioning environment for a minimum of 15 min for each 5-min period they are out of the conditioning environment.

12. Test Methods

12.1 *Testing Environment*—Conduct all testing under the recorded conditions of room temperature and humidity. These conditions must be in accordance with those stated in 11.1.1.

12.2 *Impact Locations*—~~Impact each helmet at not less than six sites. All distances referred to~~ and Test Schedule— The impact locations are defined in this ~~section are chord distances measured on~~ section. Condition two helmets at ambient, one at hot and

one at cold temperatures. One ambient conditioned helmet shall be tested at the ~~helmet. See Fig. 6 for a diagram of the~~ front, side, rear and crown locations only. The other ambient conditioned helmet shall be tested at two non-prescribed impact locations. The cold conditioned helmet shall be impacted at the two locations that yielded the single highest peak accelerations (g_{max}) from the helmet tested at ambient conditions. The hot conditioned helmet shall be impacted at the two locations that yielded the single highest peak accelerations (g_{max}) from the helmet tested at ambient conditions.

12.2.1 *Front*~~—Located in~~—The point on the ~~median~~ midsagittal plane ~~and 2 in. (50 mm)~~ which is 50 mm above the anterior intersection ~~of~~ with the ~~median and~~ reference plane~~s~~.

12.2.2 ~~*Front Boss*—A point in a plane 45° (0.78 rad) from the median plane as measured in a clockwise direction and 1 in. (25 mm) above the reference plane.~~

~~12.2.3 *Side*—Located at the~~—The point 25 mm above the reference plane and 90° from the anterior intersection of the ~~reference~~ midsagittal plane and the ~~coronal~~ reference plane (intersection of the reference and ~~90° (1.57 rad) in a clockwise direction from~~ coronal planes).

12.2.3 *Rear*—The point at the ~~an~~ posterior intersection of the ~~median~~ midsagittal and reference planes.

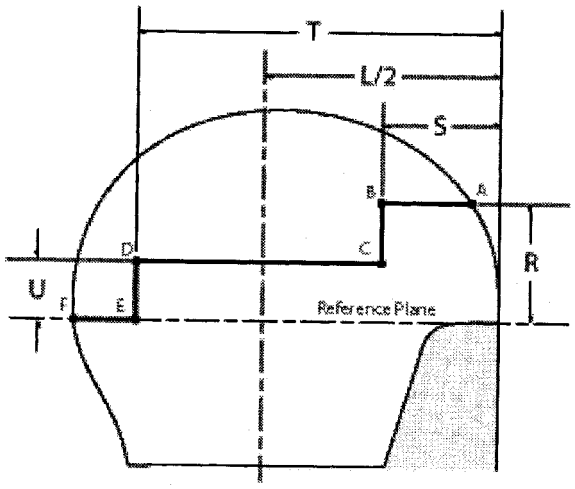
12.2.4 ~~*Lower Rear Boss*—A~~Crown—The point ~~in a plane 135° (2.36 rad) in a clockwise direction from~~ where the ~~anterior intersection~~ central vertical axis meets the top of the ~~median and reference planes and 1 in. (25 mm) below the reference plane.~~ headform.

12.2.5 ~~*Rear*—A point at~~Test Line—Draw test line A-B-C-D-E-F on the ~~posterior intersection of the median and reference planes.~~ headform as indicated in Fig. 8.

12.2.6 ~~*Crown*—A~~Non-Prescribed Impact Locations —Non-prescribed impacts shall be located on the headform. The first point ~~in~~ of contact with the anvil for any non-prescribed impact location shall be on or above the test line and at least one-fifth of the circumference of the headform from any prior impact location~~e~~ on that helmet. The headform is positione~~q~~d so that the impact location is the first point of contact with the anvil. The helmet is then placed on the headform as specified by the manufacturer's head positioning index (HPI). The location of these two non-prescribed impacts may be identified by the arc distance along the reference plane from the anterior ~~and posterior intersections~~ intersection of the meidsagittal plane with the reference plane, clockwise or counterclockwise, and the perpendicular arc distance above or below that point on the reference plane.

12.2.7 *Impact Locations on Headform and Helmet*—Determine an impact location on the headform, then mark this location on the headform. Place the helmet on the headform as specified by the manufacturer's head positioning index (HPI) and mark the corresponding impact location on the helmet before performing the impact. The impact location may be determined and marked first on the helmet and then marked on the headform. If marking the helmet first, make sure the corresponding mark on the headform is on or above the test line. Do this for all impact locations.

12.3 *Multiple Impacts*~~—Each helmet tested under~~—Impact the ambient ~~temperature conditions shall receive a total of 24 impacts. Impact~~ conditioned helmets three times at each of the ~~six~~ four impact locations ~~on the helmet~~ described in 12.2. Impact thre hot and cold conditioned helmets two times ~~with an impact velocity of 14.6 ft/s (4.5 m/s) ± 2 %. Deliver three additional impacts to~~ at each of the two ~~locations on the helmet at which the highest mean g_{max} readings were recorded. Repeat these three~~



Headform Size	Dimension				
	T	L/2	U	R	S
A	137.0	88.0	25.0	50.0	19.5
E	146.5	94.5	25.0	50.0	20.5
J	155.0	101.0	25.0	50.0	20.5
M	161.0	106.0	25.0	50.0	23.5

FIG. 8 Marking the Test Line

~~additional impacts at the two locations with a~~ non-prescribed impact locations. The impact velocity shall be 4.5 m/s (14.6 ft/s) ± 2 %.[5] The time interval between ~~each impact of~~ impacts shall be not less than 30~~-~~ s nor more than ~~90-s duration.~~

~~12.3.1 Impact the helmets that were exposed to high and low temperatures at the two impact locations at which the highest mean g_{max} recordings were obtained when the helmet was tested under ambient conditions. Impact the helmet twice at each of these two locations. Use test specimens that have not been previously impacted under each environmental condition.~~ 90 s.

12.4 *Headform and Carriage Assembly*~~—The~~— The test ~~headform (see Fig. 3)~~ headforms shall be made of K1A magnesium ~~or aluminum alloy~~ material. The headform ~~that exhibits no resonant frequencies below 3000 Hz~~ and ~~has critical dimensions described in Table 2.~~

~~NOTE 2—The weight of the~~ carriage assembly shall ~~not exceed 20 %~~ have a mass of 5.0 kg + 0.15, -0 kg with the ~~combined weight of the entire drop assembly. The maximum weight of the~~ carriage assembly ~~shall be 2.2 lb (1.0 kg).~~ contributing no more than 20 % of the total.

12.5 *Reference Marking*—Place the complete helmet to be tested on a reference headform that is firmly placed with the basic and reference planes horizontal. Apply a 10-lbf (45-N) static load to the crown of the helmet, center the helmet laterally, and adjust it in accordance with the manufacturer's recommendations. Maintaining the static load, draw a "test line" on the outside of the helmet shell corresponding to the reference plane (parallel to and at a distance above the basic plane of the headform in accordance with 12.4. In addition to the "test line," also mark plainly each of the six impact points as described in 12.2.

12.6 *Helmet Positioning*—Prior to each test drop, adjust the helmet on the headform in accordance with the manufacturer's recommendations. Secure the helmet to the headform so that it does not shift position prior to ~~or during the~~ impact. Place the retention system in such a position that it does not interfere with the free fall or the impact.

12.7 *Length Adjustment*:

12.7.1 *Chin Strap*—Adjust the free strap length between helmet attachment points to 9 in. (229 mm).

12.7.2 *Neck Strap*—Adjust the free strap length between helmet attachment points to 6 in. (152 mm).

12.8 *Deflection and Retention Test* :

12.8.1 Support the helmet on a test machine fixture and pass the strap over the rollers of the strap test apparatus shown in Fig. ~~7~~ 9. The testing machine shall be capable of providing a controlled rate of displacement between the helmet and the strap test apparatus while recording the resulting tensile force. Fasten the retention system closures.

12.8.2 Establish the perpendicular distance between a point on the strap test apparatus and a line through the points at which the retention system is attached to the helmet shell. The distance should be recorded while the applied load is 3 lbf (13.3 N). This distance shall be regarded as the point of zero displacement.

12.8.3 Increase the displacement at a speed not greater than 1 in./min (25 mm/min). Measure the distance between the strap test apparatus and the line through the attachment points when the load reaches 24 lbf (107 N).

12.8.4 Calculate the displacement of the strap at 24 lbf (107 N) as the difference between the distance measured in 12.8.2 and that measured in 12.8.3.

~~[5] The MEP impact surface~~

[5] This velocity is equivalent to a ~~60 ± 5 Durometer Shore A hardness impact surface, available from U.S. Testing Co., Inc., 1415 Park Ave., Hoboken, NJ 07030.~~ drop height of 40 in. (1016 mm).

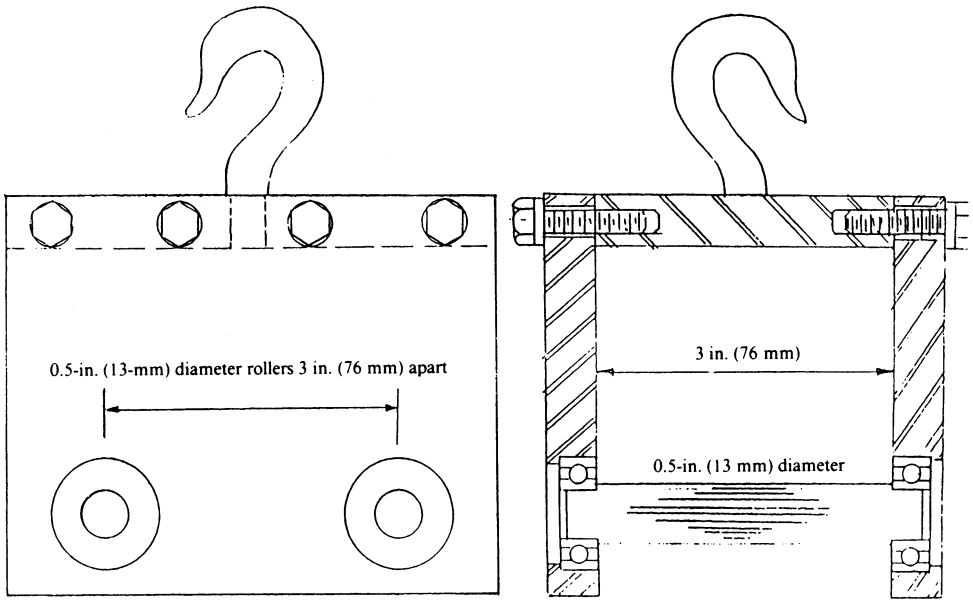


FIG. ~~7~~ 9 Chin Strap Test Apparatus

12.8.5 Continue to increase displacement at a speed not greater than 1 in./min (25 mm/min) until the retention system separates.

12.9 *Penetration Resistance Tests* :

12.9.1 *Test Blade*—The test blade is shown in Fig. 10.

12.9.2 *Headforms*—The appropriate headform, as described in Fig. 3, shall be used for testing the appropriate helmet.

12.9.3 Mount and adjust the protector on the appropriately sized headform in accordance with the instructions provided with the specimen. An attempt shall be made to enter the curved end of the test blade, in all possible orientations, into all openings of the protector within the area of coverage, excluding the ear openings.

13. Impact Requirements

13.1 Each helmet model presented for impact testing shall be furnished with ~~a reference index~~ an HPI (see 3.1.~~7~~6) as established by the helmet manufacturer. This ~~reference index~~ HPI shall be used ~~during reference marking as described in 12.5.~~

~~13.2 The average g_{max} of each set of three impacts delivered to six test locations per~~ when placing the helmet on the headform for testing. If this information cannot be obtained from the manufacturer, the technician shall ~~not exceed 275 *g*. For~~ position the ~~additional three impacts delivered~~ helmet on the appropriate headform according to the ~~two~~ fitting instructions included, and the technician's judgment. Helmets shall be tested on the appropriate test ~~locations with~~ headform size(s) as determined by the ~~highest mean g_{max}, no single impact~~ testing laboratory. Helmets shall be tested on the la~~v~~rgest and smallest size test headforms on which they fit. If a ~~g_{max} that exceeds~~ smaller size of the same model fits the smaller headform, the larger helmet will be tested on the larger headform only.

13.2 The peak acceleration of any impact shall not exceed 300 ~~*g.*~~ g.

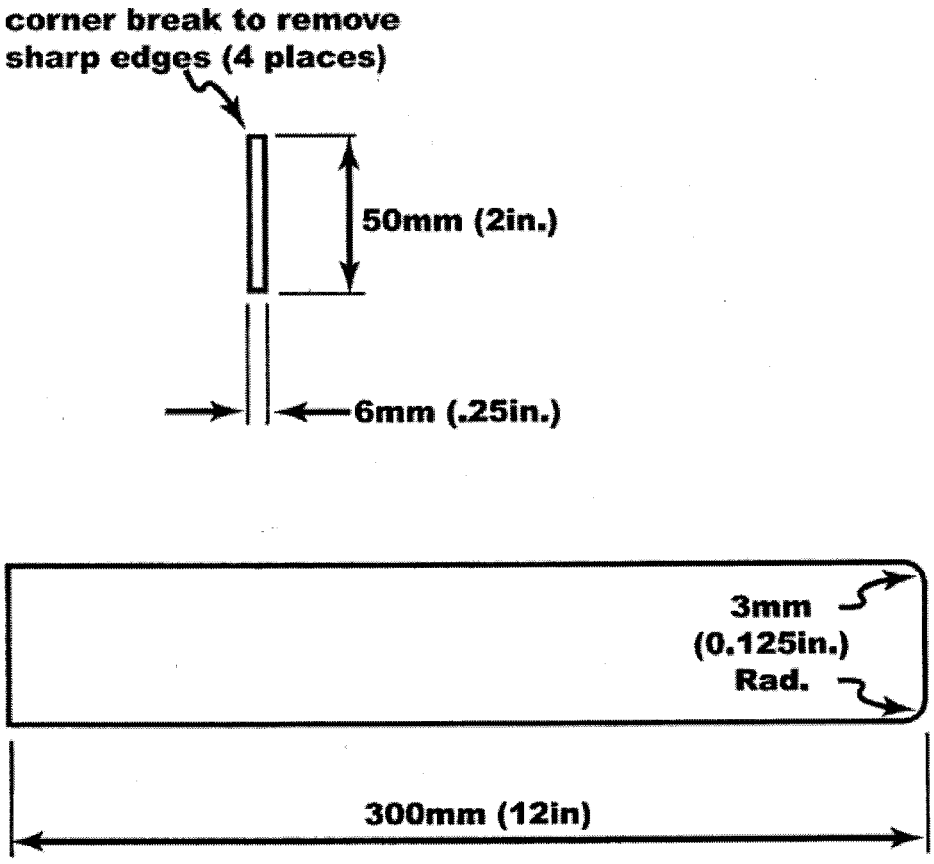
13.3 The helmet shall remain intact with no visible cracks through the thickness of the outer covering (shell).

13.4 A test report of impact tests as described in Section 15 shall be an integral part of this performance specification.

14. Calculation

14.1 Immediately after each impact, take the following measurements of the acceleration time-history trace:

14.1.1 *Maximum Acceleration*—Find the maximum amplitude of acceleration by measuring the perpendicular distance to the trace base line from the midpoint of the trace at maximum excursion and multiplying by the sensitivity factor. (Sensitivity factor = *g* per division deflection of the trace.)



NOTE—All dimensions have a tolerance of +0/-0.30 mm.

FIG. 10 Test Blade

14.1.2 *Duration of Impulse*—Determine the duration of the pulse by measuring the total width of the trace along the 50-*g* line in milliseconds.

14.1.3 *Oscillograms*—Take photographs of the oscilloscope on the third impact at each impact site conducted under ambient conditions.[6] Affix these oscillograms to the final report of testing.

15. Report

15.1 Each laboratory report shall be accompanied by the oscillograms prescribed in 14.1.3 and shall contain the following minimum information:

15.1.1 Manufacturer's identification,

15.1.2 Size,

15.1.3 Manufacturer's lot number,

15.1.4 Weight, and

15.1.5 External circumference at reference plane.

15.2 *Conditions of Test*—The report shall include detailed information of the conditions under which the tests were conducted as follows:

15.2.1 Date of test,

15.2.2 Temperature,

15.2.3 Humidity, and

15.2.4 Record of the instrument calibration.

15.3 *Test Results*—Detailed results of the impact testing shall include the following:

15.3.1 Impact location,

15.3.2 Drop height,

15.3.3 g_{max} for each impact,

15.3.4 Duration of pulse,

15.3.5 Other pertinent comments and remarks.

15.4 Fig. ~~8~~ 11 provides a sample data sheet for recording test conditions and test results.

16. Product Marking

16.1 *Warning Labels*—Each helmet shall be permanently labeled on the outside or inside of the helmet, or both, with information for the user stating the limits of protection afforded by the helmet.[7]

16.2 Each helmet shall be provided with instructions that describe proper fit and proper head position and that include a label with a statement ing~~"~~ the following or similar words: For maximum performance of the helmet, it must fit snugly, be free from cracks, and remain securely in position when adjusted for proper fit.~~"~~

16.3 Each helmet shall be permanently labeled with the following information:

16.3.1 Identification of the manufacturer,

16.3.2 Month and year of manufacture,

16.3.3 Model designation, and

16.3.4 Size or size range for proper fit.

17. Instructional Literature

17.1 Instructions accompanying the helmet must include at least the following information:

17.1.1 A warning concerning improper cleaning agents, paint, or other factors affecting helmet shell integrity or performance, or both, that the application or removal of decals is prohibited unless authorized by the manufacturer,

17.1.2 Notification that the helmet meets the minimum requirements of this ASTM performance specification for ice hockey provided it has not been reconditioned or altered in any way, and

17.1.3 Instructions to replace after a serious impact.

18. Keywords

18.1 helmet; ice hockey; protective head gear

~~[6] This velocity is equivalent to a drop height~~

[6] Computer printouts of ~~40 in. (1016 mm).~~ the acceleration time curves will satisfy this requirement.

~~[7] The metal headforms and drop assembly are available~~

[7] Such a warning label might read: "Ice Hockey is a collision sport which is dangerous. This helmet affords no protection from ~~U.S. Testing Co., Inc., 1415 Park Ave., Hoboken, NJ 07030.~~ neck or spinal injury. Severe head, brain, or spinal injuries including paralysis or death may occur despite using this helmet. Do not use this helmet if the shell is cracked, deformed, or if the interior padding is deteriorated. Read instructions carefully before wearing."

It is recommended the helmet have a red background label with white letters.

Date _____ Laboratory: _____ Test Performed by: _____

Helmet Make and Model _____ Laboratory Environment: Temperature _____ Humidity _____

Helmet Circumference (at reference plane) _____

Calibration Check		Impact Site	Drop Height (inches)	g_{max}	Impact Duration T (ms)	Remarks	Helmet No.	Helmet wt (g)
Pre-test	1 2 3						1 2 3 4	
Post-test	1 2 3							

Helmet No.	Test Condition	Impact Location	Front			Front Boss			Side			Lower Rear Boss			Rear			Crown			Reported Impacts		
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	Ambient	Record No. max *g* T (ms)																					
2	Low Temperature	Record No. max *g* T (ms)																					
3	High Temperature	Record No. max *g* T (ms)																					
4	Immersed	Record No. max *g* T (ms)																					

Remarks: (Indicate helmet condition after impact)

Signed _____ Date _____

FIG. ~~8~~ 11 Sample Data Sheet