1985 SPECIAL APPLICATIONS STANDARD FOR PROTECTIVE HEADGEAR

FOREWORD

The 1985 Special Applications Standard for protective headgear is an expansion of that first designed by the Snell Memorial Foundation in 1959 for racing crash helmets.

The first performance standard was revised in 1962 and again in 1968, 1970, 1975, 1980 and 1985 as helmet manufacturing technology advanced. The 1985 Special Applications Standard has even more demanding test requirements. The basic premise of the helmet standard is that the circumstances representing the greatest potential hazard will be reproduced under test conditions.

The 1985 Special Applications Standard is designed to establish performance characteristics rather than set forth construction and material limitations for the designer and manufacturer. The Foundation neither recommends specific products nor imposes its specifications on manufacturers or consumers. It offers test facilities to bona fide manufacturers and consumer groups and makes available to anyone the identity of those products which successfully meet the Standard. The Foundation neither has accepted nor will accept any power of enforcement from any consumer group. Snell Foundation certification of protective headgear requires a specific contractual agreement between the primary headgear manufacturer and the Foundation. Certification information may be obtained by interested manufacturers upon application to the Foundation.

The protection given by any headgear is, by nature, less than complete and may not entirely prevent head injury or death in severe accidents. The best helmet is but one link in a long chain of safety measures which may include such factors as proper training and conditioning and, most importantly, adequate safety education. The value of the entire chain of safety is lessened by the weakness of any link.

The consumer must understand that helmets are deliberately constructed so that the energy of a severe blow is absorbed by and partially destroys the helmet. The damage may not be readily apparent and the Foundation strongly recommends that consumer groups require that any helmet involved in a significant accident be returned to the manufacturer for competent inspection. If it is not possible to do so, the helmet should be replaced.

INTRODUCTION

The Standard for protective headgear contained herein is a special standard directed towards individuals engaged in competitive automobile racing or closed vehicle competition. The Standard addresses the particular circumstances which result from this type of activity. This is in contrast to the M-85 Standard of the Snell Foundation which is directed towards individuals who are engaged in vehicular sports and who may be riding a motorcycle, an ATV vehicle or a snowmobile, etc. In these activities the individual is normally not restrained and, in the case of an accident, may impact any of a large number of different shaped objects.

In developing this Standard, numerous individuals engaged in the competitive sports were interviewed as to their thoughts on requirements and, in addition, there was field testing of various designs of helmets developed by manufacturers. Discussions were undertaken with individuals expert in biomechanics by members of the Snell Board who are also expert in this area. The present Standard, therefore, incorporates suggestions and considerations from individuals not only expert in the area of biomechanics but also competitors, including members of the Board of Snell who have engaged in such activities.

The SA Standard is directed towards individuals who are normally restrained in their activities. They are held in position by shoulder straps, seat belts, seat straps, etc. They are also usually protected from direct impact with the ground or other vehicles by means of a "cage"or roll bar.

In competitive racing of this type the presence of fire is a definite hazard. This is in contrast to motorcycle sports. As a consequence, the SA Standard addresses the problem of fire.

The requirement for vertical vision is not so great as it might be in many other activities.

In many automotive sports, the thermal environment of the vehicle is such that high ambient temperatures are encountered due to lack of ventilation, engine placement, etc. Thus, it is important for the individual because of the constraints of the helmet system to have available cooling for the face and head. If this is done, it may require forced ventilation which is not normally required on individuals riding motor-

cycles or exposed to the slip-stream. The helmets, therefore, must allow for the input and exit of the ventilating air. All of these particular requirements have suggested to Snell over the years that it would be worthwhile to develop a Standard which we are calling Special Applications Standard for individuals competing in automotive sports in the present milieu of racing.

Obviously, in the very high speed found in automotive racing the weight of helmets is a factor. Modern competitive automobiles experience lateral accelerations exceeding 1 g and on occasion, depending on the track, may experience vertical accelerations in excess of 2 g's. Contemporary technology is able to reduce the weight of protective helmets per unit of protection to some extent. Nevertheless, the fundamental equation still dictates that higher levels of protection are invariably paid for by an increase in weight no matter how small. The present Standard addresses the level of protection and, as usual in Snell Standards, allows the manufacturer of protective helmets to design as he sees fit while realizing that weight is a significant problem. The Snell Memorial Foundation, therefore, has not specified a maximum weight of the helmets in this Standard.

Contemporary competitive motor vehicles are designed so that upon severe impact many of the suspension components break up. This results in the possibility of head impact with sharp metal fragments of the vehicle. Therefore, the SA Standard addresses this problem by requiring protection against sharp penetrating objects.

Finally, most helmets utilized in automotive racing today have a face shield. This face shield must protect the driver of the vehicle against objects which may be thrown up by the preceding car. The SA Standard addresses these by requiring a minimum level of protection of the face by a shield against objects thrown up or encountered. It also requires that such a shield afford protection against fire and requires that the shield have a positive "hold down".

While all of these special considerations must be met, the ultimate requirement of a head protective device must be to mitigate the effects of impact to the head. While the SA Standard has special requirements for hazards which might be encountered in automobile competition, its impact protection is essentially equivalent to the general Standard (M-85) of the Snell Memorial Foundation. Additions to the general use Standard are directed to its use under special circumstances, hence the name Special Applications Standard.

CONSTRUCTION

A. General

The helmet shall consist of a hard, smooth shell lined with energy absorbing material or fitted with other means of energy absorption. It shall be strongly attached to a retention system designed in so far as possible to retain the helmet on the wearer's head. The assembled helmet shall have a smooth external surface without rigid projections greater than 7 mm above the outside surface of the helmet unless smoothly faired. Ventilation inlets and outlets may be utilized provided they are made of flexible material such as rubber or vinyl plastic. A goggle clip may be used at the rear of the helmet or on the side.

B. Shell

The shell of the helmet shall be as nearly uniform in strength as possible using normal manufacturing methods. Ventilation holes, or slots may be used as Test Sites. Rivets, if utilized in the construction of the helmet, shall not project more than 2 mm above the outer surface and shall have no sharp edges.

All edges of the shell shall be protected by beading, and there shall be no metallic parts or other rigid projections on the inside of the shell which might injure the wearer's head in the event of an impact.

C. Materials

The materials used in the manufacture of various parts of the helmet shall be of durable quality, e.g., their characteristics shall not undergo appreciable alteration under the influence of aging or of the circumstances of normal use such as exposure to sun, rain, cold, dust, vibration, solvents and cleaning agents, contact with skin, sweat, or products applied to the hair or skin. Appropriate tests for durability under these circumstances may be instituted. Materials commonly known to cause skin irritation or disease may not be used for those parts of the assembly which come into contact with the skin. New types of materials must be shown not to be causative of skin irritation or diseases. No part of the protective components of the helmet shall be inadvertently detachable nor detached under test impact.

D. Face Shields

If a face shield is supplied with the helmet, it shall be faired into the sides of the helmet in such a way that no sharp

projections exist which could be caught on surrounding surfaces. The visor shall be fitted on the helmet with such devices which prevent the visor from lifting when properly secured.

The face shield should not cause major optical distortion and must offer a measure of protection against impacts caused by stones or debris which may be encountered at speed, and shall offer a measure of protection against fire.

E. Field of Vision

The helmet must provide a horizontal field of vision of 90°, and a vertical field of 45°.

QUALIFICATIONS FOR CERTIFICATION

For qualification testing, helmets shall be in the same condition as those on the market. No helmet shall be offered for sale after it has been subjected to any tests described in this Standard. In qualification testing, the helmets must satisfy all of the safety performance criteria described in this Standard.

RANDOM SAMPLE TESTING

In addition to the initial testing, random samples of previously certified models will be obtained by the Foundation from the open market. These also will be tested by the Foundation and must meet the performance requirements of this Standard.

When tests show that the materials used are equally protective after exposure to temperature and moisture conditions, testing for these performance requirements may be relaxed, provided that there is no change in either the materials or manufacturing techniques.

LABELING AND MARKING

1. Each helmet offered for sale shall have a securely attached label bearing an inscription to the following effect:

1.1. For optimal protection, this helmet must be of good fit and the chin strap must be securely fastened. The helmet, when fitted correctly, shall not be easily removable by pulling in any direction.

1.2. Helmets of this design are constructed so that the energy of a severe blow is absorbed by the helmet, causing the shell and/or lining to be partially destroyed, although damage may not be visible to the naked eye. If such an impact occurs, the helmet either should be returned to the manufacturer for competent inspection or destroyed and replaced.

1.3. Warning. Some reasonably foreseeable impacts may exceed the helmet's capability to protect against severe injury or death.

2. The manufacturer's name or brand and the month and year of manufacture must be indelibly marked and placed in the helmet where it is protected from obliteration.

3. Once the manufacturer is licensed by the Snell Memorial Foundation (conditions for licensure may be obtained from the Foundation) a numbered Snell decal shall be permanently affixed inside the helmet and shall not be removable by normal means.

4. A licensed manufacturer may also place a Snell marker on the exterior of the helmet.

TESTING

1. Conditioning before Testing.

a. Cold. One helmet shall be tested at ambient temperature and a second helmet shall be exposed to a temperature of -10°C ± 2°C for a period not less than 4 hours nor more than 24 hours in a mechanically cooled apparatus.

b. Heat. A third helmet shall be conditioned by being exposed to a temperature of 50°C ± 2°C for a period of not less than 4 hours nor more than 24 hours.

c. Rain. A fourth helmet may be conditioned by spraying with water at a temperature of 25°C ± 5°C for a period of not less than 4 hours nor more than 24 hours.

d. All testing shall begin within two minutes from the time of removal from the condition equipment as indicated in a, b, and c. The time between sequential tests shall not exceed one minute, or the helmet must be reconditioned.

2. Extent of Protection

The extent of protection and the areas of the helmet subject to test shall be referenced to the anatomical or basic plane delineated on a standard head. This is defined as a plane at the level of the external auditory meatus and the inferior margin of the orbit. A test line shall be marked on the helmet subjected to tests. This test line shall be parallel to and 60 mm above the basic plane as above defined, save in the posterior one-third of the helmet where it shall be the basic plane. All parts of the helmet above this test line shall attenuate shock transmission to at least the minimum requirements hereinafter specified under Shock Absorption Test, provided the impact points are 60 mm above the edge of the shell.

3. Dynamic Test of Retention System

a. The helmet shall be placed on a suitable rigid fixture so that it is supported upright by the base of the shell, with the chin strap fastened over a device approximating the shape of the bony structure of the lower jaw. This shall consist of two metal rollers, each 12.7 mm in diameter, separated by 76.2 mm on center, which would serve to represent the jaw bone. If a different retention system is used, the appropriate test apparatus shall be used to test its effectiveness utilizing the conditions outlined in b and c.

b. A 23 kg ± 0.5 kg preload shall be applied to the retention harness for 2 minutes before the dynamic test loading so that it is not additive to the test load. The preload mass removal shall occur as part of the test drop, and be completed before the test mass loads the retaining system.

c. A 38 kg ± 0.5 kg mass shall be dropped in vertical guided fall a distance of 120 mm ± 2 mm against a rubber pad with a durometer hardness of 00-93 so as to load abruptly the retaining system. The strap and its attachments must withstand this dynamic loading without parting and without greater than 30 mm increase in elongation.

4. Shell Integrity Test

a. A randomly selected helmet from a test series may be conditioned with a solvent mix of 50% toluene and 50% isooctane. A cotton cloth, or something as suitable which is 15 cm square and has been soaked in the solvent, will be used as an applicator for the solvent. The solvent will be applied to the shell first in an area within 5 mm of the chin strap fixings for not less than 5 seconds on each side and not less than 10 seconds to the

remainder of the surface. At least 30 minutes shall elapse before further conditioning and testing.

5. Shock Absorption

a. Four anvil configurations shall be used; one flat, one hemispherical, one with a 0.63 cm × 18 cm ± 1 cm face (I beam) and steel bar 20.5 cm ± 0.5 cm in length and 5 cm ± .05 cm in diameter. The flat anvil shall have a minimum surface of 0.127 m^2, i.e. 127 ± 2 mm diameter face; the hemispherical anvil shall have a 48 mm ± 0.5 mm radius.

The rigid mount for both the anvils shall consist of a solid mass of at least 135 kg, the upper surface of which shall consist of a steel plate with minimum thickness of 25 mm and minimum surface area of 0.3 m^2.

The test headform shall be of rigid, low resonance material such as magnesium alloy (or a dynamic functionally equivalent material). The headform should conform to the DOT size A, C or D (USA) specifications as outlined in the DOT FMVSS 218 Standard.

b. Shock absorption will be measured by determining imparted acceleration to an appropriately instrumented standard headform (Department of Transportation (USA) (DOT)) dropped in guided fall upon a fixed, rigid steel anvil. Each helmet shall receive two impacts in each of two sites against the flat and two impacts in each of two sites against the hemispherical anvil surfaces, in each of four quadrants and one impact against a vertical steel plate 0.63 cm in width and 18 cm in length as previously specified. A separate helmet of the series will be impacted on the rear and side against a steel bar. It shall be impacted horizontally in the rear and vertically on the side for a total of 3 impacts at each site. The center of the impact site shall be at any point above the test line, and the impacts separated from each other by a distance not less than one-sixth of the maximal circumference of the helmet.

c. For each helmet, the calculated impact energy shall be established, utilizing the basic drop test mass of headform and supporting arm without helmet, and as confirmed by measured impact velocity.

At each test locus of impact against the flat anvil, the first and second impacts under this requirement shall be 150 J and 100 J, respectively.

The impacts against the hemispherical anvil shall be 150 J and 100 J, respectively.

The impact against the I beam anvil shall be 150 J's. The impacts against the steel bar anvil shall be three in number at each site of 150 J, 120 J and 100 J, respectively. This helmet may be tested at any of the other specified temperatures.

The tolerance of the impact energy shall not exceed +1 J -0.5 J. The drop assembly weight shall be the combined weight of the instrumented test headform and supporting assembly for the drop test. The weight of the supporting assembly shall not exceed 25% of the weight of the drop assembly. The center of gravity of the combined test headform and supporting assembly shall lie within a cone with its axis vertical and forming a 10° included angle with the vertex as the point of impact.

The acceleration transducer shall be mounted at the center of gravity of the combined test headform and supporting assembly. The sensitive axis shall be aligned to within 5° of the vertical when the test headform is in the impact position. The acceleration data channel must comply with SAE recommended practice J 211 requirements for channel class 1000.

Appropriately sized headforms of similar configuration (A, C or D DOT FMVSS 218 USA) shall be used for helmets of different size, and shall have a mass approximating 5 kg's. However, none of the several sized headforms shall have a total mass with the supporting arm included but without helmet, exceeding 6.5 kg.

The peak acceleration of the helmeted headform for the impacts shall have an arithmetic average not exceeding 285 g's and no single impact shall exceed 314 g's. If either of these conditions is exceeded it will be cause for rejection.

6. Chin Bar Test

Full-face helmets utilizing an integral extension of the shell anterior to the chin of the wearer shall be subjected to a dynamic test of the chin bar.

The helmet shall be firmly mounted on a flat rigid base with no headform inside with the chin bar facing up and the helmet base 90° to the anvil's horizontal plane.

A mass of 5 kg -0 +0.2 kg having a flat striking face of 0.1 m^2 minimum area shall be dropped in guided fall and strike the central portion of the chin bar. The instantaneous maximum downward deflection of the inner surface of the chin bar shall be recorded.

The test mass shall be dropped a distance of 0.6 m -0 +5 mm. Downward deflection exceeding 60 mm shall be cause for rejection of the helmet.

7. Penetration

The complete helmet shall be placed on a rigidly mounted spherical headform which shall be covered with electrically conductive material. If the helmet to be tested contains a "sling" or other adjustable sizing component, it shall be relaxed to its most extendable position. The penetration test will be conducted by dropping the penetration test striker on to the outer surface of the helmet anywhere above the reference plane in a direction essentially perpendicular to the outside surface of the helmet. At least the tip of the striker should be electrically conductive. When tested in the above fashion the helmet shall be rejected if an electric contact is made between the penetrator and the conducting surface of the headform.

a. Conditions of the penetration test. The weight of the penetration test striker shall be 3 kg -0 +50 gms. The point of the striker shall have an included angle of 60° ± 0.5° and an altitude of 38 mm ± 0.38 mm. The radius of the striking point shall be 0.5 mm ± 0.01 mm. The hardness of the striking tip shall be 60 Rockwell (scale C ± 3 points). The height of the fall shall be 3 meters ± 15 mm.

b. The face shield (full face helmets only) must also resist penetration of a sharp soft lead pellet weighing 1 gm ± 0.1 gm with a diameter of 5.5 mm ± 0.1 mm traveling at a velocity of 500 km per hour ± 20 km. This velocity shall be measured at each impact.

The face shield attached to the helmet shall be tested at the center line and at 30° of either side of the center line. The pellet shall impact at 90° to the surface. No penetration of the face shield shall occur nor shall the maximum indentation exceed 2.5 mm ± 0.2 mm on any of the three impacts. The test shall be performed at ambient and high temperatures.

8. Flammability Test[1]

The test will be conducted at ambient temperature, between 10°C and 30°C, and utilize the thermal load of a propane flame, at the flame location representing a measured temperature of 790°C ± 40°C.

a. Shell: The flame shall impinge upon the external surface of the helmet shell for a period of 30 seconds. Simultaneous with the removal of the flame, a timing device shall be activated. The helmet shall be self-extinguishing within 10 seconds of the removal of the flame i.e., shall not continue to

1. No helmet is completely non-flammable, they differ in degree of flammability.

burn with the emission of a flame. The helmet will not be subjected to impact tests after testing for flammability.

The lining material normally in contact at any point with the wearer's head shall not exceed 70°C during the test.

b. Trim: The trim will be subjected to the same propane flame utilized in the shell test, but for a period of 15 seconds. The trim shall be self-extinguishing within 20 seconds of the removal of the thermal load.

c. Chin strap: (For full face helmets only). The chin strap utilized will be subjected to the same propane flame utilized in the shell test for a period of 15 seconds, and shall be self-extinguishing within 5 seconds of the removal of the thermal load. If the chin strap itself is protected by a non-flammable material, the flame will be directed at this element of the fastening system.

d. Face shield: (For full face helmets only). The face shield will be subjected to the flammability test. The flame shall impinge on the external surface of the face shield for a period of 45 seconds. The face shield should not melt down during this period so as to allow the propane flame to penetrate the interior of the helmet. The shield shall be self-extinguishing in 20 seconds.