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May 13, 2011

(Effective compliance date: May 13, 2013)

U.S. DEPARTMENT OF TRANSPORTATION

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

LABORATORY TEST PROCEDURE

FOR

FMVSS No. 218

Motorcycle Helmets



ENFORCEMENT

Office of Vehicle Safety Compliance

Mail code: NVS-220

1200 New Jersey Ave., SE

Washington, DC 20590

**OVSC LABORATORY TEST PROCEDURE NO. 218
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REVISION CONTROL LOG

OVSC LABORATORY TEST PROCEDURE TP-218 Motorcycle Helmets

TEST PROCEDURE		FMVSS No. 218		DESCRIPTION
REV. No.	DATE	AMENDMENT	EFFECTIVE DATE	
00	3/74	38FR22391	3/1/74	Original release signed by O.D.
01	9/7/83			Added sections 2.1-2.3, revised sections 3, 10 - 12, 16, Figure 1A
02	10/18/84			No significant changes
03	11/23/92			Revised entire document
04	6/27/2003	N/A	N/A	Updated (codes, metric, fix typos), add retention test pull rate and minor changes
05	2/28/2006	N/A	N/A	General update affecting entire document.
06	11/30/2006	N/A	N/A	Corrected typographical errors on pages 33 (retention test rate) & 49 (penetration striker radius).
07	2/1/2011	76FR28132	5/13/2013	Updated document to reflect requirement changes for labeling, environmental conditioning, impact attenuation, and retention. Added guidance to sections 12.5.4 and 12.7.1(B).
08				
09				
10				

1. PURPOSE AND APPLICATION

This document is provided by the National Highway Traffic Safety Administration (NHTSA), Office of Vehicle Safety Compliance (OVSC) for the purpose of presenting procedures for uniform testing and providing suggestions for the use of specific equipment for contracted testing laboratories. It contains requirements based on the test procedures specified in the Federal Motor Vehicle Safety Standard(s) (FMVSS). This OVSC test procedure includes requirements that are general in scope to provide flexibility for contracted laboratories to perform compliance testing and is not intended to limit or restrain a contractor from developing or utilizing any testing techniques or equipment which will assist in procuring the required compliance test data. This test procedure does not constitute an endorsement or recommendation for use of any particular product or testing method.

Prior to conducting compliance testing, contracted laboratories are required to submit a detailed test procedure to the Contracting Officer's Technical Representative (COTR) to demonstrate concurrence with the OVSC laboratory test procedure and the applicable FMVSS. If any contractor views any part of this OVSC laboratory test procedure to be in conflict with a FMVSS or observes deficiencies in a laboratory test procedure, the contractor is required to advise the COTR and resolve the discrepancy prior to the start of compliance testing or as soon as practicable. The contractor's test procedure must include a step-by-step description of the methodology that will be used to conduct the test and detailed check-off sheets. The contractor shall also provide a detailed list of test equipment that contains the make and model numbers of all equipment that will be used during testing, instrument accuracy, and calibration dates. All equipment shall be calibrated in accordance with the manufacturer's instructions. There shall be no contradictions between the laboratory test procedure and the contractor's in-house test procedure. Written approval of the in-house test procedures shall be obtained from the COTR before initiating the compliance test program.

NOTE: This OVSC Laboratory Test Procedure, prepared for the limited purpose of use by independent laboratories under contract to conduct compliance tests for the OVSC, are not rules, regulations or NHTSA interpretations regarding the meaning of a FMVSS. This laboratory test procedure is not intended to limit the requirements of the applicable FMVSS(s). In some cases, this OVSC laboratory test procedure does not include all of the various FMVSS minimum performance requirements. In addition, this laboratory test procedure may specify test conditions that are less severe than the minimum requirements of the standard. This laboratory test procedure may be modified by the OVSC at any time without notice, and the COTR may direct or authorize contractors to deviate from these

procedures, as long as the tests are performed in a manner consistent with the standard itself and within the scope of the contract. Laboratory test procedures may not be relied upon to create any right or benefit in any person. Therefore, compliance of a vehicle or item of motor vehicle equipment is not necessarily guaranteed if the manufacturer limits its certification tests to those described in this OVSC laboratory test procedure.

This version of the test procedure reflects new requirements published in 76FR28132, which apply to all motorcycle helmets manufactured on or after May 13, 2013.

2. GENERAL REQUIREMENTS

The purpose of FMVSS No. 218 is to reduce deaths and injuries to motorcyclists and other motor vehicle users resulting from head impacts. FMVSS No. 218 establishes minimum performance requirements for helmets designed for use by motorcyclists and other motor vehicle users. Each helmet shall meet the following requirements when subjected to conditioning procedures specified in S6.4 and tested in accordance with S7.1, S7.2, and S7.3 of FMVSS No. 218. Refer to FMVSS No. 218 for information referenced by section (S). Each of these tests measures the performance of a motorcycle helmet as a total system, i.e., the tests are conducted on a motorcycle helmet as a whole, rather than on helmet components.

- A. **IMPACT ATTENUATION** — When an impact attenuation test is conducted in accordance with S7.1, all of the following requirements shall be met:
 - (1) Peak accelerations shall not exceed 400 g;
 - (2) Accelerations in excess of 200 g shall not exceed a cumulative duration of 2.0 milliseconds (ms); and
 - (3) Accelerations in excess of 150 g shall not exceed a cumulative duration of 4.0 milliseconds (ms).

- B. **PENETRATION** — When a penetration test is conducted in accordance with S7.2, the striker shall not contact the surface of the test headform.

- C. **RETENTION SYSTEM** — When tested in accordance with S7.3:
 - (1) The retention system or its components shall withstand the loads specified without separation; and
 - (2) The adjustable portion of the retention system test device shall not move more than 2.5 cm measured between preliminary and test load positions.

Where the retention systems consists of components which can be independently fastened without securing the complete assembly, each

such component shall independently meet the retention system requirements.

- D. CONFIGURATION — Each helmet shall have a protective surface of continuous contour at all points on or above the test line described in S6.2.3. The helmet shall provide peripheral vision clearance of at least 105 degrees to each side of the mid-sagittal plane, when the helmet is adjusted as specified in S6.3. The vertex of these angles, shown in Figure 1 (page 3), shall be at the point on the anterior surface of the reference headform at the intersection of the mid-sagittal and basic planes. The brow opening of the helmet shall be at least 2.5 cm above all points in the basic plane that are within the angles of peripheral vision as shown in Figure 1, below.

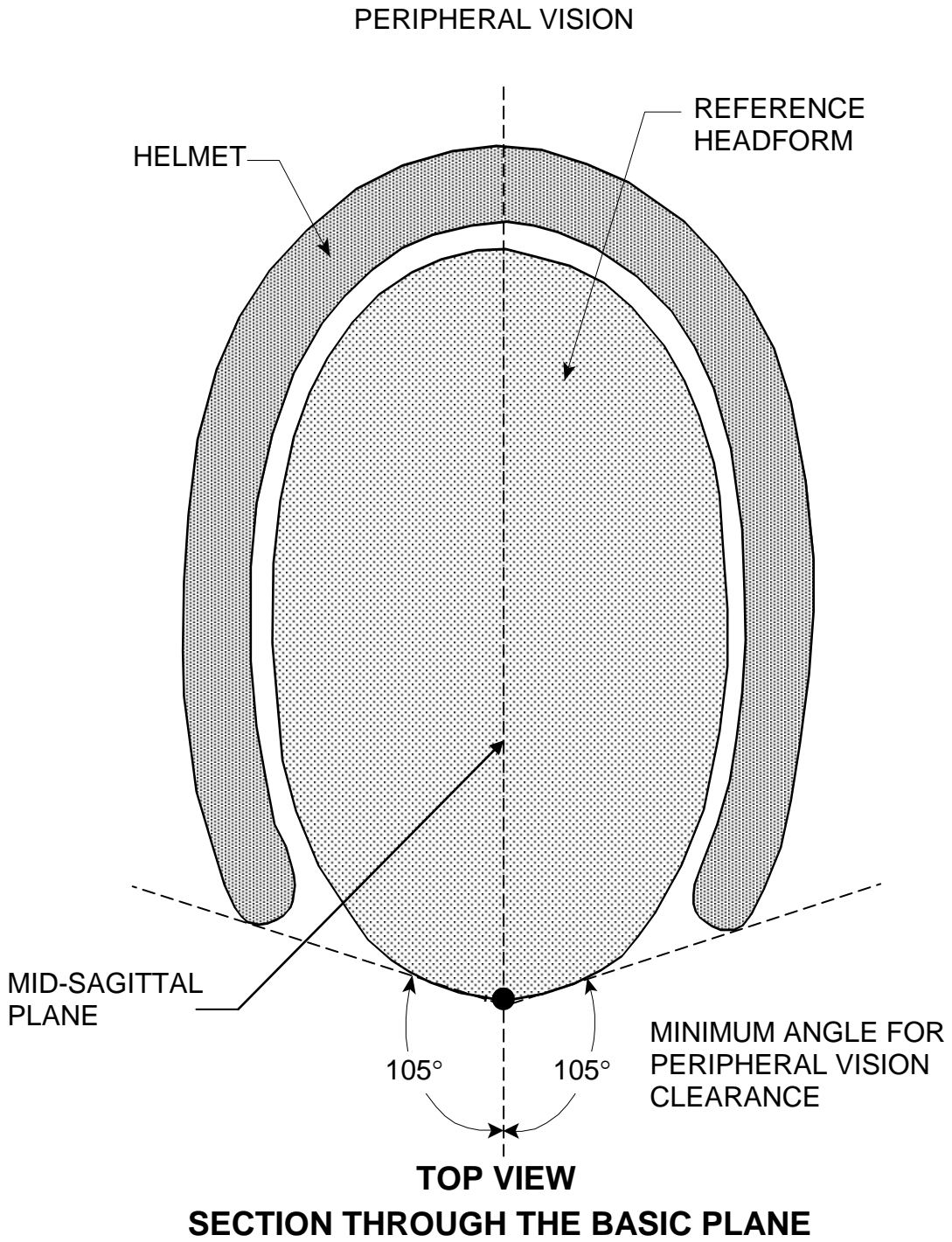
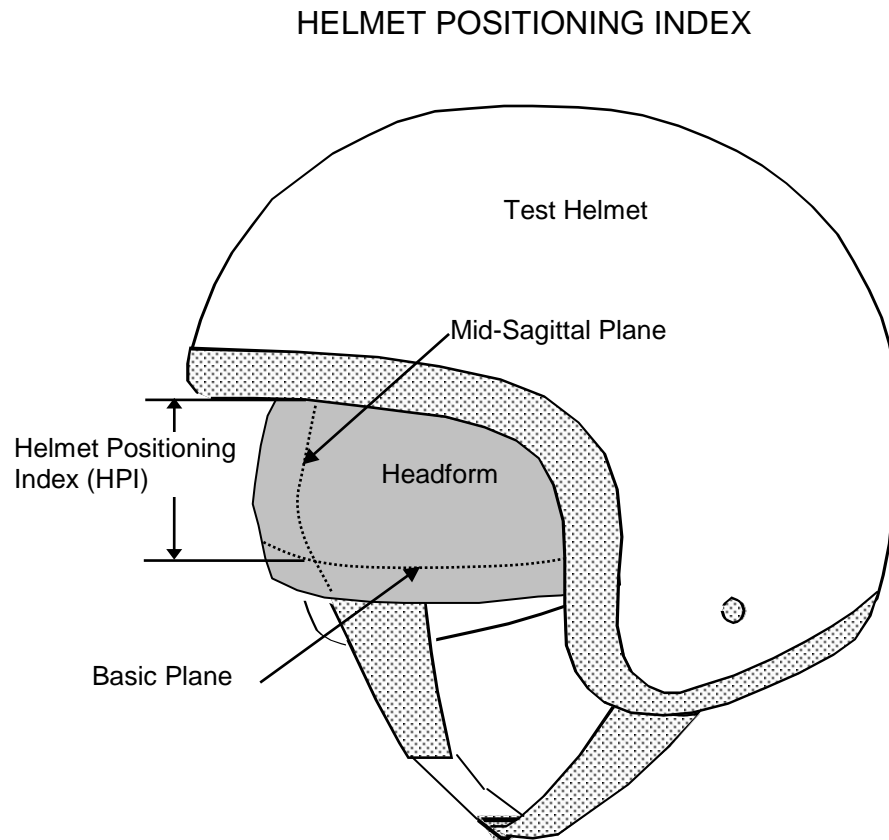


FIGURE 1

- E. PROJECTIONS — A helmet shall not have any rigid projections inside its shell. Rigid projections outside any helmet's shell shall be limited to those required for operation of essential accessories, and shall not protrude more than 5 mm.
- F. LABELING — Each helmet shall be labeled permanently and legibly, in a manner such that the label(s) can be read easily without removing padding or any other permanent part, with the following:
- (1) Manufacturer's name.
 - (2) Discrete size.
 - (3) Month and year of manufacture. This may be spelled out (for example, August 2009), or expressed in numerals (for example, 8/09).
 - (4) Instructions to the purchaser as follows:
 - (A) "Shell and liner constructed of (identify type(s) of materials)."
 - (B) "Helmet can be seriously damaged by some common substances without damage being visible to the user. Apply only the following: (Recommended cleaning agents, paints, adhesives, etc., as appropriate)"
 - (C) "Make no modifications. Fasten helmet securely. If helmet experiences a severe blow, return it to the manufacturer for inspection, or destroy it and replace it."
 - (5) Certification. Each helmet shall be labeled permanently and legibly with a label, constituting the manufacturer's certification that the helmet conforms to applicable Federal motor vehicle safety standards, that is separate from the label(s) used to comply with labeling requirements listed in parts 1-4 above. The labeling shall have the following content, format, and appearance:

- (A) The symbol "DOT", horizontally centered on the label, in letters at least 0.38 inch (1.0 cm) high.
- (B) The term "FMVSS No. 218," horizontally centered beneath the symbol DOT, in letters at least 0.09 inch (0.23 cm) high.
- (C) The word "CERTIFIED," horizontally centered beneath the term "FMVSS No. 218", in letters at least 0.09 inch (0.23 cm) high.
- (D) The manufacturer's name and/or brand horizontally centered above the symbol DOT, in letters and/or numerals at least 0.09 inch (0.23 cm) high.
- (E) The precise model designation, horizontally centered above the symbol DOT, in letters and/or numerals at least 0.09 inch (0.23 cm) high.
- (F) All symbols, letters, and numerals shall be in a color that contrasts with the background of the label.
- (G) No other information, other than the certification information listed in parts A-E above, shall appear on the label.
- (H) The label shall appear on the outer surface of the helmet and be placed so that it is centered laterally with the horizontal centerline of the DOT symbol located a minimum of 1 inch (2.5 cm) and a maximum of 3 inches (7.6 cm) from the bottom edge of the posterior portion of the helmet.

G. HELMET POSITIONING INDEX — Each manufacturer of helmets shall establish a helmet positioning index (HPI) for each helmet he or she manufactures. This index shall be furnished immediately to any person who requests the information, with respect to a helmet identified by manufacturer, model designation, and size. Refer to Figure 2, below, for a description of the HPI.



Helmet Positioning Index- The distance from the lowest point of the brow opening at the lateral midpoint of the helmet to the basic plane of a reference headform when the helmet is firmly and properly positioned on the reference headform.

FIGURE 2

3. SECURITY

The contractor shall provide appropriate security measures to protect the OVSC test equipment from unauthorized personnel during the entire compliance test program. The contractor is financially responsible for any acts of theft and/or vandalism which occur during the storage of test equipment. Any security problems which arise shall be reported by telephone to the Industrial Property Manager (IPM), Office of Contracts and Procurement, within two working days after the incident. A letter containing specific details of the security problem shall be sent to the IPM (with copy to the COTR) within 48 hours. The contractor shall protect and segregate the data that is collected during each OVSC compliance test from data generated during all previous and subsequent tests. No information concerning the compliance test program shall be released to anyone except the COTR, unless specifically authorized by the COTR or the COTR's Division Chief or Department Head.

NOTE: No individuals, other than contractor personnel directly involved in the compliance testing program or OVSC personnel, shall be allowed to witness any compliance test unless specifically authorized by the COTR.

4. GOOD HOUSEKEEPING

Contractors shall maintain the entire equipment compliance testing area, test fixtures and instrumentation in a neat, clean, and painted condition with test instruments arranged in an orderly manner consistent with good test laboratory housekeeping practices.

5. TEST SCHEDULING AND MONITORING

The contractor shall submit a test schedule to the COTR prior to testing. Tests shall be completed as required in the contract. All testing shall be coordinated to allow monitoring by the COTR.

The contractor shall submit a test schedule to the COTR prior to conducting the first compliance test. Tests shall be completed at intervals as required in the contract.

All compliance testing shall be coordinated with the COTR in order to allow monitoring by the COTR and/or other OVSC personnel if desired. The contractor shall submit a monthly test status report to the COTR. The status report forms are provided in the forms section.

6. TEST DATA DISPOSITION

The contractor shall make all preliminary compliance test data available to the COTR on location within 4 hours after the test. Final test data, including digital printouts and computer generated plots, shall be available to the COTR in accordance with the contract schedule or if not specified within two working days. Additionally, the contractor shall analyze the preliminary test results as directed by the COTR.

The test data shall be retained by the contractor for a minimum of 3 years after conclusion of each delivery order, purchase order, etc. The COTR shall direct final disposition at that time.

The contractor shall segregate and protect the data that evolves from compliance testing before and after each test.

TEST DATA LOSS

A. INVALID TEST DESCRIPTION

An invalid compliance test is one, which does not conform precisely to all requirements/specifications of the OVSC Laboratory Test Procedure and Statement of Work applicable to the test.

B. INVALID TEST NOTIFICATION

The contractor shall notify NHTSA of any test not meeting all requirements/specifications of the OVSC Laboratory Test Procedure and Statement of Work applicable to the test, by telephone, within 24 hours of the test and send written notice to the COTR within 48 hours of the test completion.

C. RETEST NOTIFICATION

NHTSA's Contracting Officer is the only NHTSA official authorized to notify the contractor that a retest is required. The retest shall be completed within 2 weeks after the contractor receives notification from the Contracting Officer that a retest is required.

D. WAIVER OF RETEST

NHTSA, in its sole discretion, reserves the right to waive the retest requirement. This provision shall not constitute a basis for dispute over the NHTSA's waiving or not waiving any requirement.

F. TEST REPORT

No test report is required for any test that is determined to be invalid unless NHTSA specifically decides, in writing, to require the contractor to submit such report. The test data from the invalid test must be safeguarded until the data from the retest has been accepted by the COTR. The report and other deliverables for the retest are required to be submitted to the COTR within 3 weeks after completion of the retest.

G. DEFAULT

The contractor is subject to the default and subsequent procurement costs for non-delivery of valid or conforming tests (pursuant to the Termination For Default clause in the contract).

H. NHTSA'S RIGHTS

None of the requirements stated herein shall diminish or modify the rights of NHTSA to determine that any test submitted by the contractor does not conform precisely to all requirements/specifications of the OVSC Laboratory Test Procedure and Statement of Work applicable to the test.

7. GOVERNMENT FURNISHED TEST ITEMS (GFTI) AND CONTRACTOR PROCURED TEST ITEMS (CPTI)

PROPERTY RECEIPT

Government Furnished Test Items (GFTI) means samples of motorcycle helmets owned or acquired by the Government and subsequently provided to a contractor for use in the performance of a contract. Contractor Procured Test Items (CPTI) means samples of motorcycle helmets acquired by the contractor on behalf of the Government and shall be treated as GFTI for the purpose of this test procedure.

The contractor has the responsibility of accepting motorcycle helmets delivered from motorcycle helmet manufacturers or distributors. In both instances, the contractor acts on the behalf of OVSC when signing an acceptance of GFTI.

The contractor shall inspect and provide evidence of receipt of the GFTI within five (5) calendar days of receiving the GFTI. All helmets shall be individually inspected. Any damaged helmet is unacceptable for testing and the COTR shall be notified immediately so that a replacement item can be obtained. Following inspection, the contractor shall record the date of receipt, make, model, quantity, and condition of all helmets. The GFTI shall be stored appropriately. The

contractor may use the monthly status report format described in Section 14.1 of and shown in Section 16 of this test procedure as evidence of receipt or may list the date of receipt, make, model, quantity, and condition of all helmets in a separate document.

The COTR may request informal interim status updates from the contractor to facilitate OVSC's internal reporting requirements.

PROPERTY STORAGE

After inspection, helmets shall be stored in a clean, dry, secure storage area to prevent damage to them in any manner that may affect test results. Refer to Section 3. Security for additional storage requirements.

DISPOSITION OF GFTI

No test items shall be destroyed or disposed of until authorized by the COTR.

Test items that have "passed" compliance requirements and any identical unused test items are typically maintained until the program year is complete. Test items that have "failed" compliance requirements and any identical unused test items are typically maintained for two years or until the investigation is closed, whichever is greater.

8. CALIBRATION OF TEST INSTRUMENTS

Before the contractor initiates the vehicle safety compliance test program, a test instrumentation calibration system must be implemented. The system shall be maintained in accordance with established calibration practices throughout the performance of the contract. As a minimum, the calibration system shall comply with the following:

- A. Standards for calibrating the measuring and test equipment shall be stored and used under appropriate environmental conditions to assure their accuracy and stability.
- B. All measuring instruments and standards shall be calibrated by the contractor, or a commercial facility, against a higher order standard at periodic intervals not exceeding 12 months for instruments and 12 months for the calibration standards except for static types of measuring devices such as rulers, weights, etc., which shall be calibrated at periodic intervals not to exceed two years. Records, showing the calibration traceability to the National Institute of Standards and Technology (NIST), shall be maintained for all measuring and test equipment.

Accelerometers shall be calibrated every twelve months or any indication from calibration checks that there may be a problem with the accelerometer, whichever occurs first.

- C. All measuring and test equipment and measuring standards shall be labeled with the following information:
 - 1. Date of calibration
 - 2. Date of next scheduled calibration
 - 3. Name of the technician who calibrated the equipment

- D. The contractor shall provide the COTR a written calibration procedure, which includes as a minimum the following information for all measurement and test equipment:
 - 1. Type of equipment, manufacturer, model number, etc.
 - 2. Measurement range
 - 3. Accuracy
 - 4. Calibration interval
 - 5. Type of standard used to calibrate the equipment (calibration traceability of the standard must be evident).
 - 6. The actual procedures and forms used to perform the calibrations.

- E. Records of calibration for all test instrumentation shall be kept by the contractor in a manner that assures the maintenance of established calibration schedules. All such records shall be readily available for inspection when requested by the COTR.

- F. The calibration system shall be accepted by the COTR before vehicle safety compliance testing commences.

- G. Test equipment shall receive a system functional check out using a known test input immediately before and after the test. This check shall be recorded by the test technician(s) and maintained on file.

- H. The contractor may be directed by NHTSA to evaluate its data acquisition system.

Further guidance is provided in the International Standard ISO 10012-1, "Quality Assurance Requirements for Measuring Equipment" and American National

Standard ANSI/NCSL Z540-1, "Calibration Laboratories and Measuring and Test Equipment General Requirements."

NOTE: In the event of a failure of a test item to meet the standard's minimum performance requirements additional calibration checks of some critically sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration will be at the COTR's discretion and shall be performed without additional cost.

9. PHOTOGRAPHIC DOCUMENTATION

Each final report shall include clear, legible, and labeled color images approximately 10 cm tall by 15 cm wide, with minimum resolution of 1,600 x 1,200 pixels. The color images must be sufficiently clear to be reproducible in black and white using standard office equipment.

A representative helmet shall be photographed sufficiently to provide a complete visual description of the helmet. The following photographs are suggested:

- A. 3/4 frontal view;
- B. Interior view, with retention system hardware and labels clearly shown;
- C. Rear or other view that clearly shows the required permanent marking;
- D. A view of the helmet showing both penetration sites;
- E. A one page, legible collage of all labels not legibly shown in the other views;
- F. Representative views of failures as described below:
 - (1) Any visually apparent damage, associated with a failure or the inability of a helmet to complete the test program with the damage circled and the helmets labeled; and.
 - (2) Any witness marks that clearly show evidence of a penetration test failure, especially where damage associated with a failure may be difficult or impossible to see;
- E. A photograph or digital image of the test setup for each phase of testing.

Upon request, the photographs shall be sent to the COTR on a CD or DVD and saved in a "read only" format to ensure that the digital photographs are the exact pictures taken during testing and have not been altered from the original. Additional photographs of test set-ups for failed helmets shall be taken and

retained on file as requested by the COTR. These photographs do not need to be included in the final report.

10. DEFINITIONS

ANY

The word *any*, used in connection with a range of values or set of items in the requirements, conditions, and procedures of FMVSS No. 218, means generally the totality of the items or values, any one of which may be selected by NHTSA for testing, except where clearly specified otherwise.

BASIC PLANE

A plane through the centers to the right and left external ear openings and the lower edge of the eye sockets of a reference headform or test headform (see Figure 3, page 12).

COMPLETE COVERAGE HELMET

A motorcycle helmet that covers the ears, base of the skull, lower face and chin.

DISCRETE SIZE

A numerical value that corresponds to the diameter of an equivalent circle representing the helmet interior in inches (± 0.25 inch) or to the circumference of an equivalent circle in centimeters (± 0.64 cm).

FULL COVERAGE HELMET

A motorcycle helmet that covers the ears and base of the skull, but not the lower face or chin.

HELMET POSITIONING INDEX (HPI)

The distance in centimeters, as specified by the manufacturer, from the lowest point of the brow opening at the lateral midpoint of the helmet to the basic plane of a reference headform, when the helmet is firmly and properly positioned on the reference headform.

IMPACT SITE

The point on the helmet where the helmet shell first contacts the test anvil during the impact attenuation test.

MIDSAGITTAL PLANE

A longitudinal plane through the apex of a reference headform or test headform that is perpendicular to the basic plane as shown in Figure 1 (page 3).

PARTIAL COVERAGE HELMET

A motorcycle helmet that covers the top of the skull but not the ears, base of the skull, lower face, or chin.

REFERENCE HEADFORM

A measuring device contoured to the dimensions of one of the three headforms described in Table 1, with surface markings indicating the locations of the basic, mid-sagittal, and reference planes, and the centers of the external ear openings.

REFERENCE PLANE

A plane above and parallel to the basic plane on a reference headform or test headform (Figure 2, page 5) at the distance indicated in Table 1.

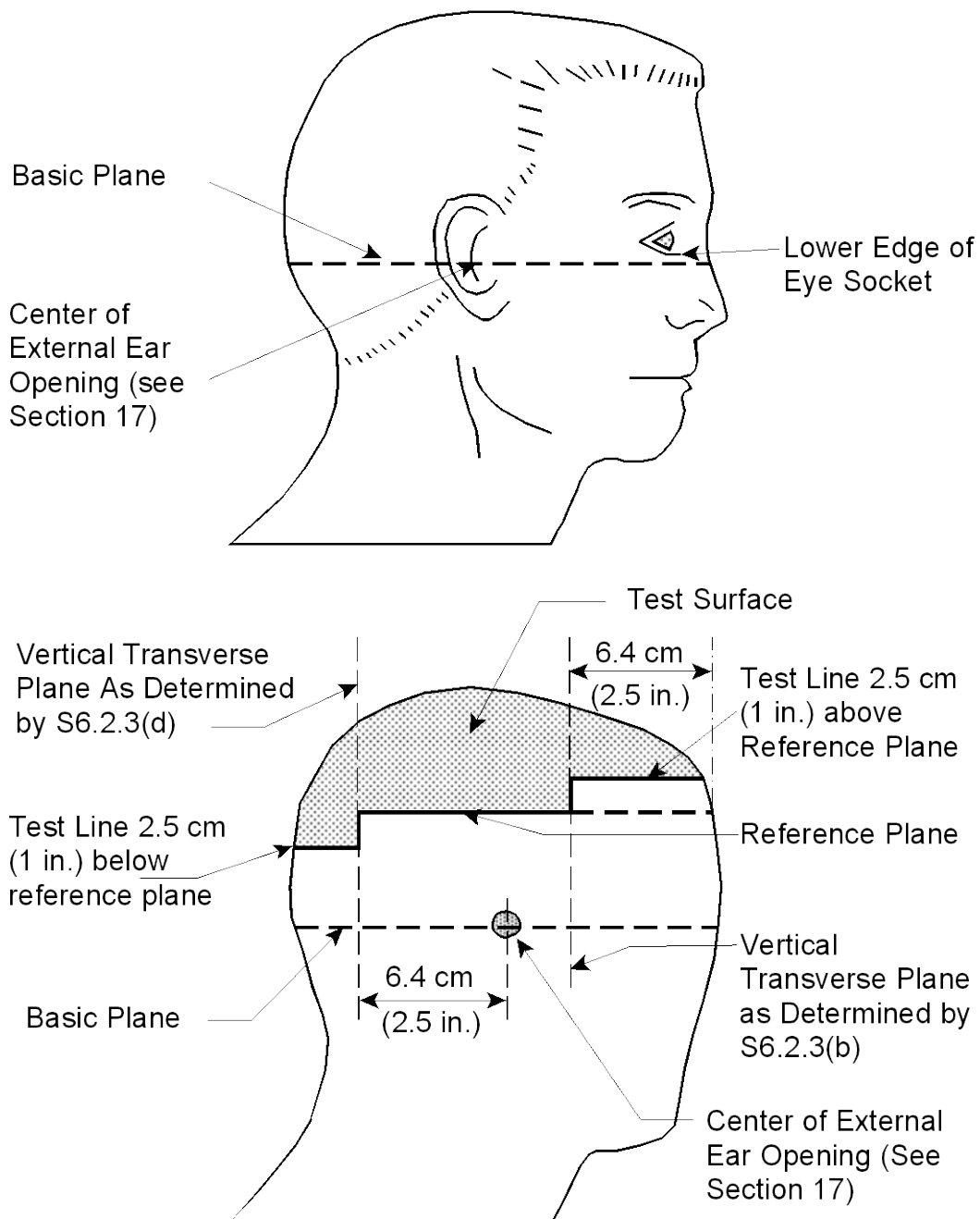
RETENTION SYSTEM

The complete assembly by which the helmet is retained in position on the head during use.

TEST HEADFORM

A test device contoured to the dimensions of one of the three headforms described in Table 1, with surface markings indicating the locations of the basic, mid-sagittal, and reference planes.

BASIC PLANE and TEST LINE



NOTE: Solid lines would correspond to the test line on a test helmet.

FIGURE 3

11. PRETEST REQUIREMENTS

11.1 CONTRACTOR TEST PROCEDURE

Prior to conducting any compliance test, contractors are required to submit a detailed in-house test procedure to the COTR that includes a step-by-step description of the methodology to be used when conducting compliance tests. Written approval must be obtained from the COTR before initiating the compliance test program so that all parties are in agreement.

The contractor shall also submit a checklist for conducting compliance tests. This checklist shall reflect the steps described in the in-house test procedure and be used to conduct each helmet test.

11.2 TEST DATA LOSS

A compliance test is not to be conducted unless all of the various test conditions specified in the applicable OVSC laboratory test procedure have been met. Failure by a contractor to obtain the required test data and to maintain acceptable limits on test parameters in the manner outlined in the applicable OVSC laboratory test procedure may require a retest at the expense of the contractor. The retest costs shall include the cost of the replacement test sample(s) and all costs associated with conducting the retest. The retest sample(s) shall be identical to the original GFTI.

The original test specimen used for the invalid test shall remain the property of OVSC, and the retest specimen shall remain the property of the contractor. If there is a test failure, the contractor shall retain the retest specimen for a period not exceeding 180 days. If there is no test failure, the contractor may dispose of the retest specimen upon notification from the COTR that the final report has been accepted.

The Contracting Officer of NHTSA is the only NHTSA official authorized to notify the contractor that a retest is required. The retest shall be completed within two (2) weeks after receipt of notification by the Contracting Officer that a retest is required. If a retest is conducted, no final report is required for the original test.

11.3 DATA RECORDING

Environmental Data

Environmental data (test area and conditioning environments) shall be continuously monitored and permanently recorded on strip charts, circular charts, in electronic files or other suitable print-out media throughout the conditioning and testing period. If the recording technique is digital, the environmental condition shall be recorded no less frequently than once per two minute interval.

Environmental data shall be recorded within the accuracy parameters specified:

- A. Temperature shall be recorded in degrees Celsius within ± 2 °C of actual values.
- B. Relative humidity shall be recorded within $\pm 5\%$ RH of actual values.

Environmental data shall be included in the final report or retained on file and made available to the COTR upon request.

Test Data

The performing agency shall, with appropriate instrumentation, permanently record the following data within the accuracy parameters specified:

- A. Headform velocity at impact shall be recorded in m/s within ± 0.2 m/s of actual values; accelerations from impact attenuation tests (FMVSS No. 218, S7.1) shall be recorded in g within ± 5.0 g of actual values, and corresponding dwell times in milliseconds (ms) shall be recorded within ± 0.04 ms of actual values.
- B. Evidence of any contact between the striker and the test headform resulting from penetration tests (FMVSS No. 218, S7.2).
- C. Retention system test loads (FMVSS No. 218, S7.3) shall be recorded in kg to within ± 1.0 kg of actual values.
- D. Net displacement of the adjustable portion of retention system test device (FMVSS No. 218, S7.3.4) shall be recorded in cm to an accuracy of ± 0.0254 cm.

11.4 DEVIATIONS

The contractor shall notify the COTR if any deviations from this test procedure are necessary prior to performing the deviation. Any additional problems or questions regarding the technical portion of this contract should also be referred to the COTR within 48 hours via telephone and within one week via e-mail or official letter.

12. COMPLIANCE TEST EXECUTION

12.1 TEST HELMETS

Five (5) structurally identical helmets of the same size shall be available for a test, four of which shall be subjected to the prescribed series of tests after proper environmental conditioning and the fifth shall be retained for use as a spare in the event that additional testing needs to be conducted. Any other use of the spare helmet for test purposes shall be discussed with the COTR first.

12.2 GENERAL TEST CONDITIONS

Unless otherwise specified, all tests and measurements shall be conducted under the following environmental conditions:

Room Ambient	61°F to 79°F (16°C to 26°C)
Relative Humidity	30% to 70%

The laboratory shall be capable of setting, controlling, and reading the environmental condition parameters so that when the accuracies of the instrumentation and the systems are considered in evaluating the recorded data the results are within the upper and lower limits of the specifications. During all phases of testing, environmental conditions shall be continuously monitored and permanently recorded in accordance with Section 11.3.

Prior to testing, helmets shall be prepared to the conditions described in Section 12.5, *Preparation of Test Samples*.

12.3 PERSONNEL TRAINING

Technicians responsible for conducting compliance tests shall be thoroughly familiar with the requirements and test conditions for each test phase to be performed. Each technician shall be specifically instructed in the proper operation of all equipment used during testing.

Personnel supervising the compliance test program shall be thoroughly familiar with the requirements, test conditions, and test equipment.

12.4 TEST SEQUENCE

Helmet preparation and tests shall be performed in the following sequence:

- A. Visual and dimensional inspection (FMVSS No. 218- S5.4, S5.5, and S5.6)
- B. Conditioning – FMVSS No. 218, S6.4
- C. Impact attenuation — FMVSS No. 218, S7.1
- D. Penetration resistance — FMVSS No. 218, S7.2
- E. Retention System strength — FMVSS No. 218, S7.3

12.5 PREPARATION OF TEST SAMPLES

12.5.1 HEADFORM SELECTION

The headform selected for compliance testing shall be based on the discrete helmet size designated on the helmet. If no discrete size designation is available, obtain guidance from the COTR before proceeding. Table 1 lists the discrete helmet sizes and the corresponding headform sizes.

HELMET DISCRETE SIZE DESIGNATION	HEADFORM SIZE
Less than or equal to 6-3/4 (European Size 54)	SMALL
Greater than 6-3/4, but less than or equal to 7-1/2 (European Size 60)	MEDIUM
Greater than 7-1/2 (European 60)	LARGE

Table 1. Headform Selection

If the helmet size designation falls into more than one of three size ranges, it shall be tested on each appropriate headform. If this is the case, the test lab shall consult the COTR before beginning the test.

12.5.2 WEIGHING

The weight of each helmet shall be measured prior to beginning testing. The helmet shall be prepared to the test configuration for the purpose of weighing. For example, if the helmet has tags or accessories that will not be in place during testing, they shall be removed prior to weighing.

12.5.3 PROJECTIONS

External projections shall be measured perpendicularly to the plane tangent to the helmet shell surface at the location of the projection.

12.5.4. LABELING

The helmet shall be inspected to determine if the required labels are present, permanent, legible, and contain the required information in the correct format and having the required appearance.

A. Certification Label

The certification label constitutes the manufacturer's certification that the helmet conforms to FMVSS No. 218. This label shall be the symbol "DOT" horizontally centered on the helmet in letters not less than 0.38 inch (1.0 cm) high. The term "FMVSS No. 218" shall be horizontally centered beneath the symbol DOT in letters not less than 0.09 inches (0.23 cm) high. The word "CERTIFIED" shall be horizontally centered beneath the term "FMVSS No. 218" in letters not less than 0.09 inches (0.23 cm) high. The manufacturer's name and/or brand, shall be horizontally centered above the model designation, in letters and/or numerals not less than 0.09 inch (0.23 cm) high. All symbols, letters and numerals shall be in a color that contrasts with the background of the label. No other information shall appear on the label. The label shall appear on the outer surface of the helmet and be placed so that the horizontal centerline of the DOT symbol is located a minimum of 1 inch (2.5 cm) and a maximum of 3 inches (7.6 cm) from the bottom edge of the posterior portion of the helmet.

B. Information Label(s)

Information can be read easily without removing padding or any other permanent part with the manufacturer's name, discrete size, month and year of manufacture, and instructions to the purchaser. Instructions to the purchaser shall include the following statements, "Shell and liner constructed of (identify types(s) of materials). Helmet can be seriously damaged by some common substances without damage being visible to the user. Apply on the following: (Recommended cleaning agents, paints,

adhesives, etc., as appropriate). Make no modifications. Fasten helmet securely. If helmet experiences a severe blow, return it to the manufacturer for inspection, or destroy it and replace it.”

C. Guidance for judging *easily read* and *permanence*.

1. OVSC compliance labs shall examine the labels to determine if they are read easily without removing padding or any other permanent part, taking into account the following guidelines:
 - a) Any label that is legible and entirely visible when the helmet is examined inside and out, shall be considered “easily read”
 - b) Easily read for the purpose of S5.6.1(a) through (c) means that the label can be located without removing a permanent part of the helmet and can be exposed if necessary so the user can read the required information.
 - c) Easily read for the purpose of S5.6.1(d) means that this label must be visible to the user without moving any part of the helmet (including replaceable padding).
2. OVSC compliance labs shall attempt to remove labels without tools and inspect for the following:
 - a) Labels according to S5.6.1(a) through (c) would be determined to be permanent if they are located in a place such that it is intended to remain there for the life of the product (i.e. not on the visor or a removable padding) and at least one of the following five conditions:
 - 1) It cannot be removed without the aid of tools or solvents, or
 - 2) Attached by a seam, or
 - 3) Tears into at least 3 or more pieces with no single piece being larger than 50% of the total area of the label when removed, or
 - 4) Removal damages the surface to which it is attached and the size of the damage is greater than 50% of the size of the label, or
 - 5) Removal creates physical evidence that an affixation was originally present or required to be present. Physical evidence may include such things as adhesive residue or an area of contrasting color showing some information is missing.
 - b) Labels according to S5.6.1(d) would be determined to be permanent if they are located in a place such that it is intended to remain there during normal use (i.e. not on the visor) and at least one of the following five conditions:
 - 1) It cannot be removed without the aid of tools or solvents, or

- 2) Attached by a seam, or
- 3) Tears into at least 3 or more pieces with no single piece being larger than 50% of the total area of the label when removed, or
- 4) Removal damages the surface to which it is attached and the size of the damage is greater than 50% of the size of the label, or
- 5) Removal creates physical evidence that an affixation was originally present or required to be present. Physical evidence may include such things as adhesive residue or an area of contrasting color showing some information is missing.

12.5.5. MARKING

Before beginning the compliance test, contact the COTR to obtain the helmet positioning index (HPI) for the helmet being tested. Refer to Section 10 for a definition of HPI and Figure 2 (page 5) for a diagram showing HPI.

Each helmet shall be marked prior to testing. It is suggested that a marking fixture be constructed and used to mark the helmet. This fixture may serve the two-fold purpose of —

- (a) Applying the $4.5 \pm .05$ kg mass to the apex of the helmet for seating (this may be accomplished with dead weight), and
- (b) Providing positioning indicators (on a base plate or otherwise external to the reference headform) to ensure consistent and accurate marking.

In accordance with FMVSS No. 218, S6.2:

- (1) Use a headform that is firmly seated with the basic and reference planes horizontal. Place the helmet to be tested on the appropriate headform (per section 12.5.1 of this test procedure).
- (2) Place a 4.5 kg mass on the helmet's apex. Center the helmet laterally and seat it firmly on the reference headform according to its HPI.
- (3) Maintaining the load and position described in step 2, draw a test line on the outer surface of the helmet along the portions of the planes that intersect with the helmet surface as described below:

- a. A plane 2.5 cm above and parallel to the reference plane in the anterior portion of the reference headform;
- b. A vertical transverse plane 6.4 cm behind the point on the anterior surface of the reference headform at the intersection of the mid-sagittal and reference planes;
- c. The reference plane of the reference headform;
- d. A vertical transverse plane 6.4 cm behind the center of the external ear opening in a side view; and
- e. A plane 2.5 cm below and parallel to the reference plane in the posterior portion of the reference headform.

Refer to Figure 3, page 12 for a diagram of the test line.

In addition to the above described marking, each helmet shall be labeled with a laboratory assigned serial number and the environmental condition to which it will be subjected, prior to and during testing.

CAUTION: Certain substances which could be used to mark helmets may cause chemical degradation of the shell material. It is therefore suggested that only water based markers or wax pencils be used for this purpose.

In addition to marking the helmet, it is recommended that the headform(s) be marked in a non-permanent fashion to provide the test operator a quick reference indicator for realigning the helmets using the HPI prior to each test.

12.5.6 PERIPHERAL VISION

Peripheral vision shall be measured while the helmet is properly positioned and seated, with a $4.5 \pm .05$ kg static load, on the reference head-form. A device with an accuracy of $\pm 1^\circ$ shall be used for this measurement.

Each helmet shall provide a minimum peripheral vision of 105° to each side of mid-sagittal plane.

12.5.7 CONDITIONING

Immediately prior to testing, condition each test helmet in accordance with any one of the following procedures:

- (1) Ambient – Expose to any temperature from 61°F to and including 79°F (from 16°C to and including 26°C) and any relative humidity from 30 to and including 70 percent for a minimum of four hours.
- (2) Low Temperature – Expose to any temperature from 5°F to and including 23°F (from -15°C to and including -5°C) for a minimum of four hours and no longer than 24 hours.
- (3) High Temperature – Expose to any temperature from 113°F to and including 131°F (from 45°C to and including 55°C) for a minimum of four hours and no longer than 24 hours.
- (4) Water Immersion – Immerse in water at any temperature from 61°F to and including 79°F (from 16°C to and including 26°C) for a minimum of four hours and no longer than 24 hours.

Testing shall commence at two minutes after the helmet has been removed from its conditioning environment and the helmet shall be returned to its conditioning environment after testing. A record of test dates and times out of the conditioning environment shall be made for each helmet test. Although this data shall be collected and made available to the COTR upon request, it is not required to be included in the final report. Before beginning a subsequent test on that helmet, the helmet shall be maintained at the appropriate environmental condition as described below in Table 2.

If the time out of the conditioning environment is x	Then the helmet must be returned to the conditioning environment for y
$x \leq 4$ minutes	$y \geq 3$ minutes; or
$4 \text{ minutes} < x \leq 5$ minutes	$y \geq 6$ minutes; or
$5 \text{ minutes} < x \leq 6$ minutes	$y \geq 9$ minutes; or
$6 \text{ minutes} < x \leq 7$ minutes	$y \geq 12$ minutes; or
$n \text{ minutes} < x \leq n+1$ minutes (where n is an integer)	$y \geq 3(n-2)$ minutes

Table 2. Required Time for Reconditioning

The laboratory shall be capable of setting, controlling, and recording the temperatures maintained by the environmental conditioning equipment so that when the accuracies of the instrumentation and the systems are considered in evaluating the recorded data, the results are within the upper and lower limits of the specifications.

12.6 IMPACT ATTENUATION TEST

The following information is provided to clarify FMVSS No. 218, S7.1.

12.6.1 TEST EQUIPMENT AND TOLERANCES

A. Test Headforms

The test headforms used for the impact attenuation test shall conform to the dimensions described in Figures 4, 5, 6, and 7 (pages 24-27) and Section 17.

These headforms shall be constructed of magnesium alloy (K-1A), and exhibit no resonant frequencies below 2,000 Hz. The center of gravity of the test headform and the supporting assembly is specified in FMVSS No. 218, S7.1.8

B. Drop Test System

A monorail drop test system is used for impact attenuation.

The apparatus used to guide the drop assembly shall be constructed and maintained to ensure a free fall within $\pm 1^\circ$ of vertical. The guide-drop assembly interface shall be designed with suitable tolerances and materials in order to minimize any frictional effects and comply with the requirements of S7.1.7-S7.1.8. The acceleration transducer shall be mounted at the center of gravity of the test headform with the sensitive axis aligned to within 5° of vertical when the test headform assembly is in the impact position. The acceleration data channel shall comply with the SAE Recommended Practice J211 MAR 95, "Instrumentation for Impact Tests- Part 1- Electronic instrumentation," requirements for channel class 1,000.

The laboratory must be capable of setting the drop heights so that when the accuracy of the measuring device is considered in evaluating the recorded data the results are within the specified limits.

Drop Assembly Weights

The combined weight of the instrumented test headform and supporting assembly for impact tests shall be as follows:

SMALL	7.6 – 8.0 lbs (3.4 – 3.6 kg)
MEDIUM	10.8 – 11.2 lbs (4.9 – 5.1 kg)
LARGE	13.2 – 13.6 lbs (6.0 – 6.2 kg)

C. Anvils

The flat anvil is constructed of steel with a 12.7 cm minimum diameter impact face, and the hemispherical anvil is constructed of steel with a 4.8 cm radius impact face.

12.6.2. TEST LOCATION

Each helmet is impacted at four sites with two successive impacts at each site. Two of these sites are impacted upon a flat steel anvil and two upon a hemispherical steel anvil. The impact sites are at any point on the area above the test line, and separated by a distance not less than one-sixth of the maximum circumference of the helmet in the test area. The laboratory shall perform impact attenuation tests at the same impact sites on each of the helmets conditioned to the various conditioning procedures. For each site, the location where the helmet first contacts the anvil on the second impact shall not be greater than 0.75 inch (1.9 cm) from the location where the helmet first contacts the anvil on the first impact.

The laboratory shall implement a method to record impact sites. For example, marking the point on the anvil where the helmet first contacts the anvil with an “●” using a water-based marker or wax pencil that transfers to the helmet during testing, is a suitable method.

The laboratory shall perform impact attenuation tests within ± 45 degrees of the locations identified on Data Sheet 4, or as directed by the COTR.

12.6.3 SYSTEM CHECK

Immediately prior to, and at the conclusion of the 32-impact series for each set of helmets, the entire system shall be tested for possible faults by making a series of check drops onto a standardized impact media (a 2.54 cm open blue Modular Elastomer Programmer (MEP) Calibration Pad has proven suitable for this purpose).

The drop height and media for these checks shall be chosen to demonstrate the system's capability to produce and record an acceleration

vs. time history of (nominally) 400 g with a minimum 1 ms duration above 200 g.

Check drops shall be made using the same headform and drop assembly that will be used to conduct the impact attenuation test. The headform shall be bare and the point of impact and accelerometer axis shall be vertically aligned. During the posttest, the headform shall be aligned in a manner that is consistent with the pretest check drop.

A systems check shall consist of 6 drops. The first 3 drops are considered "warm-up" drops. Permanent recording of data is not required for these impacts. The second 3 drops shall be recorded and the results of these drops shall become part of the test data presented in the final report.

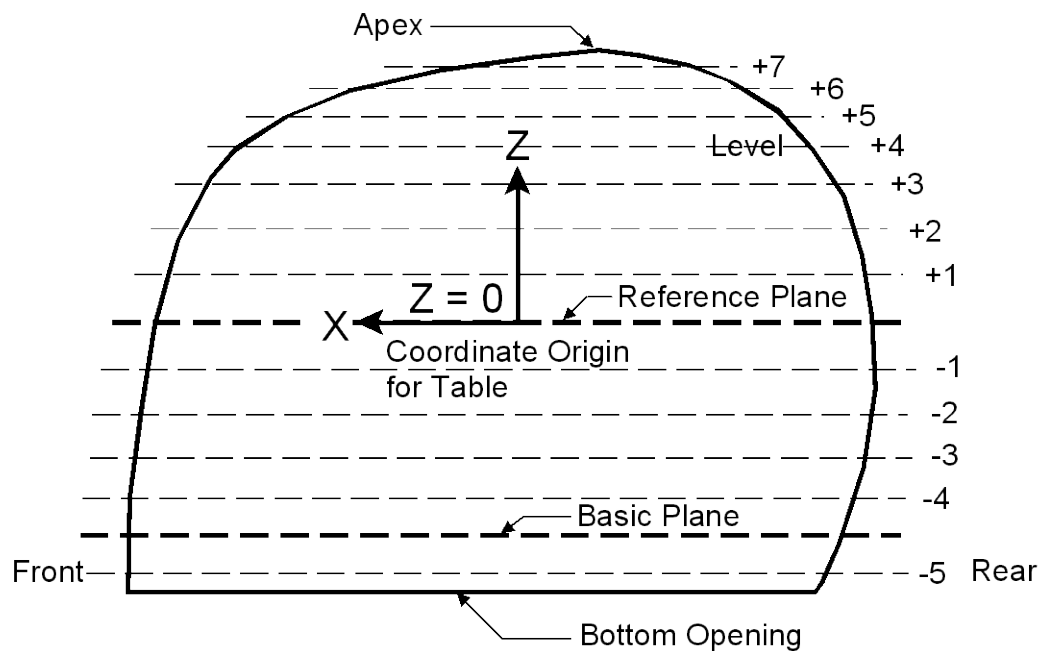
If either of the following conditions exist, stop testing immediately, trouble shoot and contact the COTR before proceeding with testing for NHTSA —

- (1) none of the three recorded accelerations are greater than 375 g, or
- (2) the average of pretest and posttest checks (recorded drops only) differs by more than 15 g.

In addition, immediately prior to the first drop check and after the final posttest check, a highly accurate ($\pm 0.1\%$ voltage) calibration signal shall be injected into the system. The output produced by this signal shall be recorded and maintained on file.

HEADFORM SECTIONS

Mid-Sagittal Plane (Symmetrical Plane)



Headform Coordinate Systems (Right Hand Rule)

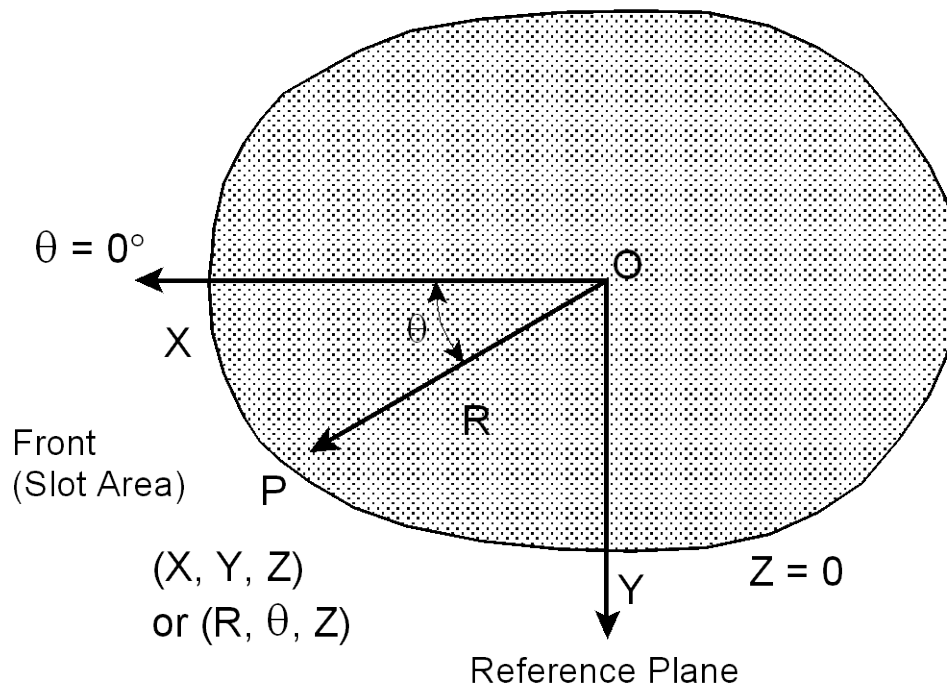


FIGURE 4

SMALL HEADFORM

Interior Design

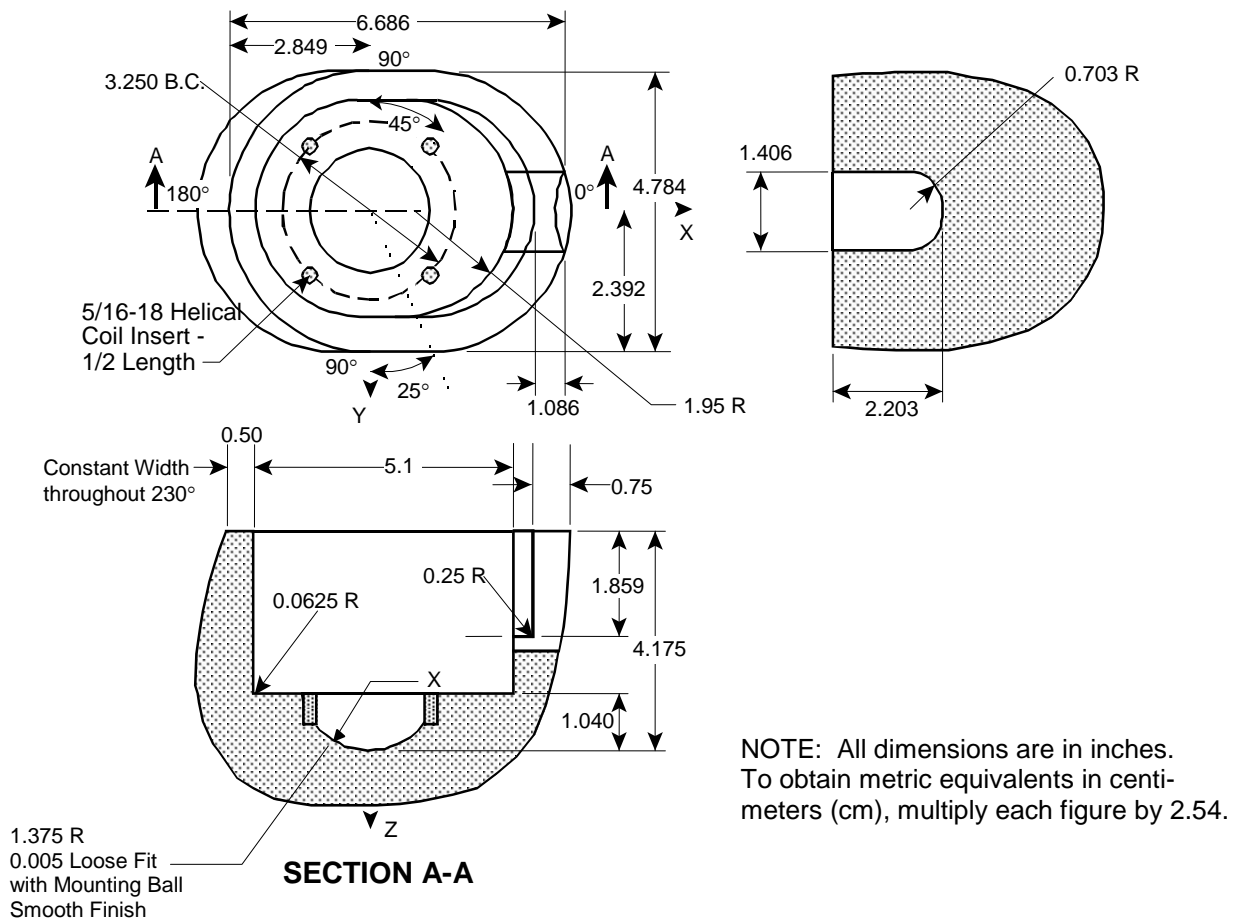
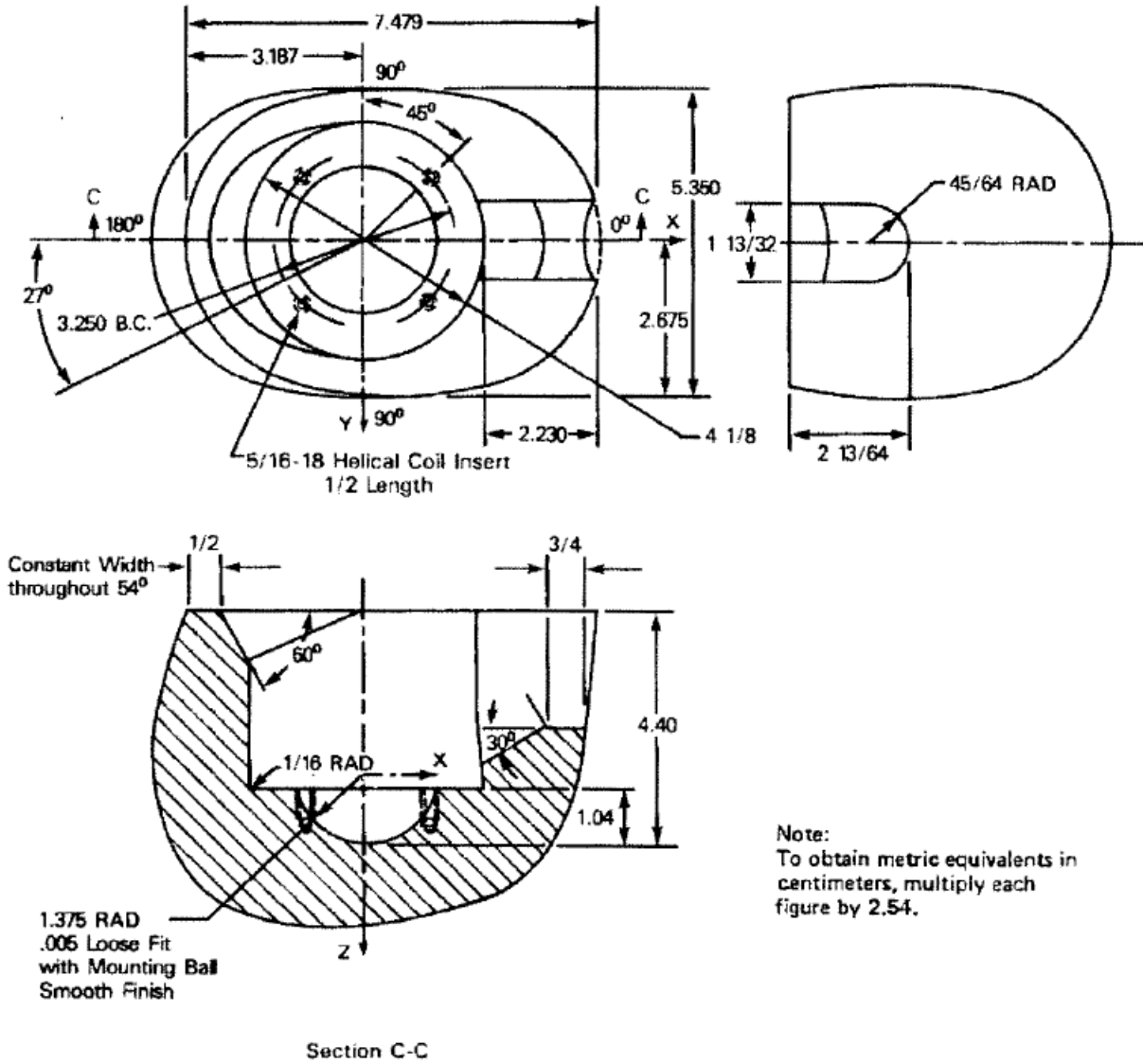


FIGURE 5

MEDIUM HEADFORM

Interior Design

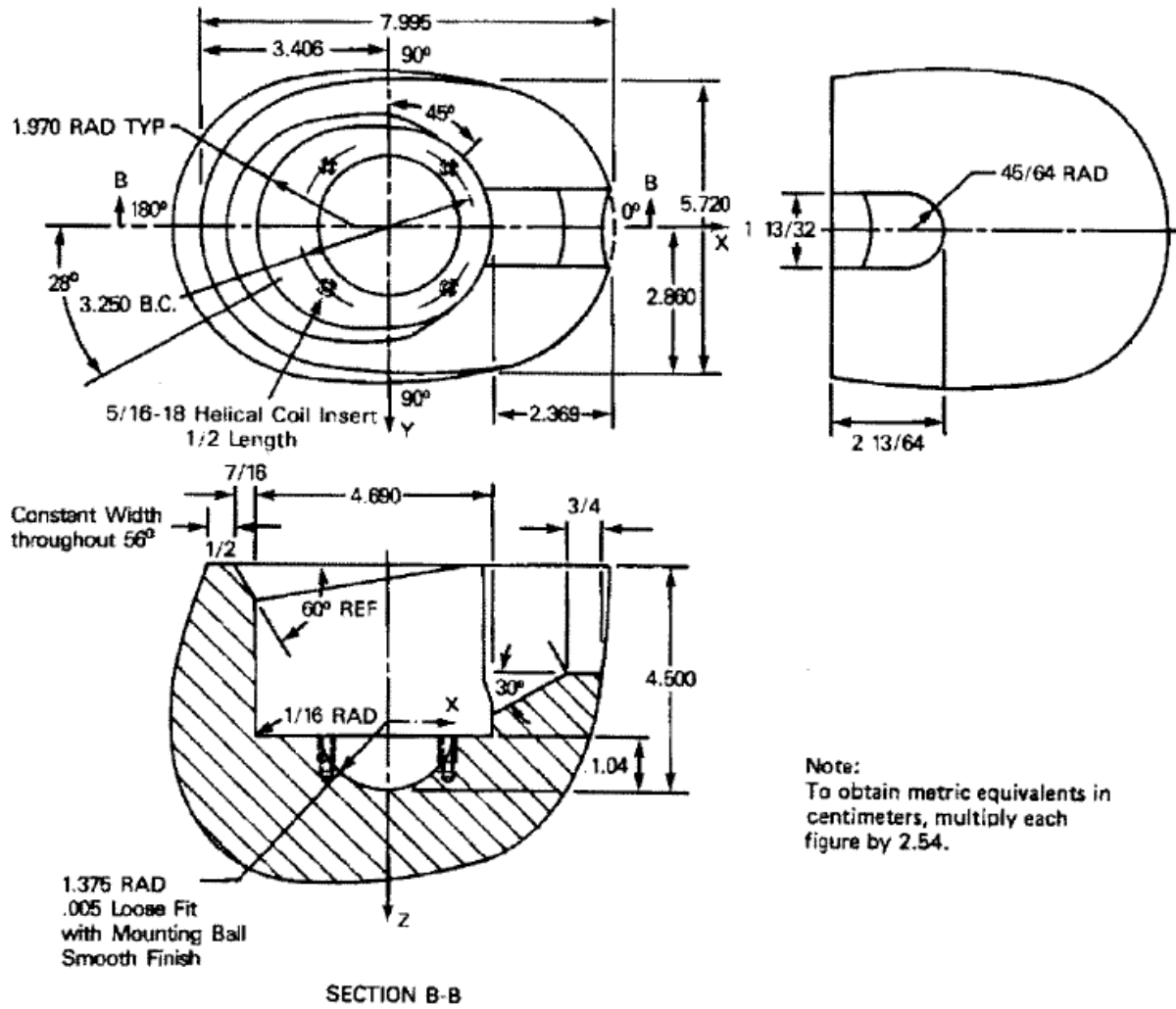


Note:
To obtain metric equivalents in centimeters, multiply each figure by 2.54.

FIGURE 6

LARGE HEADFORM

Interior Design



Note:
To obtain metric equivalents in centimeters, multiply each figure by 2.54.

FIGURE 7

12.6.4. TEST PROCEDURE

- (1) Once systems checks are completed, replace the MEP with either of the two steel anvils. Align the test headform for the desired impact location.
- (2) Prepare the anvil with witness marks that will transfer to the helmet upon impact. The witness marks are intended to show the impact site and the distance between first and second impacts, therefore it is recommended that the point of first contact between the helmet and anvil be marked.
- (3) Place the subject helmet on the test headform and adjust it in accordance with the manufacturer's HPI. Use the chinstrap to fasten the helmet to the drop assembly and prevent slippage during free fall.

CAUTION: Secure the helmet so that it does not shift position before impact or before application of force during testing. Do not tighten chinstrap with more force than is necessary to prevent the helmet from moving before impact or before application of force during testing, as this will result in abnormal deformation and stress prior to impact.

Reposition the helmet as necessary after each impact to realign the helmet with the HPI.

- (4) Raise the drop assembly to the height necessary to achieve the required impact speed (see Table 3). Calibrated measuring rods are a suitable measuring technique to ensure consistency throughout testing. The laboratory shall monitor the drop heights to ensure the mechanical drop system is functioning properly.

Anvil	Impact Speed	Nominal Drop Height
Hemispherical	16.4 – 17.7 ft/s (5.0 – 5.4 m/s)	138.4 cm
Flat	19.0 – 20.3 ft/s (5.8 – 6.2 m/s)	182.9 cm

Table 3. Impact attenuation impact speeds

- (5) Simultaneously release the drop assembly and trigger the instrumentation system to permanently record the acceleration-time trace. The acceleration-time trace for all 32 test drops shall be included in the final report. Each report shall include information identifying the helmet, drop number, time, date, helmet test condition (such as ambient, low temperature, high temperature, or water immersed), impact location, anvil type, impact velocity, peak acceleration (g), and dwell times (ms) at 150 g and 200 g.
- (6) Repeat the above steps (changing headform position and anvils as necessary) until all 32 impacts are completed. Each helmet is impacted at four sites with two successive impacts at each site. For each site, the location where the helmet first contacts the anvil on the second impact shall not be greater than 0.75 inch (1.9 cm) from the location where the helmet first contacts the anvil on the first impact. Two of these sites are impacted upon a flat steel anvil and two upon a hemispherical steel anvil.
- (7) Perform posttest systems checks in accordance with Paragraph 12.6.3, *System Check*.
- (8) Record test data as follows:
 - a. Data shall be recorded to at least one more significant digit than to which it is reported. This data shall be retained in the test file in the event that there is an investigation and needs to be accessed.
 - b. Data shall be rounded for the purpose of reporting (0-4 rounds down; 5-9 rounds up).
- (9) Report the results of the impact attenuation test on Data Sheet 4 and include the data sheet in the final report. Round reported test data as follows:
 - a. Peak accelerations (reported in g) shall be rounded to the ones place
 - b. Dwell times (reported in ms) shall be rounded to the tenths place
 - c. Velocities (reported in m/s) shall be rounded to the hundredths placeFor each impact, the drop number, helmet test condition, impact location, anvil type, peak g, dwell times at 150 g and 200 g, and impact velocity shall be recorded.

12.6.5 FAILURE CRITERIA

Accelerations in excess of 400 g or cumulative dwell times in excess of 2.0 ms above 200 g or 4.0 ms above 150 g shall be recorded as failures.

12.7 PENETRATION TEST

The following information is provided to clarify FMVSS No. 218, S7.2.

12.7.1 TEST EQUIPMENT AND TOLERANCES

(A) Headform

The test headforms used for the penetration test shall conform to the dimensions described in Figures 4, 5, 6, and 7 (pages 25 - 28) and Section 17.

Test contactable surface of the headforms used for the penetration test shall be constructed of a metal or metallic alloy having a Brinell hardness number no greater than 55. If, during the course of testing, the headform is damaged (indented) by the penetration striker, it shall be repaired prior to the next test.

(B) Guided free-fall apparatus

The apparatus used to guide the penetration striker during free-fall shall be constructed and maintained to ensure a path within $\pm 1^\circ$ of vertical. If the apparatus completely encloses the striker (such as a tube), it shall provide a clearance between the striker and guide of not greater than 5.1 mm total. Also, it has been shown that completely enclosed apparatuses having very small tolerances between the striker and tube can reduce the free-fall velocity of the striker and artificially reduce the severity of the test. Any guided free-fall apparatus shall be constructed so that it ensures the velocity of the striker to be as close to 100% of the theoretical velocity as possible.

(C) Striker

The weight of the penetration striker is not less than 6 pounds, 8 ounces and not more than 6 pounds 12 ounces (2.95 to 3.06 kg). The point of the striker has an included angle of $60^\circ \pm 0.5^\circ$, a cone height of 1.5 ± 0.015 inch (3.8 ± 0.038 cm), a tip radius of 0.02 ± 0.004 inch (0.5 ± 0.1 mm), and a minimum hardness of 60 Rockwell, C-scale.

12.7.2 TEST LOCATION

The laboratory shall perform penetration tests at the same locations on each of the four helmets. These locations shall be above the test line such that penetration sites are at least 7.6 cm apart, and at least 7.6 cm from the center of any impact applied during impact attenuation testing and not on a fastener or other rigid projection.

Typically, the location of the first penetration test shall be in the crown area of the helmet, greater than 7.6 cm from the center of any impact applied during the impact attenuation test or as directed by the COTR.

Typically, the location of the second penetration test shall be on the side area of the helmet, greater than 7.6 cm from the center of any impact applied during the impact attenuation test and from the first penetration test location, or as directed by the COTR.

The laboratory shall photograph the penetration test sites and include the image in the final report.

12.7.3 TEST PROCEDURE

- (1) Align the headform for the desired penetration location and apply witness tape to the potential contact area.
- (2) Place the subject helmet on the test headform and adjust it in accordance with the manufacturer's HPI. Use the chinstrap as necessary to fasten the helmet to the drop assembly and prevent slippage prior to the striker contacting the helmet.
- (3) Raise the penetration striker assembly to the proper height using a suitable measuring technique (calibrated measuring rods are suggested). The penetration striker shall be dropped in a guided free fall from a height of 118.1 ± 0.6 in (3 ± 0.015 m), as measured from striker point to the impact point on the outer surface of the test helmet when properly positioned on the test headform.
- (4) Release the striker assembly.
- (5) Remove the helmet from the headform and examine the headform for evidence of contact between it and the striker. Record the results on Data Sheet 5 and include this sheet in the final report. If contact is made, photograph the penetration site on the headform and carefully remove the witness tape from the headform. Retain and store the evidence securely with the data sheets for that helmet. Removal and storage of the witness tape shall be done in

such a manner as to not destroy, distort or otherwise obliterate the resultant indentation. A digital image of the witness tape showing evidence of a failure shall be included in the final report.

- (6) If the headform is damaged, refinish it before conducting the next test.

12.7.4 FAILURE CRITERIA

Contact between the striker and the surface of the test headform at any point above the test line shall be recorded as a failure.

Contact between the headform and striker shall be demonstrated using some evidence that can be stored after the test is complete. For instance, evidence of the penetration failure may be provided through use of witness tape or similar material applied to the headform before the test in order to reveal any contact of the striker onto the headform that is indicative of the penetration failure.

12.8 RETENTION SYSTEM TEST

The following information is provided to clarify FMVSS No. 218, S7.3.

12.8.1 TEST EQUIPMENT AND TOLERANCES

- (A) Headform

The test headforms used for the retention system test shall conform to the dimensions described in Figures 4, 5, 6, and 7 (pages 25 - 28) and Section 17.

- (B) Retention System Test Device

The retention system test device shall consist of both an adjustable loading mechanism by which a quasi-static tensile load is applied at any rate from 0.4 to and including 1.2 inch/min (from 1.0 to and including 3.0 cm/min) to the helmet retention assembly and a means for holding the test headform and helmet stationary. The retention assembly shall be fastened around two freely moving rollers, both of which have a 0.5 inch (1.3 cm) diameter and a 3 inch (7.6 cm) center-to-center separation, and which are mounted on the adjustable portion of the tensile loading device. The helmet is fixed on the test headform as necessary to ensure that it does not move during the application of the test loads to retention assembly. Refer to Figure 8 (page 35).

The laboratory shall be capable of applying the retention system loads so that when the accuracies of the instrumentation and the systems are considered in evaluating the recorded data the results are within the upper and lower limits of the specified conditions.

12.8.2 TEST PROCEDURE

- (1) Inspect the retention system to determine if the helmet can be fastened without securing the complete assembly. If this is possible, contact the COTR to determine how to test the retention system before beginning the test.
- (2) Place the subject helmet on the test headform such that the basic plane is normal to the force of gravity and adjust it in accordance with the manufacturer's HPI.
- (3) Securely fasten the retention system around the two freely moving rollers in a manner that avoids contact between the rollers and helmet's buckle.
- (4) Apply a preliminary load of 22.7 kg, + 4.5 kg, - 0 kg in the direction normal to the basic plane to the retention system and hold for a minimum of 30 seconds.
- (5) Record the vertical distance between the apex of the helmet and a fixed point on the moveable test device.
- (6) Increase the load to 136 kg, + 0.0 kg, - 4.5 kg at the rate of 1.0 - 3.0 cm/min measured between the roller assembly and the headform. Maintain this load for 120 seconds, + 0 seconds, - 10 seconds.
- (7) After 120 seconds (+0 seconds, -10 seconds) at full test load, measure and record the vertical distance between the apex of the helmet and a fixed point on the moveable test device (same point as used for previous measurement).
- (8) Record test data as follows:
 - a. Data shall be recorded to at least one more significant digit than to which it is reported. This data shall be retained in the test file in the event that there is an investigation and needs to be accessed.
 - b. Data shall be rounded for the purpose of reporting (0-4 rounds down; 5-9 rounds up).

- (9) Summarize the results of the retention tests on Data Sheet 6 and include the data sheet in the final report. Report the extension test data in cm to the tenths place. Include the retention system test plots for each of the four retention system tests in the final report. Each plot shall include information identifying the helmet, date, helmet test condition (such as ambient, low temperature, high temperature, or water immersed), maximum load, and extension at the maximum load.

12.8.3 FAILURE CRITERIA

When tested as previously described —

- A. The retention system, its components and attachments (including the helmet shell) shall attain the specified loads without separation; and
- B. The adjustable portion of the retention system test device shall not move more than 2.5 cm, measured between preliminary and full test load positions.

RETENTION SYSTEM TEST DEVICE

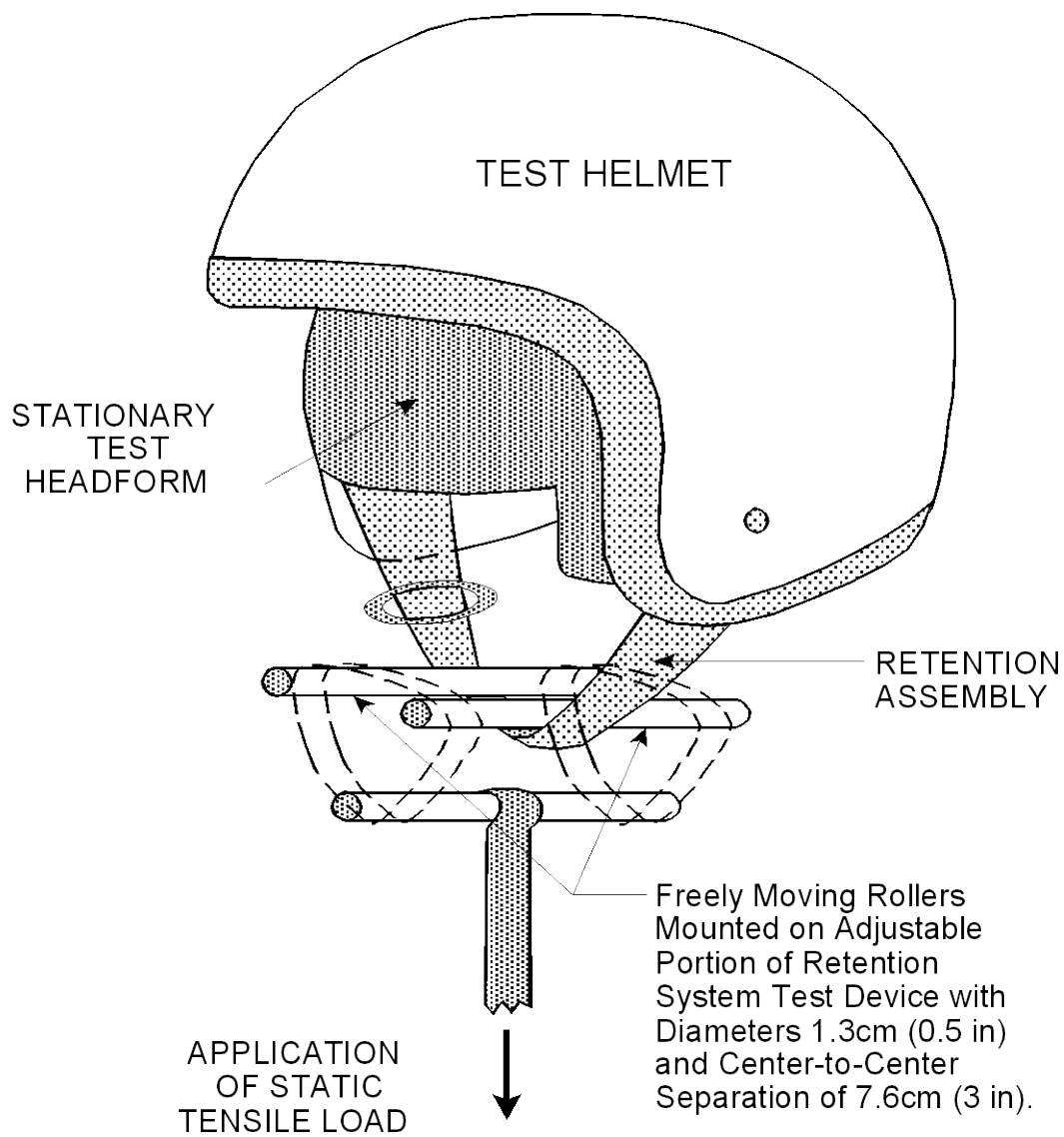


FIGURE 8

13. POSTTEST REQUIREMENTS

The contractor shall verify all data sheets have been filled out completely and accurately and all necessary photographs have been taken.

14. REPORTS

14.1 MONTHLY STATUS REPORTS

The contractor shall submit a monthly report to the COTR on the 20th day of each month beginning when the first test item is received until the last test is completed for the fiscal year.

Monthly status reports shall include the following:

- A. Test assets received and number of tests and reports scheduled for the reporting period and completed during the reporting period;
- B. Schedule for tests and reports for the next reporting period;
- C. Brief description of test failures which occurred during the reporting period;
- D. Problems or delays that the contractor experienced during the reporting period which are related to the supplies and services required under this contract;
- E. Specific action that the contractor proposes to correct problems or delays identified

The COTR may request informal interim status updates from the contractor to facilitate OVSC's internal reporting requirements.

A sample Monthly Status Report is shown Section 16, *Forms*. This report shall list the report number; the brand, model, size, and type of helmet; the date the helmet is received at the lab; the date testing is started; and if the helmet passes or fails testing. For helmets that fail testing, a brief failure description, e.g., peak-g, dwell time, penetration, retention, labeling, DOT-symbol, etc. will be provided.

The contractor shall also submit a monthly report to the COTR listing the equipment that is being stored. This Equipment Storage Report shall be submitted until all items of equipment are disposed of. A sample Equipment Storage Report is shown Section 16, *Forms*.

14.2 TEST FAILURE NOTIFICATION

Any indication of a test failure shall be communicated by telephone to the COTR within 1 working day and in writing by e-mail or fax within 2 working days. A Notice of Test Failure (see Section 16. *Forms*) with a copy of the particular compliance test data sheet(s), preliminary data plot(s), and photographs as applicable shall be included. In the event of a test failure, a posttest calibration check of some critically sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration shall be at the COTR's discretion and shall be performed without additional costs to the OVSC.

The final determination of "passed" or "failed" shall be made by the COTR upon acceptance of the final report. Therefore, no test items shall be destroyed or disposed of until authorized by the COTR. Test items which have "failed" compliance requirements and any unused test items identical to the test items which have "failed" compliance requirements, shall be stored by the contractor for at least 2 years after the test failure at no additional cost, unless directed by the COTR to do otherwise.

14.3 FINAL REPORTS

14.3.1 COPIES

One paper and one electronic copy of the final report shall be submitted to and received by the COTR for acceptance within three weeks of test completion or received before the end of the fiscal year, whichever comes first. The final report format to be used by all contractors is described in Sections 14.3.2-14.3.5 of this report.

Payment of contractor's invoices for completed compliance tests may be withheld until the final report is accepted by the COTR. Contractors are requested to NOT submit invoices before the COTR is provided copies of the final report.

Contractors are required to submit a draft version of the final report within two weeks after the compliance test is conducted.

Contractors shall **PROOF READ** all final reports before submitting them to the COTR. The OVSC will not act as a report quality control office for contractors. Reports containing a significant number of errors will be returned to the contractor for correction, and a "hold" will be placed on invoice payment for the particular test.

The electronic copy of the final report shall be provided to the COTR in MS Word or .pdf format that is compatible and size appropriate for storage in the OVSC's database. The final report shall be provided with all required signatures. The recommended compression settings can be obtained from the COTR.

14.3.2 REQUIREMENTS

The final report and associated documentation (including photographs, see Section 9) are relied upon as the chronicle of the compliance test. The final report will be released to the public domain after review and acceptance by the COTR. For these reasons, each final report must be a complete document capable of standing by itself.

The contractor shall describe in detail any compliance test events that deviate from the test procedures approved by the COTR as well as any events that are not directly associated with the standard but are of technical interest shall also be included in the final report. Such events shall be included in Appendix A of the final report.

Instructions for the preparation of the first three pages of the final report are provided below for the purpose of standardization.

14.3.3 FIRST THREE PAGES

A. FRONT COVER

A heavy paperback cover (or transparency) shall be provided for the protection of the final report. The information required on the cover is as follows:

- (1) Final Report Number such as 218-ABC-XX-001, where —
218 is the FMVSS tested
ABC are the initials for the laboratory
XX is the last two digits of the Fiscal Year of the test program
001 is the Group Number (001 for the 1st test, 002 for the 2nd test, etc.)

- (2) Final Report Title and Subtitle such as

SAFETY COMPLIANCE TESTING FOR FMVSS No. 218
Motorcycle Helmets

Safety Equipment Company
(state the brand and model of the tested helmet)

- (3) Contractor's Name and Address such as

COMPLIANCE TESTING LABORATORIES, INC.
4335 West Dearborn Street
Detroit, Michigan 48090



NOTE: DOT SYMBOL WILL BE PLACED BETWEEN ITEMS (3) AND (4)

- (4) Date of Final Report completion
- (5) The words "FINAL REPORT"
- (6) The sponsoring agency's name and address as follows

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Enforcement

Office of Vehicle Safety Compliance
Mail Code: NVS-220, W43-481
1200 New Jersey Ave., SE
Washington, DC 20590

B. FIRST PAGE AFTER FRONT COVER

A disclaimer statement and an acceptance signature block for the COTR shall be provided as follows

This publication is distributed by the U. S. Department of Transportation, National Highway Traffic Safety Administration, in the interest of information exchange. The opinions, findings and conclusions expressed in this publication are those of the author(s) and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof. If trade or manufacturers' names or products are mentioned, it is only because they are considered essential to the object of the publication and should not be construed as an endorsement. The United States Government does not endorse products or manufacturers.

Prepared By: _____
(signature)
(printed name)

Approved By: _____
(signature)
(printed name)

Approval Date: _____

FINAL REPORT ACCEPTANCE BY OVSC:

Accepted By: _____

Acceptance Date: _____

- C. **SECOND PAGE AFTER FRONT COVER**
A completed Technical Report Documentation Page (Form DOT F1700.7) shall be completed for those items that are applicable with the other spaces left blank. Sample data for the applicable block numbers of the title page follows.

Block 1 — REPORT NUMBER

218-ABC-XX-001

Block 2 — GOVERNMENT ACCESSION NUMBER

Leave blank

Block 3 — RECIPIENT'S CATALOG NUMBER

Leave blank

Block 4 — TITLE AND SUBTITLE

Final Report of FMVSS No. 218 Compliance Testing of (Helmet brand and model)

Block 5 — REPORT DATE

(month, date and year) e.g. October 28, 2011

Block 6 — PERFORMING ORGANIZATION CODE

ABC (NHTSA's 3-digit alpha-code for test lab)

Block 7 — AUTHOR(S)

John Smith, Project Manager / Bill Doe, Project Engineer

Block 8 — PERFORMING ORGANIZATION REPORT NUMBER

(in testing lab's format if different from DOT report number)

Block 9 — PERFORMING ORGANIZATION NAME AND ADDRESS

ABC Laboratories
405 Main Street
Detroit, MI 48070

Block 10 — WORK UNIT NUMBER

Leave blank

Block 11 — CONTRACT OR GRANT NUMBER

DTNH22-YY-D-12345

Block 12 — SPONSORING AGENCY NAME AND ADDRESS

US Department of Transportation
National Highway Traffic Safety Administration
Office of Vehicle Safety Compliance (NVS-220)
1200 New Jersey Ave, SE, Room W45-304
Washington, DC 20590

Block 13 — TYPE OF REPORT AND PERIOD COVERED

Final Test Report
Month Day, Year – Month Day, Year

Block 14 — SPONSORING AGENCY CODE

NVS-220

Block 15 — SUPPLEMENTARY NOTES

Leave blank

Block 16 — ABSTRACT

Compliance tests were conducted on the (insert brand and model of helmet tested) Motorcycle Helmet in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure No. TP-218-XX. Test failures identified were as follows:

None

NOTE: Above wording must be shown with appropriate changes made for a particular compliance test. Any questions should be resolved with the COTR. If there is a failure, replace “None” with the section of FMVSS No. 218 relating to the failure and a brief description of the failure.

Block 17 — KEY WORDS

Compliance Testing
Safety Engineering
FMVSS No. 218

Block 18 — DISTRIBUTION STATEMENT

Copies of this report are available from —

National Highway Traffic Safety Administration
Technical Information Services Division, NPO-411
1200 New Jersey Avenue SE (Room E12-100)
Washington DC 20590

e-mail: tis@nhtsa.dot.gov
FAX: 202-493-2833

Block 19 — SECURITY CLASSIFICATION OF REPORT

Unclassified

Block 20 — SECURITY CLASSIFICATION OF PAGE

Unclassified

Block 21 — NUMBER OF PAGES

Add appropriate number

Block 22 — PRICE

Leave blank

14.3.4 TABLE OF CONTENTS

Final Report Table of Contents shall include the following:

- A. Section 1 — Purpose of Compliance Test
- B. Section 2 — Compliance Test Data Summary
- C. Section 3 — Test Data
- D. Section 4 — Test Failure Details (if applicable)
- E. Appendix A — Interpretations or Deviations From FMVSS No. 218
- F. Appendix B — Test Equipment List and Calibration Information
- G. Appendix C — Photographs

15. FORMS**FMVSS No. 218 MONTHLY STATUS REPORT**

Contract No.: _____

Date: _____

LAB No.	Manufacturer Brand & Model Size	Headform Size HPI	Status Received- M/DD/YY Tested- MM/DD/YY	Results
01				
02				
03				
04				
05				
06				
07				
etc.				

Number of tests scheduled for the next reporting period: _____

Number of reports scheduled for the next reporting period: _____

Description of any problems and/or delays in testing:

Description of specific actions taken to correct the problems and/or delays:

LABORATORY NOTICE OF TEST FAILURE TO OVSC

Contract Number	DTNH22-	
Fiscal Year		
Date(s) of Failure		
Report Number		
Brand & Model		
Manufacturer		
Helmet Coverage		
Size		
Date(s) of Manufacture		
Failure Reported By		
Test Failure Description		
<i>Section(s) & Requirement(s)</i>	<i>Failure(s)</i>	
Comments		
Notification to NHTSA		
COTR:		
Date:		
Signature:		

16. DATA SHEETS

DATA SHEET 1
HELMET DATA

HELMET BRAND NAME: _____

HELMET MODEL DESIGNATION: _____

HELMET MANUFACTURER: _____

HELMET SIZE: _____

HELMET COVERAGE: Partial - _____; Full - _____; Complete Facial _____

HELMET POSITIONING INDEX: _____

SHELL MATERIAL: _____

LINER MATERIAL: _____

BUCKLE DESCRIPTION: _____

HELMET	A Ambient	B Low Temp	C High Temp	D Water Immersed	E Spare
SHELL COLOR/PATTERN					
WEIGHT (grams)					
MONTH & YEAR OF MANUFACTURE					

COMMENTS:

RECORDED BY: _____

DATE: _____

APPROVED BY: _____

**DATA SHEET 2
SUMMARY OF TEST RESULTS**

REPORT NO.: _____

DATE: _____

P - Pass or F - Fail

HELMET	A	B	C	D	COMMENTS
TEST	AMBIENT	LOW TEMP	HIGH TEMP	WATER IMMERSED	
IMPACT					
PENETRATION					
RETENTION					

INDICATE P - PASS OR F - FAIL

TEST	PASS	FAIL
PERIPHERAL VISION		
PROJECTIONS		
LABELING		

COMMENTS:

RECORDED BY: _____

DATE: _____

APPROVED BY: _____

**DATA SHEET 3
SELECTION OF APPROPRIATE HEADFORM**

REPORT NO.: _____

DATE: _____

Paragraph S6.1 - If the helmet size designation falls into more than one of three size ranges, it shall be tested on each appropriate headform. Consult with the COTR before beginning the test.

HELMET SIZE DESIGNATION	HEADFORM SIZE
Less than or equal to 6-3/4 (European Size 54)	SMALL
Greater than 6-3/4, but less than or equal to 7-1/2 (European Size 60)	MEDIUM
Greater than 7-1/2 (European 60)	LARGE

COMMENTS:

CONDITIONING FOR TESTING — Paragraph S6.4 — The protective headgear shall be conditioned for not less than 4 hours, in the specified environmental condition shown below, prior to test.

Ambient Conditions	61°F – 79°F (16°C – 26°C); 30% to 70% Relative Humidity
Low Temperature	5°F – 23°F (-15°C – -5°C)
High Temperature	113°F – 131°F (45°C – 55°C)
Water Immersion	61°F – 79°F (16°C – 26°C)

The maximum time during which the protective headgear may be out of the conditioning environment shall not exceed 4 minutes. It must then be returned to the conditioning environment for a minimum of 3 minutes for each minute or portion of a minute in excess of 4 minutes out of the conditioning environment before proceeding with testing on that helmet.

RECORDED BY: _____

DATE: _____

APPROVED BY: _____

DATA SHEET 4
IMPACT ATTENUATION- SYSTEMS CHECK

REPORT NO.: _____

DATE: _____

Paragraph S5.1 and S7.1

Anvil	Impact Velocity
Hemispherical	16.4 – 17.7 ft/s (5.0 – 5.4 m/s)
Flat	19.0 – 20.3 ft/s (5.8 – 6.2 m/s)

Ambient Temperature (°C)	Relative Humidity (%)
Headform Size	Drop Assembly Weight (kg)

SYSTEMS CHECK	TRIAL DROP	DROP HEIGHT (cm)	VEL. (m/s)	PEAK g	DWELL TIME (ms)		TEST RECORD	GROUP NO.
					150 g	200 g		
PRETEST	1						A	
	2						B	
	3						C	
PRETEST AVERAGE		XXXX	XXXX		XXX	XXX	XXXXX	XXXXX
POSTTEST	1						D	
	2						E	
	3						F	
POSTTEST AVERAGE		XXXX	XXXX		XXX	XXX	XXXXX	XXXXX
DIFFERENCE BETWEEN PRETEST AND POSTTEST AVERAGES					DIFFERENCE NOT TO EXCEED 40 g			

(Continued on next page)

DATA SHEET 4 IMPACT ATTENUATION

Helmet	Condition	Helmet Type	Impact Location (+/- 45 degrees)							
		Half /Full	Forehead		Left Side		Right Side		Rear	
		Complete	Left Front		Right Rear		Right Front		Left Rear	
		Impact No.	1	2	1	2	1	2	1	2
A	Ambient	Anvil	HEMI		HEMI		FLAT		FLAT	
		Test Record No.	1	2	9	10	17	18	25	26
		PEAK g								
		ms @ 150 g								
		ms @ 200 g								
		VEL. (m/s)								
B	Low Temp.	Anvil	HEMI		HEMI		FLAT		FLAT	
		Test Record No.	3	4	11	12	19	20	27	28
		PEAK g								
		ms @ 150 g								
		ms @ 200 g								
		VEL. (m/s)								
C	High Temp.	Anvil	HEMI		HEMI		FLAT		FLAT	
		Test Record No.	5	6	13	14	21	22	29	30
		PEAK g								
		ms @ 150 g								
		ms @ 200 g								
		VEL. (m/s)								
D	Water Immersed	Anvil	HEMI		HEMI		FLAT		FLAT	
		Test Record No.	7	8	15	16	23	24	31	32
		PEAK g								
		ms @ 150 g								
		ms @ 200 g								
		VEL. (m/s)								

COMMENTS:

RECORDED BY: _____

DATE: _____

APPROVED BY: _____

DATA SHEET 5 PENETRATION

REPORT NO.: _____

DATE: _____

Paragraph S5.2 and S7.2

WEIGHT OF STRIKER: 6 pounds 10 ± 2 ounces (2.00 ± 0.05 kg)

POINT OF STRIKER: Tip angle of $60 \pm 0.5^\circ$, Cone height of 1.5 ± 0.015 in. (3.8 ± 0.038 cm), Tip radius of 0.02 ± 0.004 inch (0.5 ± 0.1 mm), and a minimum hardness of 60 Rockwell, C-scale.HEIGHT OF FALL: 118.1 ± 0.6 in (3 ± 0.015 m), as measured from striker point to the impact point on the outer surface of the test helmet.

FAILURE CRITERION: When tested, the protective headgear shall be failed if the striker has made an indentation in the headform.

TEST	HELMET	PASS	FAIL	CONDITIONS
1	A			AMBIENT
2	A			AMBIENT
3	B			LOW TEMPERATURE
4	B			LOW TEMPERATURE
5	C			HIGH TEMPERATURE
6	C			HIGH TEMPERATURE
7	D			WATER IMMersed
8	D			WATER IMMersed

COMMENTS:

RECORDED BY: _____

DATE: _____

APPROVED BY: _____

**DATA SHEET 6
RETENTION SYSTEM**

REPORT NO.: _____

DATE: _____

Paragraph S5.3 and S7.3

AMBIENT TEMPERATURE: _____ °C ; AMBIENT HUMIDITY: _____ %

REQUIREMENTS:

READING	REQUIREMENT
Initial	22.7 kg, + 4.54 kg, - 0 kg
Final	136 kg, + 0 kg, - 4.5 kg

ELONGATION NOT TO EXCEED 2.54 cm AFTER LOAD INCREASE

HELMET	CONDITIONS	INITIAL READING cm	FINAL READING cm	ELONGATION cm
A	AMBIENT			
B	LOW TEMPERATURE			
C	HIGH TEMPERATURE			
D	WATER IMMersed			

PERIPHERAL VISION - Paragraph S5.4 - Helmet shall provide a minimum peripheral vision of 105° to each side of the mid-sagittal plane. The brow opening shall be at least 2.54 cm above all points in the basic plane that are within the angles of peripheral vision.

	REQUIREMENTS	RESULTS
DEGREE EACH SIDE M.S. PLANE	> 105°	
BROW OPENING	> 2.54 cm	

COMMENTS:

RECORDED BY: _____

DATE: _____

APPROVED BY: _____

DATA SHEET 7 PROJECTIONS

REPORT NO.: _____

DATE: _____

Paragraph S5.5

PROJECTION	REQUIREMENT
Internal rigid	None
External rigid	Operational, shall not protrude more than 5 mm

TEST RESULTS:

PROJECTION	PRESENT? (Y/N)	HEIGHT (mm)
Internal		
External		

COMMENTS:

RECORDED BY: _____

DATE: _____

APPROVED BY: _____

DATA SHEET 8 LABELING

REPORT NO.: _____

DATE: _____

S5.6 *Labeling* - Each helmet shall be permanently and legibly labeled, in a manner such that the label(s) can be easily read without removing padding or any other permanent part, with the following:

Required Information	Pass/Fail
Manufacturer's name	
Discrete size	
Month and year of manufacture	
Instructions to the purchaser as follows:	-----
"Shell and liner constructed of (identify type(s) of materials)."	
"Helmet can be seriously damaged by some common substances without damage being visible to the user."	
"Apply only the following: (Recommended cleaning agents, paints, adhesives, etc., as appropriate.)"	
"Make no modifications."	
"Fasten helmet securely."	
"If helmet experiences a severe blow, return it to the manufacturer for inspection, or destroy it and replace it."	
Required Certification Information	Pass/Fail
The symbol "DOT", horizontally centered on the label, in letters at least 0.38 inch (1.0 cm) high	
The term "FMVSS No. 218," horizontally centered beneath the symbol DOT, in letters at least 0.09 inch (0.23 cm) high.	
The word "CERTIFIED," horizontally centered beneath the term "FMVSS No. 218", in letters at least 0.09 inch (0.23 cm) high.	
The precise model designation, horizontally centered above the symbol DOT, in letters and/or numerals at least 0.09 inch (0.23 cm) high.	
The manufacturer's name and/or brand, horizontally centered above the model designation, in letters and/or numerals at least 0.09 inch (0.23 cm) high.	
All symbols, letters, and numerals are in a color that contrasts with the background of the label.	
No information, other than the certification information listed above, appears on the certification label.	
The label appears on the outer surface of the helmet and is placed so that it is centered laterally with the horizontal centerline of the DOT symbol located a minimum of 1 inch (2.5 cm) and a maximum of 3 inches (7.6 cm) from the bottom edge of the posterior portion of the helmet.	

RECORDED BY: _____

DATE: _____

APPROVED BY: _____

17. MEDIUM HEADFORM- EXTERIOR DIMENSIONS

BOTTOM OPENING, Z=-3.02 & LEVEL -5, Z= -2.900

θ	Bottom Opening Z = -3.02			Level -5 Z= -2.900		
	R	X	Y	R	X	Y
0	4.292	4.292	0	4.293	4.293	0
10	4.266	4.201	0.741	4.270	4.205	0.742
20	4.159	3.908	1.423	4.172	3.920	1.427
30	3.967	3.436	1.984	3.961	3.430	1.981
40	3.660	2.804	2.353	3.670	2.811	2.359
50	3.332	2.142	2.553	3.352	2.155	2.568
60	3.039	1.520	2.632	3.067	1.534	2.656
70	2.839	0.971	2.668	2.869	0.981	2.696
80	2.720	0.472	2.679	2.772	0.481	2.730
90	2.675	0	2.675	2.709	0	2.709
100	2.703	-0.469	2.662	2.724	-0.473	2.683
110	2.764	-0.945	2.597	2.794	-0.956	2.626
120	2.888	-1.444	2.501	2.917	-1.459	2.526
130	2.985	-1.919	2.287	3.040	-1.954	2.329
140	3.100	-2.375	1.993	3.175	-2.432	2.041
150	3.175	-2.750	1.588	3.232	-2.799	1.616
160	3.186	-2.994	1.090	3.246	-3.050	1.110
170	3.177	-3.129	0.552	3.237	-3.188	0.562
180	3.187	-3.187	0	3.246	-3.246	0

Units: R, X, Y, and Z- inches. To convert to centimeters, multiply each figure by 2.54.
 θ - degrees.

BASIC PLANE, Z= -2.360 & LEVEL -4, Z=-2.000

θ	Basic Plane Z = -2.360			Level-4 Z= -2.000		
	R	X	Y	R	X	Y
0	4.272	4.272	0	4.247	4.247	0
10	4.248	4.184	0.738	4.223	4.159	0.733
20	4.147	3.897	1.418	4.120	3.872	1.409
30	3.961	3.430	1.981	3.940	3.412	1.970
40	3.687	2.824	2.370	3.683	2.821	2.367
50	3.384	2.175	2.592	3.392	2.180	2.598
60	3.111	1.556	2.694	3.132	1.566	2.712
70	2.927	1.001	2.751	2.960	1.012	2.782
80	2.815	0.489	2.772	2.860	0.497	2.817
90	2.779	0	2.779	2.838	0	2.838
100	2.802	-0.487	2.759	2.861	-0.497	2.818
110	2.887	-0.987	2.713	2.958	-1.012	2.780
120	3.019	-1.510	2.615	3.098	-1.549	2.683
130	3.180	-2.044	2.436	3.260	-2.096	2.497
140	3.306	-2.533	2.125	3.405	-2.608	2.189
150	3.398	-2.943	1.699	3.516	-3.045	1.758
160	3.458	-3.250	1.183	3.585	-3.369	1.226
170	3.475	-3.422	0.603	3.612	-3.557	0.627
180	3.472	-3.472	0	3.609	-3.609	0

Units: R, X, Y, and Z- inches. To convert to centimeters, multiply each figure by 2.54.
 θ - degrees.

LEVEL -3, Z=-1.500 & LEVEL-2, Z=-1.000

θ	Level -3 Z= -1.500			Level -2 Z= -1.000		
	R	X	Y	R	X	Y
0	4.208	4.208	0	4.148	4.148	0
10	4.179	4.116	0.726	4.112	4.050	0.714
20	4.075	3.829	1.394	4.013	3.771	1.373
30	3.902	3.379	1.951	3.844	3.329	1.922
40	3.654	2.799	2.349	3.609	2.765	2.320
50	3.377	2.171	2.587	3.352	2.155	2.568
60	3.094	1.547	2.680	3.137	1.569	2.717
70	2.982	1.020	2.802	2.989	1.022	2.809
80	2.891	0.502	2.847	2.902	0.504	2.858
90	2.876	0	2.876	2.884	0	2.884
100	2.918	-0.507	2.874	2.943	-0.511	2.898
110	3.021	-1.033	2.839	3.052	-1.044	2.868
120	3.170	-1.585	2.745	3.225	-1.613	2.793
130	3.337	-2.145	2.556	3.397	-2.184	2.602
140	3.483	-2.668	2.239	3.536	-2.709	2.273
150	3.604	-3.121	1.802	3.657	-3.167	1.829
160	3.682	-3.460	1.259	3.751	-3.525	1.283
170	3.725	-3.668	0.647	3.807	-3.749	0.661
180	3.741	-3.741	0	3.822	-3.822	0

Units: R, X, Y, and Z- inches. To convert to centimeters, multiply each figure by 2.54.
 θ - degrees.

LEVEL -1, Z=-0.500 & REFERENCE PLANE, Z=0.000

θ	Level -1 Z = -0.500			Reference Plane Z = 0.0		
	R	X	Y	R	X	Y
0	4.067	4.067	0	3.971	3.971	0
10	4.033	3.972	0.700	3.935	3.875	0.683
20	3.944	3.706	1.349	3.853	3.621	1.318
30	3.777	3.271	1.889	3.701	3.205	1.851
40	3.552	2.721	2.283	3.491	2.674	2.244
50	3.323	2.136	2.546	3.279	2.108	2.512
60	3.126	1.563	2.707	3.101	1.551	2.686
70	2.987	1.022	2.807	2.979	1.019	2.799
80	2.912	0.506	2.868	2.910	0.505	2.866
90	2.893	0	2.893	2.890	0	2.890
100	2.895	-0.503	2.851	2.945	-0.511	2.900
110	3.064	-1.048	2.879	3.062	-1.047	2.877
120	3.231	-1.616	2.798	3.228	-1.614	2.796
130	3.411	-2.193	2.613	3.413	-2.194	2.615
140	3.560	-2.727	2.288	3.563	-2.729	2.290
150	3.682	-3.189	1.841	3.681	-3.188	1.841
160	3.783	-3.555	1.294	3.773	-3.546	1.290
170	3.885	-3.826	0.675	3.832	-3.774	0.665
180	3.857	-3.857	0	3.844	-3.844	0

Units: R, X, Y, and Z- inches. To convert to centimeters, multiply each figure by 2.54.
 θ - degrees.

LEVEL +1, Z=0.500 & LEVEL+2, Z=1.000

θ	Level +1 Z = 0.500			Level +2 Z= 1.000		
	R	X	Y	R	X	Y
0	3.830	3.830	0	3.665	3.665	0
10	3.801	3.743	0.660	3.613	3.558	0.627
20	3.725	3.500	1.274	3.554	3.340	1.216
30	3.587	3.106	1.794	3.436	2.976	1.718
40	3.399	2.604	2.185	3.271	2.506	2.103
50	3.205	2.060	2.455	3.102	1.994	2.376
60	3.044	1.522	2.636	2.959	1.480	2.563
70	2.927	1.001	2.751	2.854	0.976	2.682
80	2.861	0.497	2.818	2.792	0.485	2.750
90	2.855	0	2.855	2.783	0	2.783
100	2.897	-0.503	2.853	2.832	-0.492	2.789
110	3.007	-1.029	2.826	2.938	-1.005	2.761
120	3.176	-1.588	2.751	3.102	-1.551	2.686
130	3.372	-2.168	2.583	3.294	-2.117	2.523
140	3.520	-2.697	2.263	3.450	-2.643	2.218
150	3.643	-3.155	1.822	3.564	-3.087	1.782
160	3.728	-3.503	1.275	3.637	-3.418	1.244
170	3.777	-3.720	0.656	3.675	-3.619	0.638
180	3.782	-3.782	0	3.670	-3.670	0

Units: R, X, Y, and Z- inches. To convert to centimeters, multiply each figure by 2.54.
 θ - degrees.

LEVEL +3, Z=1.450 & LEVEL+4, Z=1.860

θ	Level +3 Z = 1.450			Level +4 Z= 1.860		
	R	X	Y	R	X	Y
0	3.419	3.419	0	3.061	3.061	0
10	3.382	3.331	0.587	3.035	2.989	0.527
20	3.299	3.100	1.128	2.966	2.787	1.014
30	3.197	2.769	1.599	2.872	2.487	1.436
40	3.052	2.338	1.962	2.754	2.110	1.770
50	2.911	1.871	2.230	2.642	1.698	2.024
60	2.786	1.393	2.413	2.522	1.261	2.184
70	2.700	0.924	2.537	2.477	0.847	2.328
80	2.647	0.460	2.607	2.442	0.424	2.405
90	2.636	0	2.636	2.442	0	2.442
100	2.691	-0.467	2.650	2.492	-0.433	2.454
110	2.796	-0.956	2.627	2.599	-0.889	2.442
120	2.961	-1.481	2.564	2.758	-1.379	2.389
130	3.147	-2.023	2.411	2.936	-1.887	2.249
140	3.301	-2.529	2.122	3.081	-2.360	1.980
150	3.408	-2.951	1.704	3.176	-2.751	1.588
160	3.479	-3.269	1.190	3.230	-3.035	1.105
170	3.514	-3.461	0.610	3.270	-3.220	0.568
180	3.502	-3.502	0	3.271	-3.271	0

Units: R, X, Y, and Z- inches. To convert to centimeters, multiply each figure by 2.54.
 θ - degrees.

LEVEL +5, Z=2.250 & LEVEL+6, Z=2.560

θ	Level +5 Z=2.250			Level +6 Z= 2.560		
	R	X	Y	R	X	Y
0	2.526	2.526	0	1.798	1.798	0
10	2.521	2.483	0.483	1.798	1.771	0.312
20	2.464	2.315	0.843	1.757	1.651	0.601
30	2.387	2.067	1.194	1.719	1.489	0.860
40	2.305	1.766	1.482	1.678	1.285	1.079
50	2.232	1.435	1.710	1.652	1.062	1.266
60	2.174	1.087	1.883	1.641	0.821	1.421
70	2.144	0.733	2.015	1.645	0.563	1.546
80	2.132	0.370	2.100	1.673	0.291	1.648
90	2.147	0	2.147	1.712	0	1.712
100	2.213	-0.384	2.179	1.809	-0.314	1.782
110	2.316	-0.792	2.176	1.925	-0.658	1.809
120	2.463	-1.232	2.133	2.066	-1.033	1.789
130	2.624	-1.687	2.010	2.213	-1.423	1.695
140	2.763	-2.117	1.776	2.358	-1.806	1.516
150	2.863	-2.479	1.432	2.469	-2.138	1.235
160	2.919	-2.743	0.988	2.536	-2.383	0.867
170	2.954	-2.909	0.513	2.561	-2.522	0.445
180	2.958	-2.958	0	2.556	-2.556	0

Units: R, X, Y, and Z- inches. To convert to centimeters, multiply each figure by 2.54.
 θ - degrees.

LEVEL +7, Z=2.750 & NOTES

θ	Level +7 Z=2.750			NOTES:
	R	X	Y	
0	1.081	1.081	0	<p>1. Apex is located at (-0.75, 0, 3.02) for (X, Y, Z) or (0.75, 180, 3.02) for (R, Θ, Z).</p> <p>2. Center of ear opening is located at (0.40, 2.78, - 2.36) for (X,Y,Z) or (2.80, 81.8, - 2.36) for (R, Θ,Z).</p> <p>3. Scale all dimensions by 0.8941 for small headform.</p> <p>4. Scale all dimensions by 1.069 for large headform.</p> <p>5. Headform is symmetrical about the mid-sagittal plane.</p> <p>6. Units: R, X, Y, Z – inches Θ – degrees</p> <p>7. To obtain metric equivalents in centimeters multiply each figure by 2.54.</p>
10	1.088	1.072	0.189	
20	1.055	0.991	0.361	
30	1.039	0.900	0.520	
40	1.039	0.796	0.668	
50	1.052	0.676	0.806	
60	1.068	0.534	0.925	
70	1.106	0.378	1.039	
80	1.171	0.203	1.153	
90	1.242	0	1.242	
100	1.422	-0.247	1.400	
110	1.489	-0.509	1.399	
120	1.683	-0.842	1.458	
130	1.801	-1.158	1.380	
140	1.954	-1.497	1.256	
150	2.083	-1.804	1.042	
160	2.138	-2.009	0.731	
170	2.175	-2.142	0.378	
180	2.175	-2.175	0	

Units: R, X, Y, and Z- inches. To convert to centimeters, multiply each figure by 2.54.
 θ - degrees.