

**STANDARD TEST METHOD AND
EQUIPMENT USED IN EVALUATING THE
PERFORMANCE CHARACTERISTICS OF
HEADGEAR/EQUIPMENT**

NOCSAE DOC ND 001 – 17m25

Prepared By

NOCSAE®

**NATIONAL OPERATING COMMITTEE
ON STANDARDS FOR ATHLETIC EQUIPMENT**

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PREFACE

In an effort to reduce the severity and number of head injuries in certain organized sports, the National Operating Committee on Standards for Athletic Equipment (NOCSAE®)¹ has developed methods and performance requirements for testing protective equipment. It is believed that fewer injuries will be incurred provided the following conditions are met:

- a. Manufacturer adherence to the certification of new headgear/equipment utilizing the appropriate NOCSAE standards.
- b. Manufacturer implementation of an effective Quality Assurance Program (referred to herein as QA/QC protocols).
- c. Consumer adherence to a program of periodically having used headgear inspected and recertified in accordance with the appropriate NOCSAE standards.
- d. Recertifiers adherence to the testing of recertified headgear in accordance with the appropriate NOCSAE standards and procedural guides.
- e. Recertifier implementation of effective QA/QC protocols.
- f. Participation in ongoing Round Robin system verification of all laboratories performing testing to NOCSAE standards.

This standard test method specifies basic performance requirements, methods, and equipment used for testing protective headgear/equipment. Appropriate NOCSAE performance standards (standard specifications) will use these methods and equipment. Impact velocities, pass/fail criteria, and other performance requirements will be specified in appropriate NOCSAE standard specifications, tailored to the needs of a particular activity.

The test methods and performance requirements are based on research initiated in 1971 at Wayne State University, Department of Neurosurgery Biomechanics Laboratory under the direction of Dr. Voight R. Hodgson and later at the Sports Biomechanics Laboratory of the University of Tennessee and continues today in part through grants awarded by NOCSAE. These test methods incorporate many aspects of other recognized headgear performance standards. These test methods draw from work done by others where appropriate for this test method. These standards may be referenced.

NOCSAE recognizes the difficulty of formulating a laboratory standard to reduce head injury in an environment in which the injury incidence is relatively low. Further, many injury mechanisms remain unknown, and no tolerable index is available for hemorrhagic injuries or subdural hematomas that are a primary cause of death and permanent injury in certain organized sports. The NOCSAE drop test method defines impact limits for linear acceleration. The standards are recommended procedures for headgear/equipment manufacturers and recertifiers, which should aid in the reduction of future injuries.

¹The NOCSAE board is comprised of individuals chosen by various national athletic and professional organizations which represent a balance of key stakeholder interests, including public, end-user, medical and scientific, manufacturer, and national governing bodies. These diverse interests have joined forces in an attempt to arrive at a common goal of reducing sports-related injuries. End user and public stakeholders include the American Football Coaches Association, the National Athletic Trainers Association, the Athletic Equipment Managers Association, and the American College Health Association. Medical and scientific stakeholders include The American College of Sports Medicine, American Academy of Pediatrics, American Medical Society for Sports Medicine, and the American Orthopedic Society for Sports Medicine. Manufacturing interests include the Sports Fitness Industry Association, the National Athletic Equipment Reconditioners Association, and two at-large board membership positions. Public and national governing body interests include The National Federation of State High School Associations and the National Collegiate Athletic Association.

Since the testing requirements and certification of manufacturer's models are based on new products, it is recommended that the consumer maintain a Recertification Program.

It is recognized that interested parties should continuously review NOCSAE standards in the light of progress in injury reporting, research and manufacturing techniques and suggestions for improvement. In instances where changes affect any of the following critical test parameters, the effective date of the revised standard will be the time of issuance plus a minimum of 12 months:

- a. Headform characteristics
- b. Drop heights/velocities
- c. Environmental conditions
- d. Anvil and/or impact surface characteristics
- e. Severity Index (SI) Limits
- f. Pass/Fail Criteria
- g. Number of impacts
- h. Impact location
- i. Instrumentation

Revised NOCSAE Standards must be in writing and the year of revision adopted as the suffix of the Document number. All NOCSAE standards that have not been revised or modified for a period of five (5) years shall be referred to the standards committee for action. The standards committee shall decide to maintain the standard in its current form, revise the standard, or withdraw the standard within one year. Withdrawn standards are not supported and should not be referenced by any governing body.

Minor changes to a NOCSAE Standard are identified as being a "modification." Modifications are to be adhered to at the time of the subsequent issuance of that document. Upon modification, the month and year of the modification is noted on the cover page of the modified document.

NOCSAE publishes standards but does not conduct surveillance to assure compliance to standards. This is the sole responsibility of a third-party certification entity per section 6 below.

Manufacturers must be aware that with any mechanical system there are tolerances (i.e. the stem and rotator angles have a $\pm 1^\circ$ tolerance) that may affect the outcome of the tests. For example, with the tolerance of the stem and rotator taken into account, some random locations may be deemed outside of the impact area in some labs on some helmets while inside the impact area in others. Therefore, it is recommended that manufactures take necessary steps to be certain that products tested with consideration to all tolerances remain in compliance with NOCSAE standards. If an impact location is determined to be within the impact area on a mechanical system that is within the allowable tolerances, then that impact location is considered to be a valid impact site for all NOCSAE systems.

NOCSAE does not approve, disapprove, certify, or recertify athletic equipment of any kind.

1. Scope

- 1.1. This standard test method describes laboratory equipment and basic requirements pertinent to testing headgear/equipment. Deviations, additions, or both, to this test method will be specified as required in the appropriate NOCSAE standard performance specifications. Measurement units shall be those expressed in English units, metric approximate equivalency values are provided as a reference but shall not be the official measure.
- 1.2. This standard test method is limited to use with products associated with specific NOCSAE standards. The determination of the applicability of NOCSAE standards and the implementation of any aspect of NOCSAE standards including but not limited to test methodology and equivalency shall be determined by the NOCSAE board.
- 1.3. *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced/Historical Documents

- 2.1. Aikens, Charles H., *Quality Inspired Management, The Key to Sustainability*, Prentice-Hall, 2011, ISBN 978-0-13-119756-3.
- 2.2. ANSI/ASQ Z1.4, *Sampling Procedures and Tables for Inspection by Attributes*.
- 2.3. ANSI/ASQ Z1.9, *Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming*.
- 2.4. ANSI/ISO/ASQ Q9000 *Quality Management Systems Requirements Standards: ANSI/ISO/ASQ Q9000, ANSI/ISO/ASQ Q9001, and ANSI/ISO/ASQ Q9004*.
- 2.5. ASTM F1446, *Standard Test Methods for Equipment and Procedures Used in Evaluating the Performance Characteristics of Protective Headgear*.
- 2.6. ASTM E2234, *Standard Practice for Sampling a Stream of Product by Attributes Indexed by AQL*.
- 2.7. ASTM E2762, *Standard Practice for Sampling a Stream of Product by Variables Indexed by AQL*.
- 2.8. Churchill, E., et al., *Anthropometry Research Project Yellow Springs, Ohio, December 1971; Anthropometry of the U.S. Army Aviators - 1970; National Technical Information Service; U.S. Department of Commerce; 5285 Port Ridge, Springfield, VA 22151; December 1971*.
- 2.9. Claus, W. D., et al., "Development of Headform for Sizing Infantry Helmets," Technical Report 75-23 CAMEL Project Ref.LT662713Dj90 Series CEMEL-131; Clothing, Equipment, and Materials Engineering Laboratories, Natwick, MA 01760.
- 2.10. Farkas, Leslie G. (M.D., C.Sc., D.Sc., FRCS (C) Assoc. Prof., Dept. of Surgery University of Toronto), *Anthropometry of the Head and Face*, 1st Edition, Raven Press, NY

- 2.11. Farkas, Leslie G. (M.D., C.Sc., D.Sc., FRCS (C) Assoc. Prof., Dept. of Surgery University of Toronto), *Anthropometry of the Head and Face*, 2nd Edition, Raven Press, NY
- 2.12. Gadd, C.W. (600793), "Use of a Weighted - Impulse Criterion for Estimating Injury Hazard", *Proceedings of the Tenth Stapp Car Crash Conference, November 8-9, 1966*. SAE, Incorporated, Two Pennsylvania Plaza, New York, New York 10001.
- 2.13. Halstead, D. et al, "Recommendations for Mechanical Test System Revisions." *Technical Report, NOCSAE, 1994*"
- 2.14. ISO 2859, *Sampling Procedures for Inspection by Attributes – Part 1: Sampling Schemes Indexed by Acceptance Quality Limit (AQL) for Lot-by-lot Inspection*.
- 2.15. ISO 3951, *Sampling Procedures for Inspection by Variables – Part 1: Specification for Single Sampling Plans Indexed by Acceptance Quality Limit (AQL) for Lot-by-lot Inspection for a Single Quality Characteristic and a Single AQL*.
- 2.16. ISO/IEC 17065 (Effective September 15, 2015, currently ISO Guide 65), *Conformity Assessment – Requirements for Bodies Certifying Products, Processes, and Services*.
- 2.17. ISO 17011, *Conformity Assessment-General Requirements for Accreditation Bodies Accrediting Conformity Assessment Bodies*
- 2.18. Military Standard 105, *Sampling Procedures and Tables for Inspection by Attributes*.
- 2.19. Military Standard 414, *Sampling Procedures and Tables for Inspection by Variables for Percent Defective*, 1957,
- 2.20. Neubauer, Dean V. (Corning Incorporated) and Luko, Stephen N. (United Technologies Aerospace Systems), "Comparing Acceptance Sampling Standards, Part 1," *Quality Engineering, Vol. 25, 2013, 73-77*.
- 2.21. Neubauer, Dean V. (Corning Incorporated) and Luko, Stephen N. (United Technologies Aerospace Systems), "Comparing Acceptance Sampling Standards, Part 2," *Quality Engineering, Vol. 25, 2013, 181-187*.
- 2.22. NOCSAE DOC ND 011, *Manufacturers Procedural Guide for Product Sample Selection for Testing to NOCSAE Standards*.
- 2.23. NOCSAE DOC ND 015, *Standard Test Method and Specification Used in Evaluating the Corrosion Characteristics and Effects on Metallic Hardware Disassembly*.
- 2.24. NOCSAE DOC ND 100, *Troubleshooting Guide for Test Equipment and Impact Testing*.
- 2.25. NOCSAE DOC ND 101, *Equipment Calibration Procedures*.
- 2.26. Prasad, P. and Mertz, H.J., "The Position of the United States Delegation to the ISO Working Group 6 on the Use of HIC in the Automotive Environment," *SAE Technical Paper 851246, 1985*.

- 2.27. Roebuck, J.A. Jr, *Anthropometric Methods: Designing To Fit The Human Body – Monographs in Human Factors and Ergonomics*, Human Factors and Ergonomics Society, 1995, ISBN 978-0945289012.
- 2.28. Technical Report J211a, "*Instrumentation for Impact Tests - SAE J211a*," *SAE Handbook*, Society for Automotive Engineers, Inc. 1973.
- 2.29. Ulijaszek, S.J. and Mascie, C. G. N., "*Anthropometry: The individual and the Population Cambridge Studies in Biological Anthropology*," Taylor Department of Biological Anthropology University of Cambridge, Cambridge, UK
- 2.30. Additional data used in headform development.
 - 2.30.1. *Anthropometry of the Head, Neck and Face*, MIT Press
 - 2.30.2. SAE publications on Human Anthropometry
 - 2.30.3. Halstead Study of Facial And Cranial Features In Athletes, 1987 Unpublished
 - 2.30.4. Reicho data is from that individual's ongoing, as yet unpublished, data on eye and face anthropometrics.

3. Terminology

- 3.1. Acceptance Sampling: Acceptance sampling uses statistical probabilities and a relatively small proportion of a production lot (as a sample) to estimate the quality of the entire lot and use this estimate as to the basis to either accept or reject the lot.
- 3.2. Ambient: Normal laboratory environment, 72° F, ± 5° F (22° C, ± 2° C).
- 3.3. Acceptable Quality Limit (AQL): The base line requirement for the quality of the manufacturer's product when using a sampling plan.
- 3.4. Basic Plane (Frankfort Plane): An anatomical plane that includes the superior rims of the auditory meatuses (the upper edges of the external openings of the ears) and the notches of the inferior orbital ridges (the bottom edges of the eye sockets).
- 3.5. Bill: See visor
- 3.6. Chin Strap: See Retention System
- 3.7. Common Substances: Household and other readily available materials that are likely to come in contact with headgear/equipment either intentionally (i.e. attempts to clean or polish) or unintentionally via transfer or proximity to the equipment (Hair treatments, bug spray, lotions, sunscreen, etc.).
- 3.8. Confidence Level: Confidence is a measure of how certain one is that some hypothesis or prediction is correct or that a chosen course of action is the best. Confidence levels for acceptance sampling plans used to determine compliance with NOCSAE standards shall be based on the producer's risk α . When a sample is presented for testing one can then be α confident that the 'accept/reject' decision is the correct one. For example, an acceptance

sampling plan that has been designed with an α of 5% (a 95% confidence level), provides a 95% chance that a good lot (i.e. one equal to or better than the stipulated AQL) will be correctly accepted, and a 5% (100% - 95%) chance that a good lot will be incorrectly rejected. Confidence levels for inspection plans prescribed by MIL-STD-105 and MIL-STD-414 range from around 91% for small lots to 99% for large ones. The level of protection increases with increasing lot size in recognition of the comparatively high cost of rejecting large versus small production lots. Using these plans one can be $(1 - \alpha)$ confident that all lots that should be accepted will be accepted. The corollary to this is that α percentage of good lots will be rejected and erroneously scrapped or subjected to needless rework costs. Confidence level can also be established by in process Statistical Quality plans that demonstrate statistical process capability and levels of control.

- 3.9. Coronal Plane: An anatomical plane perpendicular to both the basic plane and the midsagittal plane and containing the midpoint of a line connecting the superior rims of the right and left auditory meatuses.
- 3.10. Crack: A structural discontinuity which cannot support a load normal to its surface without the creation of new surface area.
- 3.11. Critical Component: Any material, piece, part, or device that is necessary for the product to perform to the requirements of the standard.

3.12. Critical Sizes:

3.12.1. The helmet's "Stetson" size typically denoted as a numeric value that is the circumference divided by pi, i.e. $7\frac{1}{4}$, that corresponds to the correct headform's "Stetson" size.

3.12.2. The thinnest padding configuration for a particular helmet shell on the largest headform designated for the selling size range for that particular shell.

Note: In the event that the largest size of a model is too small to fit the smallest headform, data and conclusions from a substantially similar model may be used to certify the smaller model. In the event the largest size of a model is too large for the largest headform the helmet must still be tested and may be shimmed to approximate proper fit for impact testing.

- 3.13. Document Naming Convention: Following the document number (NDxxx-YYmZZ) is the year the document was last revised (YY). Revisions require NOCSAE Standards Committee approval. The year following the "m" is the year the document was last modified (ZZ or ZZa, etc...). Modifications do not require Standards Committee approval. A list of all revisions/modifications is provided at the end of the document.
- 3.14. Dycal: A dynamic signal generator used to calibrate the Severity Index computation system using only a digital voltmeter.
- 3.15. Edge: That portion of a headgear's lower perimeter that lies on or below the theoretical lines which define the specified area of impact.
- 3.16. Eye Protector: A device that may be attached to a headgear and is designed to offer limited protection to the ocular area of the face.

- 3.17. Face: That portion of the head that is anterior to a plane paralleling the Coronal plane; said plane bisects the posterior most portion of the external canthus.
- 3.18. Faceguard: Headgear that when correctly fitted to a helmet is designed to offer protection to that portion of the wearer's face, not covered by the helmet, which is covered by the faceguard as worn. Also known as the face protector.
- 3.19. Failures: If the testing program shows that a production lot may contain units that fail the acceptance criteria, as specified in the applicable QA/QC protocols, for compliance with one or more requirements of the standard, no unit in the production lot can bear the certification mark pending the completion of QA/QC protocol-specified remedial actions. If rectification¹ sampling is possible and can identify all noncomplying units in the lot, then such noncomplying units must be destroyed or altered by repair, to the extent necessary to make them conform to the standard. Where rectification sampling is not possible the entire production lot must be scrapped or reworked. In the case of rework, the entire lot must be resubmitted for testing as required by the applicable QC/QA protocols. If any rework results in a new model as defined herein then such new model must be treated as if it were never certified.
- 3.20. Figure: Illustrations, representations, and/or photographs that are intended as an aid to understanding the test method, performance criteria, or procedures. Figures are not typically definitive and in any case where the written text is or seems in conflict with a figure, the text shall be deemed as the standard.
- 3.21. Hardware: Any device, arrangement, or component (not otherwise defined) that facilitates an object to become attached to headgear, including those systems that are integral to or apart from any other headgear component.
- 3.22. Head: That portion of the body that is above the neck and specifically does not include any part of any vertebral bodies (cervical or any other sections of the spine).
- 3.23. Headform (NOCSAE): An instrumented model human head designed to fit the carriage assembly and possessing a high bio-fidelity.
- 3.24. Headgear: Any device placed on the head, or attached to any other appliance placed on the head, to provide protection to the head and/or face of the wearer.
- 3.25. Helmet (See Headgear): A protective device worn on the head in an effort to reduce or minimize injury to that portion of the head which is within the specified area of coverage while participating in various activities where risk of head injury is recognized.
- 3.26. Impact Area: The area above the basic plane aft of a specified point anterior to the coronal plane and above the reference plane forward of that same point unless otherwise specified in an appropriate NOCSAE standard performance specification.
- 3.27. Intact: The component or system is considered intact if it can withstand a repeat test at the same magnitude and location that raised the question as to whether the component or system remained intact. The repeat test must render results that meet the standard

¹ Rectification inspection is a strategy whereby production lots that have been rejected under attributes inspection are then subjected to 100% screening inspection during which all defective items found in the production lot are replaced with non-defective ones.

requirements in all aspects. Intact does not mean undamaged or unblemished but does mean ready to perform the intended function of the component or system in question.

- 3.28. Legible: May be easily read at a distance of not less than 18 inches by an individual with 20/20 corrected vision.
- 3.29. Level 3: A class of protective equipment for which a functional failure presents a risk of grave and irreversible injury or death. Examples of Level 3 equipment may include, but are not limited to, headgear, projectiles, eye protectors, and chest protectors.
- 3.30. Level 2: A class of protective equipment for which a functional failure presents a risk of serious injury, but not grave and irreversible injury or death. Examples of Level 2 equipment may include, but are not limited to, shin guards.
- 3.31. Level 1: A class of equipment for which safety is not the primary function, and where non-conformance to the applicable standard presents no risk of personal injury. Examples of Level 1 equipment may include, but are not limited to, certain types of football hand coverings designed to aid in handling/catching the ball.
- 3.32. Modular Elastomer Programmer (MEP): A cylindrical shaped pad used as the impact surface.
- 3.33. Metallic Hardware: Any device, arrangement, or component (not otherwise defined) made of metal that facilitates an object to become attached to headgear such that its emergent removal may be necessary to facilitate access to an injured wearer. Examples are metal bolts, t-nuts, washers, snaps, and other fasteners.
- 3.34. Midsagittal (Median) Plane: An anatomical plane perpendicular to the basic plane and containing the midpoint of the line connecting the notches of the right and left inferior orbital ridges, and the midpoint of the line connecting the superior rims of the right and left auditory meatus.
- 3.35. Model: A family or design of headgear/equipment typically available in more than one size that is intended to be identical in every way, except for size. While it may be substantially similar to some other model, it is not intended to be identical to it. Component parts must be the same except for geometries needed to create different sizes. Energy management systems must be of the same materials and construction. Graphical treatments and colors may be variable. If only available in one size or size range, the design must be unique in some respect and therefore is not part of some other family or design (model). Any changes to the model other than size, graphics, or color create a new model, which must have a unique model designation.
- 3.36. Neck Strap: See Retention System
- 3.37. Nose Gauge: A device used to determine that a helmet is consistently positioned on the test headform with respect to the headform's nose.
- 3.38. Permanent (Component): A product component that is not intended to be removed or replaced.
- 3.39. Permanent (Label/Marking): A label, or similar marking, that cannot be readily: (1) removed

without leaving a trace of its previous existence, (2) erased, or (3) smudged to the point that it is illegible. If it **requires** chemical or mechanical means such as the use of solvents, abrasives, grinding, etc., to remove a label or marking, then that label or marking is acceptable.

- 3.40. Primary Retention: See Retention System
- 3.41. Procedural Guide: A document that provides guidance to accepted laboratory/quality control practices that is used in conjunction with NOCSAE test methods and/or performance specifications. Where appropriate, NOCSAE provides recommended procedural guides. Licensees and others who choose not to utilize the provided guide shall recognize that the provided guide establishes a benchmark upon which any substituted guide may be measured.
- 3.42. Production Lot: A production lot is a collection of units that is manufactured during a period in which there is no change in parts/materials, suppliers of parts/materials, or production methods within that lot. Units in a production lot are usually, though not necessarily, produced in one continuous production run involving one set-up. The manufacturer shall establish a new production lot when: (1) a change occurs during a production run that could affect the homogeneity of future production, or (2) when units of different lots are mixed thus creating the possibility that units produced after the change may have a different ability to comply with the requirements of the standard.
- 3.43. Reference Plane: A plane marked on the headforms at a specified distance above and parallel to the basic plane.

Note: See Table 1 and Figure 1 for other anatomical reference points on NOCSAE headforms.

- 3.44. Retention System: The complete assembly that secures the helmet in a stable position on the wearer's head.
- 3.44.1. Chin Strap: A component of the helmet retention system which, when properly adjusted, rests on or encompasses the anterior and inferior most portions of the user's face.
- 3.44.2. Neck Strap: A component of the helmet retention system which, when properly adjusted, rests beneath the user's mandible.
- 3.44.3. Primary Retention: If the helmet is equipped with both a chinstrap and a neck strap, the neck strap is the component to be tested.
- 3.45. Severity Index: A measure of the severity of impact with respect to the instantaneous acceleration experienced by the headform as it is impacted. Acceptable Severity Index (SI) levels measured during impact cannot exceed the limit specified in the appropriate NOCSAE standard performance specification. The Severity Index is defined as:

$$SI = \int_0^T A^{2.5} dt$$

Where: A is the instantaneous resultant acceleration expressed as a multiple of g (acceleration of gravity), dt is the time increment in seconds, and the integration is carried

out over the essential duration (T) of the acceleration pulse.

For purposes of electronic data gathering, the integration as called for in this formula must begin after the system triggers but before the initial signal rises above 4 g's. The integration must then end when the signal falls below 4 g's, after it has peaked.

- 3.46. Shell: The exterior casing of a helmet. Normally the rigid structural component of a helmet.
- 3.47. Shimming: Refers only to the situation where a critical size is too large for the largest headform. A helmet that is too large can be shimmed to approximate fit so long as the shim material is of a mechanical property of low density and compression when compared to the primary energy management system used in the helmet. Shims must be placed in such a way that no part of the shim material is involved in the direct, initial impact. The helmet shall be shimmed so that the impacted area is fit to the head as intended for that area if the helmet were a proper fit to the headform. Additional time of up to three extra minutes shall be allowed for the onset of testing for conditioned samples to facilitate shim placement.
- 3.48. Signal Conditioner: A module of the Severity Index computation system that conditions the input for the Vector Analyzer and Severity Index computation system. It will excite and condition the signals from a triaxial accelerometer of a specific type, or accept ± 5 volts of maximum input directly.
- 3.49. Signal Word: A particular word or symbol on some types of labels that is meant to draw the attention of, and has meaning to, the reader and/or user of the product to which the label is affixed or calls attention to that label. Examples would be words like **WARNING, DANGER, CAUTION, STOP**, or the like.
- 3.50. Similar Model: Refers only to the situation that prevents a small size helmet from being tested because it is too small for the smallest headform and there is no larger size of the same model available for testing. Similar model shall mean a model that, except for size, has geometry substantially the same as a larger tested size and has an energy management system that is of the same density, compression resistance, and thickness tolerances as on the larger size tested model. If the parameters stated above are not the appropriate measures for a particular type of energy management system, it shall be incumbent on the manufacturer to prove the energy management system on the similar model is the same in function as the larger tested model. Any fitting system and the retention system must also be substantially the same as the larger tested model. If there is not a testable size of a larger model that is substantially similar to the smaller model, the smaller un-testable helmet model may not be certified and shall not bear the NOCSAE mark.
- 3.51. Statistical Process Control (SPC): SPC is a method of in-process quality control that uses statistical tools to monitor and control production processes with the aim of building quality into a product at the point of manufacture.
- 3.52. Testing Program: Part of a quality control system developed by the manufacturer that demonstrates compliance with requirements of all applicable NOCSAE standards.
- 3.53. Triaxial Accelerometer: A small piezoelectric acceleration transducer with three (3) axes, designed specifically for vibration measurement in three (3) orthogonal axes. The accelerometer must be mounted at the center of gravity of the test headform with a sensitive axis aligned to within 5 degrees of the vertical when the headform is in the top impact

position. The acceleration data channel complies with the SAE Recommended Practice J211a JUN 80-channel class 1000 filter with the cutoff at 1000 Hz (a low pass filter having a 4-pole Butterworth transfer function and a corner frequency of 1000 Hz meets this requirement). Digital filtering at 1000 Hz can be substituted. (Note: Some other helmet test systems specify the same class filter with a 1650 Hz roll off)

- 3.54. Visor: An extension of the shell that may be an added component or an integral portion of the shell that extends forward from the front surface in such a way so as to shield the wearer's eyes from the sun. The visor may have attachment points for face protection mounting. The visor is limited to that part of the device that is not in contact with the shell. If the visor is an integral portion of the shell (i.e., shell and visor is molded as one piece), then the visor is that portion that extends into space outward from the helmet's edge.

4. Significance and Use

- 4.1. The purpose of this test method is to provide reliable and repeatable measurements for the evaluation of various types of protective equipment. This test method is based primarily on attributes (pass/fail criteria) and provides the opportunity to capture variables (measurement data) for statistical analyses. A passing unit of equipment is able to withstand the impact at an acceptable SI and meets all other requirements of the Performance Specifications when tested in accordance with the test method. In order to certify a model as compliant with NOCSAE standards, all sizes of that model that are required to be tested shall be compliant with the appropriate specifications and must meet all aspects of the standard.
- 4.2. This test method must be used in conjunction with the specific appropriate NOCSAE standard performance specifications relative to a specific activity.

5. Summary of Test Method

- 5.1. A headgear is positioned on a headform and then dropped in order to achieve an accepted free fall velocity. At impact, the instantaneous acceleration is measured by the triaxial accelerometers and the resultant acceleration shall be used for Severity Index calculation.
- 5.2. The impact velocities specified in the appropriate NOCSAE performance standards for impact testing shall be measured during the last 1.5 in. (38 mm) of free fall for each test. The measured velocities shall be within the limits specified in the appropriate NOCSAE performance standards.
- 5.3. If an impact that exceeds the specified velocity range results in a test exceeding the performance criterion, the testing for the sample shall be declared inconclusive and must be repeated.
- 5.4. The impact velocities specified in the individual performance standards are based on specific velocities and not drop heights. Typical velocity measurement systems record the average velocity of the drop system for a distance just prior to impact which may introduce over a 1% difference from the actual velocity (higher velocities will have less error than lower velocities). To attain the proper velocity for an impact, it is likely that the drop height will need to be adjusted to compensate for both friction and velocity measurement error. If height adjustments made to attain the proper velocity for an impact account for more than 10% of the total drop height the drop system should be evaluated for repair.

6. Certification

6.1. Certification Expiration:

6.1.1. Helmets intended to be recertified shall have a recertification interval provided by the manufacturer. Certification life is limited to this time period. Helmets not recertified during the stated interval shall no longer be certified. Recertification interval required for warranty validation shall satisfy this requirement.

6.1.2. Helmets that are not to be recertified, as mandated by the manufacturer shall have a certification expiration.

6.2. NOCSAE publishes standards but does not conduct routine surveillance to assure compliance. Historically, the certification of compliance with the standard has been the responsibility of the manufacturer of the product that carries the NOCSAE mark. During 2015, NOCSAE began implementing a requirement that certification of compliance with a NOCSAE standard shall be made by an ISO/IEC 17065 accredited product certification body selected by NOCSAE. Currently, NOCSAE has selected the Safety Equipment Institute (SEI) Inc. as the certification body, consistent with the requirements set forth below. All newly manufactured equipment certified as compliant with the NOCSAE standard will indicate "SEI certified MEETS NOCSAE Standard" along with the appropriate mark. The certification organization shall not be owned or controlled by manufacturers or vendors of the product being certified.

6.2.1. The certification body shall be primarily engaged in certification work and shall not have monetary interest in the product's ultimate profitability.

6.2.2. The certification body shall be accredited to ISO/IEC 17065 with a scope which includes personal protective equipment. The accreditation shall be issued by an accreditation body operating in accordance with ISO/IEC 17011.

6.3. The certification body shall have a surveillance program, which includes initial and annual testing and quality audits, to ensure the NOCSAE licensee and manufacturing facilities of the certified product has a quality system in place that meets the requirements of this standard. The certification body shall not allow a reduction in QC/QA protocols as specified in this standard. Annual surveillance audits shall be conducted. During annual surveillance audits samples shall be selected for annual certification testing. Where a remote audit is conducted, samples for annual certification testing will be selected from the open market or submitted by the manufacturer in accordance with the Certifying Bodies' procedures.

6.3.1. Licensees whose products fall into Equipment Levels 2 and 3 shall, at a minimum, undergo an onsite audit upon initial participation in the certification program. Upon certification, annual surveillance audits shall be required with an onsite audit at least every three years. Audits in years two and three following an onsite audit may be accomplished by remote surveillance audits if all of the following is true:

1. There were no critical testing non-compliances during annual certification testing.

2. The initial onsite audit showed no major non-conformities as defined by the certification entity.

3. There were no new model categories (e.g. new products certified to standards not utilized during initial audit) presented during the non-onsite audit years.
4. The equipment being certified has at least three years of QA/QC data available for review through an annual remote audit.

If any of the above criteria are not met, remote surveillance audits shall not be permitted.

- 6.3.2. Licensees whose products fall into Equipment Level 1, shall undergo a remote audit upon initial participation in the certification program and annually thereafter. However, an onsite surveillance audit may be conducted in the event the remote audit is unsatisfactory or there are multiple testing non-compliances during annual certification testing.
- 6.4. Firms that manufacture certified products shall conduct a testing program and shall include ongoing QC/QA protocols to effectively control the quality and performance of all products that bear the NOCSAE mark/compliance language. The QC/QA protocols shall include testing programs that will provide documentary evidence that the certified products produced, and released for shipment to their respective markets, are in compliance (as defined below in Section 6.4.1) with all applicable NOCSAE standards.
 - 6.4.1. Products will be considered to be in compliance when the following criteria are satisfied and supported by statistical analyses of applicable test results.
 - 6.4.1.1. Level 3 Equipment: Manufacturers shall demonstrate a statistical process capability of at least three standard deviations in cases where statistical control can be documented and four standard deviations in cases where control either cannot be established or cannot be documented. This requirement can be demonstrated for example with a capability analysis as described in Section 5.3 of NOCSAE DOC ND 011. When manufacturers rely on Acceptance Sampling procedures, an Acceptable Quality Level (AQL) equal to or more demanding than 0.65 shall be used. Individual performance requirements may exempt a particular requirement from Level 3 and assign a lower level of compliance.
 - 6.4.1.2. Any level other than 3 Equipment: Manufacturers shall demonstrate a statistical process capability of at least 1.5 standard deviations in cases where statistical control can be documented and 2 standard deviations in cases where control either cannot be established or cannot be documented. This requirement can be demonstrated for example with a capability analysis as described in Section 5.3 of NOCSAE DOC ND 011. When manufacturers rely on Acceptance Sampling procedures, an Acceptable Quality Level (AQL) equal to or more demanding than 2.5 shall be used. Individual performance requirements may specify a different level of compliance for specific criteria.
- 6.5. Test reports shall comply with the test report requirements of Section 14.
- 6.6. A model/product cannot be certified until each available size of that model/product has passed all tests and met all requirements.

7. Construction

- 7.1. General: Headgear is worn on the head in an effort to reduce or minimize injury to that portion of the head which is within the specified area of coverage, and shall be constructed to reduce the risk of injury to the wearer's head, and to remain on the wearer's head, during impact. Optional devices fitted to the headgear/equipment shall be designed so that they are unlikely to cause injury during use. For example: wire face protectors must not be designed with weld junctions and/or wire terminus ends in the ocular area, such that in the event of a weld separation, the wire ends could come into contact with the ocular area.
- 7.2. The headgear/equipment must survive all test protocols substantially intact and ready for use.
- 7.3. Projections: Any internal rigid projections that may contact the wearer's head during impact shall be covered to reduce the likelihood of injury. Pressure sensitive film or electronic methods may employed to evaluate the transmitted force of internal projections suspected to be a likely source of injury, such forces shall be limited to a maximum of 750 lbs/in².
- 7.4. Metallic Hardware shall meet the requirements of ND015, *Standard Test Method and Specification Used in Evaluating the Corrosion Characteristics and Effects on Metallic Hardware Disassembly*.

8. Materials

- 8.1. Materials used in the headgear/equipment should be durable and resistant to exposure to sun, rain, cold, dust, vibration, perspiration, and products likely to be applied to the skin or hair. If hydrocarbons, cleaning fluids, paints or transfers/decals or other additions may affect the equipment adversely, a warning shall be provided.

9. Labeling & Instructions

- 9.1. Each headgear/equipment shall be permanently and legibly labeled or marked in a manner such that the following information can be easily read and is not obscured in any manner.
 - 9.1.1. Name of Manufacturer
 - 9.1.2. Model Designation
 - 9.1.3. Size
- 9.2. Each headgear/equipment shall be permanently and legibly labeled or marked in a manner such that the following additional information can be easily read without removing any permanent component. The following labels shall contain a signal word which shall not be obscured in any manner:
 - 9.2.1. A label that warns the user that no headgear can protect against all possible impacts and the headgear/equipment must be fitted and attached properly to the wearer's head in accordance with the manufacturer's fitting instructions.
 - 9.2.2. A label that warns the user that the headgear/equipment can be damaged by accidental, incidental, or intentional contact with common substances (for example,

certain solvents, cleaners, hair treatments, etc.) and that this damage may or may not be visible to the user. This label should also list any recommended cleaning agents or procedures, or both.

- 9.2.3. Warnings: Each headgear/equipment shall have appropriate warning information as called for in the appropriate NOCSAE performance specifications.
- 9.3. The appropriate NOCSAE standard performance specifications may require additional labeling or marking on the interior or exterior of the product, or both.
- 9.4. A permanent and legible label or mark that denotes the month and year of manufacture that can be easily read without removing any permanent component. If this mark or label requires a “code” to determine month and year, such code shall be made available upon request.
- 9.4.1. A label that denotes the first intended season of use may be used.
- 9.5. Headgear that are not to be recertified as mandated by the manufacturer shall bear a permanent and legible warning on the exterior of the headgear stating the following:
1. This headgear shall not be recertified.
 2. The life of certification, which shall be no longer than 5 years from the date of manufacture.
- 9.6. Manufacturers of headgear intended to be recertified shall make available the information required in 6.1.1.
- 9.7. Each headgear/equipment shall have fitting/positioning instructions provided. Including any attachment instructions for authorized accessories, where applicable.
- 9.8. Warning and other informational requirements, unless in quotations, need not contain the exact wording but must effectively communicate to the end user the required information using the same or similar language. Except where in quotes the language provided in the standards is exemplary only.
- 9.9. A legible, permanent replica of one of the appropriate NOCSAE mark (see Appendix 3) shall appear on the exterior of the headgear/equipment, see note below marks. High quality files of the marks are available from NOCSAE.
- 9.10. Packaging for products that have been certified to meet the NOCSAE standard may include a legible replica of the following mark;



Replicas of NOCSAE marks that appear on the products that SEI has certified to meet the NOCSAE standard are to be placed only on the appropriate products as specified in

appropriate NOCSAE standards

10. Samples for Testing

- 10.1. Headgear/equipment shall be tested complete, in the condition as offered for sale or use unless specified otherwise in an appropriate NOCSAE performance specification.
- 10.2. Headgear/equipment used for testing must be selected in a random manner.

11. Sample Determination

- 11.1. Conformance to NOCSAE standards requires sufficient sampling and testing for statistical analysis.

12. Conditioning Environments

- 12.1. Ambient Temperature: Expose headgear/equipment to testing environment for a minimum of four hours.
- 12.2. High Temperature: Expose headgear/equipment to conditioned temperature of $115 \pm 5 \text{ F}^\circ$ ($46 \pm 3 \text{ C}^\circ$) for a minimum of four hours and a maximum of twenty-four (24) hours.
- 12.3. Testing Environment: The tests must be performed in an environment with a temperature of 72 F° , $\pm 5 \text{ F}^\circ$ (22 C° , $\pm 2 \text{ C}^\circ$). Always monitor laboratory conditions (temperature and humidity) prior to testing and at periodic intervals during testing.
- 12.4. When performing conditioned environment temperature testing, the first impact shall occur between the 1st and 2nd minute after removing the sample from the conditioning environment. Successive impacts in each location shall occur 75 seconds ($\pm 15 \text{ sec}$) after the preceding impact. If the sample cannot be tested within these time constraints, the sample must be returned to the conditioning environment for a minimum of 3 minutes for each minute the sample was out of the conditioning environment. Conditioning must be complete before testing can resume on that sample.

13. Test Headforms

- 13.1. This section describes the headforms that must be used to conduct NOCSAE tests. Valid NOCSAE headforms include the acronym NOCSAE and a unique serial number which allows traceability to the headform's original physical properties. Headform performance must be verified prior to each test series.

Physical properties of the NOCSAE headforms to be used in this standard drop test method are given in Table 1 and Figure 1.¹

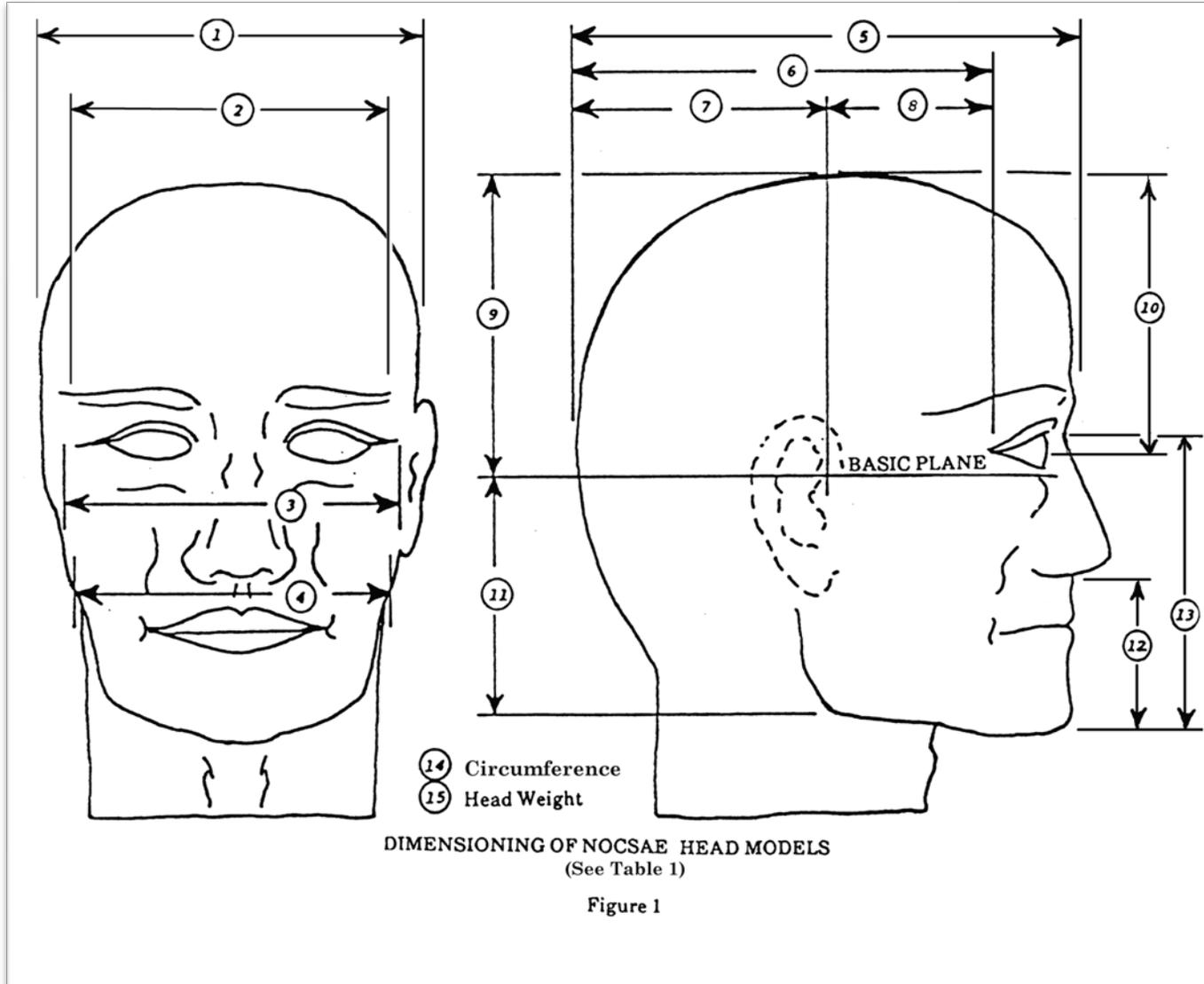
¹ Headforms are available from Southern Impact Research Center.

TABLE 1
APPROXIMATE MEASUREMENTS OF NOCSAE HEADFORMS † - inches (mm)
(See Figure 1)

POINTS OF MEASURE	HEADFORM SIZES		
	6 5/8	7 1/4	7 5/8
1 Head Breadth	5.63 (143)	5.98 (152)	6.46 (164)
2 Maximum brow width (frontal diameter)	4.65 (118)	5.20 (132)	5.52 (140)
3 Ear hole to ear hole (bitracion diameter)	5.24 (133)	5.51 (140)	6.06 (154)
4 Maximum jaw width (bigonial diameter)	4.13 (105)	4.65 (118)	5.08 (129)
5 Head length (glabella landmark to back of head)	7.09 (180)	7.87 (200)	8.15 (207)
6 Outside eye corner (external canthus) to back of head	6.22 (158)	6.81 (173)	7.32 (186)
7 Ear hole (tragion) to back of head	3.50 (89)	3.86 (98)	4.25 (108)
8 Ear hole to outside corner of eye (tragion to ext. canthus)	2.72 (69)	2.95 (75)	3.07 (78)
9 Ear hole to top of head (tragion to vertex)	4.72 (120)	5.24 (133)	5.67 (144)
10 Eye pupil to top of head	4.13 (105)	4.53 (115)	4.96 (126)
11 Ear hole ‡ to jaw angle (tragion to gonion)	3.31 (84)	3.03 (77)	2.84 (72)
12 Bottom of nose to point of chin (subnasal to menton)	2.56 (65)	2.80 (71)	3.03 (77)
	4.45 (113)	4.88 (124)	5.39 (137)
13 Top of nose to point of chin (nasion to menton)	21.02 (534)	22.68 (576)	24.17 (614)
14 Head circumference	9.08 lb (4.12 kg)	10.8 lb (4.90 kg)	13.08lb (5.93 kg)
15 Head weight including mounting interface			

† The anthropometric measurements are based upon references 2.3 and 2.4.

‡ The right ear of each headform shall be removed flush with the skin surface.



Note: The right ear has been removed from the models to facilitate right side head impacts. Models with both ears intact are available for special purposes. Models able to accept a nine-array accelerometer block are available. Details of measurement locations are available from NOCSAE's Technical Director

14. Reports/Record Keeping

- 14.1. **Lab Reports:** Maintain complete test reports for all testing. The reports must be stored electronically and made available upon request. The test report shall contain the following information:
- 14.1.1. Date of test
 - 14.1.2. Name and location of the test laboratory.
 - 14.1.3. Name of laboratory technician.
 - 14.1.4. Model and size of each product tested, name of manufacturer, date of manufacture, and condition of submitted samples.
 - 14.1.5. Observed temperatures in each conditioning and testing environment.
 - 14.1.6. Pre and post system check or other validation/supporting data.
 - 14.1.7. Test results incorporating data such as the impact locations, velocity, Severity Index, peak linear acceleration, peak rotational acceleration, and headform size for each impact.
 - 14.1.8. Any and all other data required by this standard or the appropriate NOCSAE standard performance specification as well as any additional data the technician feels would contribute to an understanding of the product's performance.
 - 14.1.9. Storage of test report data must be kept electronically and in a format that is compatible with the Excel spreadsheet program. The spreadsheet must contain all of the data in the same format as described in the appendix. Additional information may be included if desired, provided the additional data does not alter the format required above.
- 14.2. **Production Records:** NOCSAE Licensees shall maintain detailed records of the sampling plan used, including sample size, how determined, how individual products were selected for testing, and the description of the batch from which the sample was taken as well as any other supporting data necessary to support the sampling plan utilized.
- 14.2.1. Records must be stored for the useful life of the certified product or a minimum of ten years, whichever is longer. Detailed documentation is required on formal QC/QA protocols, including evidence that the particular quality program and procedures so implemented, must comply with some widely recognized quality standard, such as ISO 9001. The documentation submitted should, at a minimum, include details on the statistical process used for certifying and releasing for shipment individual production lots, the sampling plans utilized, the specified AQLs and inspection levels, the procedures for defining and isolating production lots, and any statistical process control methods in place. Protocols should additionally address what internal procedures are activated in the case of test failures.
 - 14.2.2. Any applicable control chart information and capability analyses, or other

supporting documentation that demonstrates compliance to NOCSAE standards shall be available.

14.2.3. In the event of a dispute between a NOCSAE licensee and the certifying body, the determination of the adequacy of any aspect of the certification program shall be made solely by the certifying body in accordance with their procedures and agreements.

14.2.4. Records must be kept electronically in English and be available in a format that is compatible with Microsoft Office.

15. Impact Test Instruments and Equipment

Note: This section describes mechanical equipment used to conduct NOCSAE drop tests, it should be noted that alternate equipment if used must be demonstrable as equivalent in every way. In addition to the mechanical test equipment, PC based, or other digital signal processing systems, if used, must be demonstrable as having equivalent performance to the NOCSAE recommended data acquisition equipment parameters.

15.1. Recommended Guide and Carriage Assembly (refer to Figure 2 and Table 2 below)

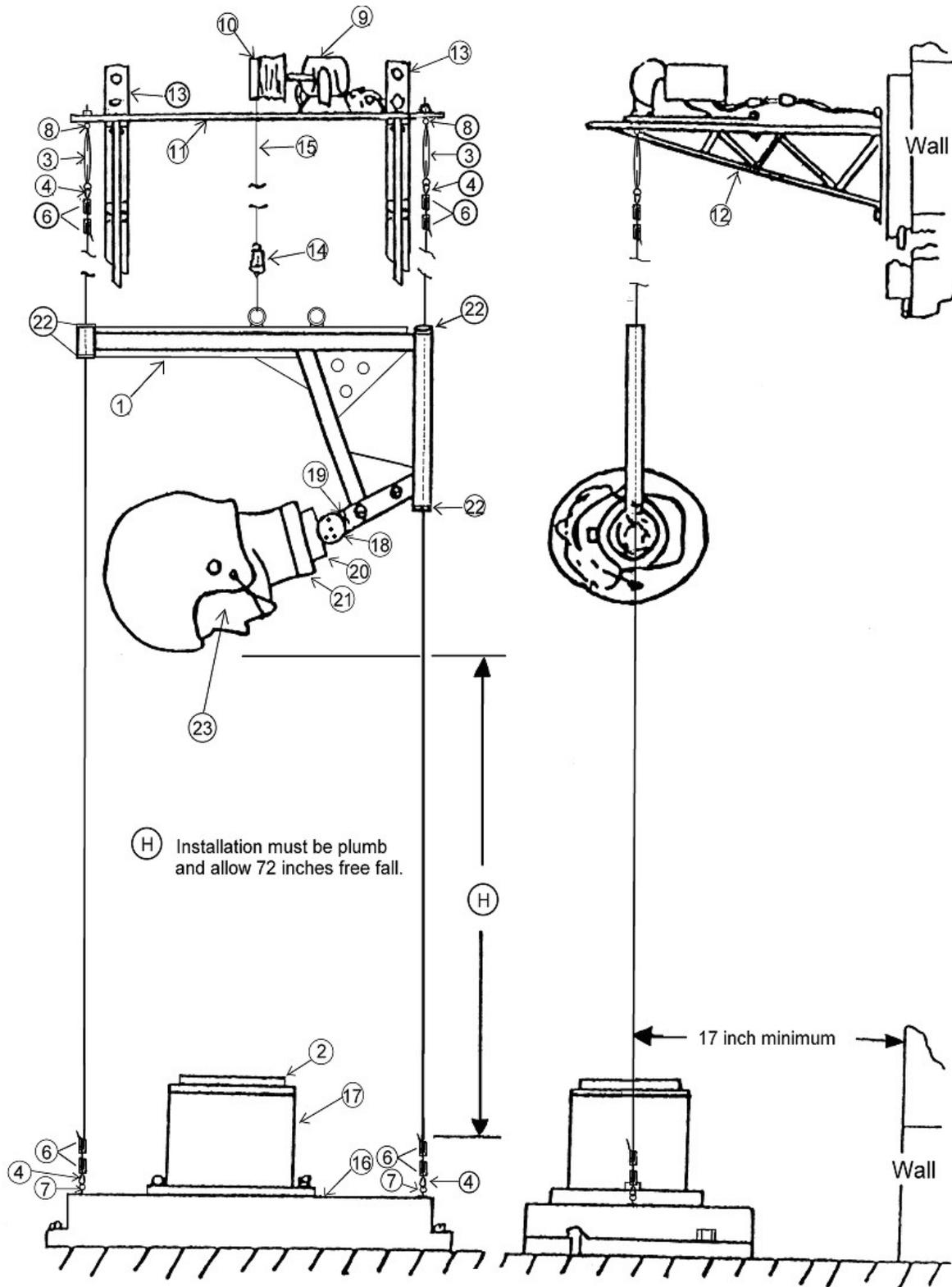


Figure 2

**TABLE 2
HEADGEAR DROP TEST MECHANICAL SYSTEM COMPONENTS**

CODE	DESCRIPTION	AVAILABILITY ¹	DRAWINGS AVAILABLE	SIRC PART NO.
1	Drop Carriage	SIRC ²	Yes ³	1001
2	½" MEP Testing Pad	SIRC	No	1006
2	1/8" MEP Faceguard Testing Pad	SIRC	No	1007
2	3" MEP Calibration Pad	SIRC ⁴	No	1005
3	Hook-eye Turnbuckle, Forged Steel, 3/8" with a 6" take-up	SIRC/H ⁵	N	1043
4	1/8" Wire Rope Thimble	SIRC/M ^C ⁶	N	1044
5	1/8" Spring Music Wire	SIRC/M ^C ⁷	N	1045
6	1/8" Wire Rope, Tiller Rope Clamp, Bronze	SIRC/M ^C ⁸	N	1046
7	3/8" 16 x 3 "Eye Bolt	SIRC/H	N	1041
8	3/8" Forged Eye Bolt	SIRC/H	N	1040
9	Right Angle DC Hoist Motor	SIRC/G ⁹	N	2000
Not Shown	DC Motor Speed Controller (Reversible)	SIRC/G ¹⁰	N	2001
10	Single Groove Sheave (Pulley), 3 ¾"	SIRC/G ¹¹	N	2002
11	Top Mount Plate	SIRC	Y	2003
12	18" Top Channel Bracket	SIRC/H	N	2004
13	Wall Mount Channel Bracket, 4' x 1 5/8"	SIRC/H	N	2005
14	Mechanical Release System	SIRC	Y	2006
15	Lift Cable, Wire Rope, 20' Coil	SIRC/H	N	2007
16	Anvil Base Plate	SIRC	Y	2010
17	Anvil	SIRC	Y	2011
18	Headform Adjuster	SIRC	Y	2012
19	Headform Rotator Stem	SIRC	Y	2013
20	Headform Threaded Lockring	SIRC	Y	2016
21	Headform Collar	SIRC	y	2014
22	Nylon Bushing	SIRC	Y	1803
23	Small Headform	SIRC ⁴	N	1100
23	Medium Headform	SIRC ⁴	N	1101
23	Large Headform	SIRC ⁴	N	1102

¹While all of these components are available from SIRC, alternatives are offered.

²Southern Impact Research Center (SIRC).

³SIRC will make these drawings available for those who would prefer to have this component machined on their own.

⁴Available from Southern Impact Research Center (SIRC).

⁵While this component is available from SIRC, you may also be able to purchase it from a large hardware store.

⁶While this component is available from SIRC, you may also purchase this component from McMaster-Carr Supply.

⁷While this component is available from SIRC, you may also purchase this component from McMaster-Carr Supply.

⁸While this component is available from SIRC, you may also purchase this component from McMaster-Carr Supply.

⁹While this component is available from SIRC, you may also purchase this component from W. W. Grainger, Inc.

¹⁰While this component is available from SIRC, you may also purchase this component from W. W. Grainger, Inc.

¹¹While this component is available from SIRC, you may also purchase this component from W. W. Grainger, Inc.

15.2. Impact Surfaces Specifications (See Appendix 1)

15.2.1. 3" Calibration MEP Pad

Dimensions: Approximately a 3 inch (7.6 cm) thick by 6 inch (15.2 cm)

15.2.2. ½" Test MEP Pad

Dimensions: Approximately a ½ inch (1.3 cm) thick by 6 inch (15.2 cm)

15.2.3. 1/8" Faceguard Test MEP Pad

Dimensions: Approximately a 1/8 inch (3.2 mm) thick by 6 inch (15.2 cm)

15.3. Triaxial Accelerometer: PCB Triaxial Accelerometers, #354MO3, #356A66, or equivalent

15.4. Impact Recording Equipment: Preferred data acquisition systems include Headrop testing software and the analog KME Severity Index analyzer. Additional digital SI analyzer recommendations can be obtained by contacting Southern Impact Research Center or NOCSAE's Technical Director. Users who choose to design their own digital SI analyzers can do so provided their design complies with the following specifications:

1. The system shall be capable of capturing data simultaneously from three accelerometer channels
2. Minimum Sampling Rate shall be 10 kHz per channel for drop testing and 33 kHz per channel for projectile testing.
3. Accelerometer data shall be filtered AFTER the resultant acceleration is calculated using a filter with a 1 kHz cutoff and a 4 pole roll-off.

Those choosing not to use one of the recommended solutions shall demonstrate their chosen system is equivalent to Headrop or the analog KME SI analyzer.

15.5. Headforms (Physical properties are described in Section 13.)

15.5.1. Small NOCSAE Headform

15.5.2. Medium NOCSAE Headform

15.5.3. Large NOCSAE Headform

16. Instrument Calibration

- 16.1. Verify that the instrumentation used for data acquisition is correctly executing algorithms that will result in appropriate SI levels $\pm 3\%$ across a range of 300 SI to 2495 SI with a maximum of $\pm 2\%$ at 1200 SI.

17. Headform Calibration

- 17.1. Each headform must be calibrated prior to testing utilizing an accelerometer, calibration MEP pad, and drop locations/velocities as identified in the NOCSAE Calibration Pad Qualification (or Re-Qualification) Report for the particular MEP Calibration Pad to be used. Velocities specified for headform calibration will have a very narrow tolerance in order to assure valid headform response. Resultant SI for each of the three (3) positions (front, side, top) on each headform must be 1200 SI, $\pm 2\%$, when headforms are impacted in accordance

with the specified velocities. At a minimum, calibration must be performed each time a headform is attached to the drop carriage, an electrical interruption occurs, a mechanical failure of the drop system components occurs, or any component attached to the NOCSAE headform is adjusted (i.e. accelerometer, coupler, collar nuts). Headforms used for testing in non-drop test situations where SI is to be recorded and reported must be calibrated on the drop system and then moved to the other test machinery without removal of the accelerometer from the headform. All data must be collected with the accelerometer/headform combination that was calibrated using the drop system.

- 17.2. The MEP Calibration Pad shall be requalified at least annually at the laboratory¹ specified by NOCSAE.

18. System Check

- 18.1. A system check must be performed after each calibration and just prior to testing product and the results maintained as part of the certification test data.
- 18.2. A system check must again be performed upon the completion of a product testing session and the results maintained as part of the certification test data.
- 18.3. Any variation between 18.1 and 18.2 must be 7% or less.

19. Impact Attenuation Tests

- 19.1. The maximum Severity Index and peak acceleration cannot exceed the limits specified in the appropriate NOCSAE standard performance specification.
- 19.2. Each headgear/equipment shall be impacted in accordance with the requirements of the appropriate NOCSAE standard performance specification with respect to drop velocities, impact locations, and test conditions.
- 19.3 The time between successive impacts in each location shall be 75 ± 15 seconds.
- 19.4 Standard Impact Locations [Medium Headform²] (refer to Figure 3 below)

Note: The anvil and the impact surface shall be centered as close as possible to the impact site on the headform. The anvil must be bolted securely to the base plate with both bolts tightened prior to impact.

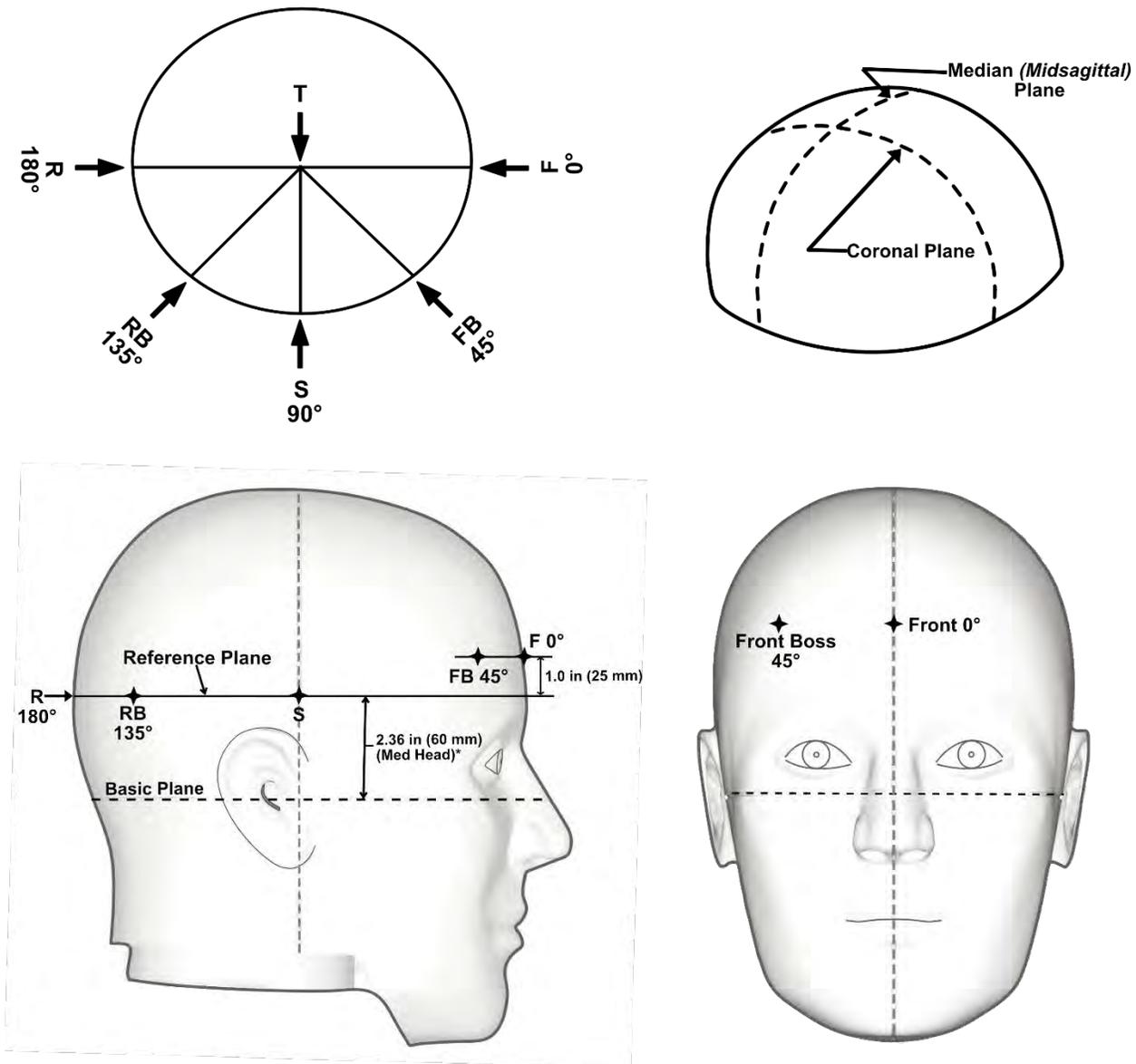
- 19.4.1 Front (F): Located in the median plane approximately 1 inch above the anterior intersection of the median and reference plane.
- 19.4.2 Front Boss (FB): A point approximately in the 45-degree plane from the median plane measured clockwise and located approximately 1 inch above the reference plane.

¹ Southern Impact Research Center

² Impact locations are determined by the carriage, stem and rotator assemblies per established drawings and are approximated on the medium head for reference. Periodic inspection of the components is required to maintain impact location integrity.

- 19.4.3 Side (S): Located approximately at the intersection of the reference and Coronal planes on the right side of the headform.
- 19.4.4 Rear Boss (RB): A point approximately on the reference plane located approximately 135 degrees clockwise from the anterior intersection of the median and reference planes.
- 19.4.5 Rear (R): Approximately at the posterior intersection of the median and reference planes.
- 19.4.6 Top (T): Located approximately at the intersection of the median and Coronal planes. The right hand carriage release ring should be used for this drop.
- 19.4.7 Random: Any individual impact location selected from any point within the impact area so that the initial point of contact between the headform and the impact surface shall be on or above the lines that define the impact area as specified in the appropriate NOCSAE performance specification. Random locations must allow rotator assembly to be locked in the position selected within the physical limitations of the impact test equipment defined in Section 14. See Appendix 2 for additional information. A lab conducting a single series of tests per the appropriate performance specification shall use the same random location for each sample of a given size.

APPROXIMATE IMPACT LOCATIONS



*For the small headform, the REFERENCE PLANE is 2.16 inches above the BASIC PLANE. For the large headform, the REFERENCE PLANE is 2.48 inches above the BASIC PLANE.

The random impact location may be selected from any point within the allowed impact area. Specific limitations on random impacts, if any, will be specified in the appropriate NOCSAE performance specification for each headgear.

Random impact locations chosen must allow the rotator assembly to be locked in the position selected.

Impact Area – specified in the appropriate NOCSAE performance specification for each headgear.

Figure 3

20. Helmet Positioning/Fit

- 20.1 Manufacturing fitting instructions shall be used to obtain a reasonable fit on the test headform. In the event that these instructions are unclear or result in a fit that is likely to yield erroneous test results, the technician shall fit the helmet to the best of their ability on the most appropriate test headform.
- 20.2 The ear holes (if so equipped) of the helmet should be concentric with the headform ear index holes and the lower front rim of the helmet should be aligned with the nose gauge (or the equivalent measurements), using the notch/gauge that is appropriate for the headform in use.
- 20.3 A manufacturer of a helmet may require a different position by specifying the lower front rim distance from the basic plane as measured vertically from the basic plane on the median plane. If so specified, then that resulting position shall be used instead of the nose gauge position.

Note: Since fit is subjective on humanoid headforms, the headform size specified by the manufacturer, or the headform closest to matching the labeled helmet size, should be used as a beginning point. In any case, the resulting fit must be reasonable as determined by the test technician. Where, in the opinion of the technician, the specified headform is incorrect and would yield erroneous test results, the technician **must** substitute a different headform to obtain a better fit.

A measure as to the reasonableness of fit can be conducted as follows: After positioning the helmet as above, with the chin strap and/or other retention straps unfastened, you should be able to smoothly rotate the headform to the inverted (Top) position without any visible motion of the helmet. This is one way to determine if a helmet is too large for a given headform. This method may not be accurate if the helmet has a faceguard attached. If the helmet is too small for a headform, one way to judge this is to measure or observe the distance from the top of the headform to the inside surface of the helmets fitting system. If the top or crown of the headform and the inside of the helmet are not in contact, the helmet is likely too small for that particular headform. In any case, the final decision as to reasonableness of fit rests with the test technician/laboratory.

This standard is subject to revision at any time by the responsible technical authority and must be reviewed every five years and if not revised either reapproved or withdrawn. Your comments are invited for either revision, modification or creation of additional standards and should be addressed to NOCSAE's Executive Director. Check the web at www.nocsae.org to obtain the latest version of a standard.

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APPENDIX 1

I. Specifications

A. Impact Surfaces:

1. 3" Calibration MEP Pad

- a) Dimensions: Approximately a 3-inch (7.6 cm) thick by 6-inch (15.2 cm) diameter pad.
- b) Material: Molded from polyurethane thermoplastic elastomer.
- c) Performance: Must provide a 232 g response (± 40 g's) when impacted at 5.44 meters/second ($\pm 2\%$) by a falling impactor having a spheroidal radius of 73 mm (± 1 mm) and a total drop mass of 5 kg (± 5 gm). The carriage and follower assembly cannot exceed 20% of the total drop mass, per ASTM F1446.
- d) All new and annually requalified calibration MEP pads shall not require headform drop velocities greater than a 5.5 ft/s (1.68 m/s) deviation from the norm as determined by the requalification lab in any position for any headform size.
- e) Additional performance characteristics may be required as deemed appropriate by NOCSAE's specified re-qualification laboratory.

2. ½" Test MEP Pad

- a) Dimensions: Approximately a ½ inch (1.3 cm) thick by 6-inch (15.2 cm) diameter pad.
- b) Material: Molded from polyurethane thermoplastic elastomer.
- c) Performance: Must provide a 385 g response (± 38 g's) when impacted at 3.9 meters/second ($\pm 2\%$) by a falling impactor having a spheroidal radius of 73 mm (± 1 mm) and a total drop mass of 5 kg (± 5 gm). The carriage and follower assembly cannot exceed 20% of the total drop mass, per ASTM F 1446.

3. 1/8" Faceguard Test MEP Pad

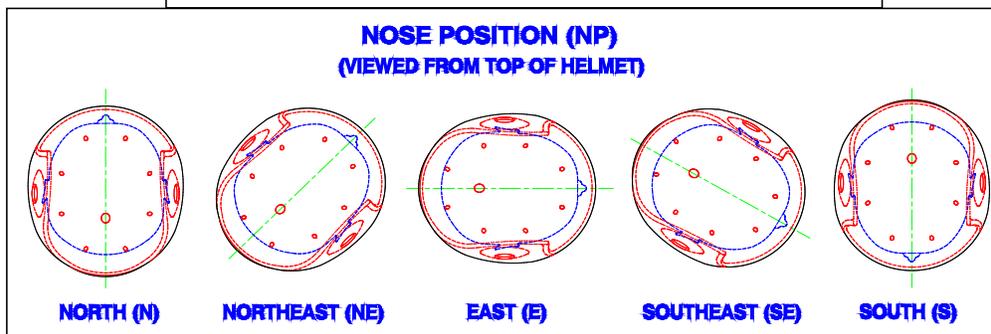
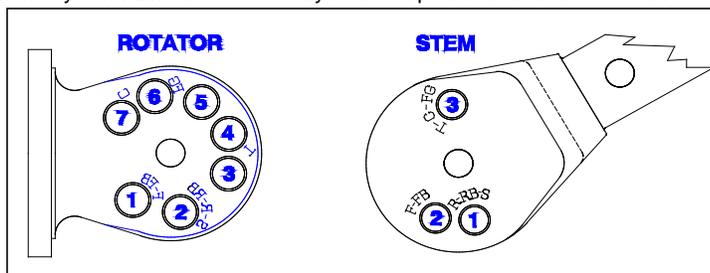
- a) Dimensions: Approximately a 1/8-inch (3.2 mm) thick by 6-inch (15.2 cm) diameter pad.
- b) Material: Molded from polyurethane thermoplastic elastomer.
- c) Performance: Must have a durometer of greater than 70 Shore "A".

Appendix 2

IMPACT LOCATION GUIDE - NOCSAE TWIN GUIDE WIRE DROP ASSEMBLY

POSITION	ROTATOR	STEM	NOSE POSITION	COMMENTS
1	1	2	SOUTH	NORMAL FRONT POSITION
2	1	2	SOUTHEAST	NORMAL RIGHT FRONT BOSS POSITION
3	2	1	EAST	NORMAL SIDE POSITION
4	2	1	NORTHEAST	NORMAL RIGHT REAR BOSS POSITION
5	2	1	NORTH	NORMAL REAR POSITION
6	4	3	NORTH	NORMAL TOP POSITION
7	4	3	SOUTH	VALID RANDOM POSITION
8	4	3	SOUTHEAST	VALID RANDOM POSITION
9	4	3	EAST	VALID RANDOM POSITION
10	4	3	NORTHEAST	VALID RANDOM POSITION
11	1	1	SOUTH	VALID RANDOM POSITION
12	1	1	SOUTHEAST	VALID RANDOM POSITION
13	1	1	EAST	VALID RANDOM POSITION
14	1	1	NORTHEAST	VALID RANDOM POSITION
15	1	1	NORTH	VALID RANDOM POSITION
16	1	2	NORTH	VALID RANDOM POSITION
17	1	2	NORTHEAST	VALID RANDOM POSITION
18	1	2	EAST	VALID RANDOM POSITION
19	5	3	SOUTH	VALID RANDOM POSITION
20	5	3	SOUTHEAST	VALID RANDOM POSITION
21	5	3	EAST	VALID RANDOM POSITION
22	5	3	NORTHEAST	VALID RANDOM POSITION
23	5	3	NORTH	VALID RANDOM POSITION
24	6	3	NORTHEAST	VALID RANDOM POSITION
25	6	3	NORTH	VALID RANDOM POSITION
26	6	3	EAST	VALID RANDOM POSITION

The above are typically Valid positions, there may be additional valid positions other than the above listed ,due to mechanical tolerances in the system. Like wise there may be listed positions that are not valid on a given test head/helmet/rig.



**Appendix 3
NOCSAE Marks**

ND002 Football Helmet



ND019 Football Hand Covering



ND022 Batters Helmet



ND024 Catchers Helmet



ND027 Baseball



ND029 Fielders Headgear



ND030 Ice Hockey Helmet



ND041 Lacrosse Helmet



**Appendix 3 (continued)
NOCSAE Marks**

ND049 Lacrosse Ball



ND050 Polo Helmet



ND061 Field Hockey Headgear



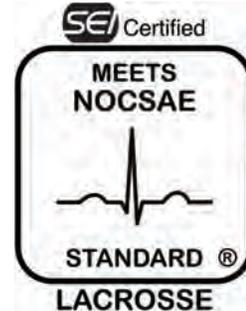
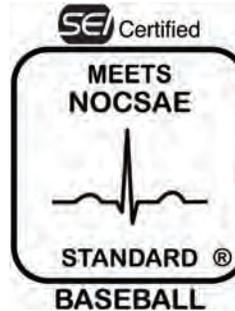
ND069 Field Hockey Ball



ND090 Soccer Shinguards



ND200 Protectors for Commotio Cordis



NOTE: You must have an executed, valid license agreement with NOCSAE and comply with the Safety Equipment Institute's certification program to use any of the NOCSAE marks at any time. NOCSAE, the NOCSAE marks, and the National Operating Committee on Standards for Athletic Equipment are registered marks and the exclusive property of the Committee. Use of the marks in any manner is prohibited without prior written permission of the NOCSAE Board of Directors.

JANUARY 2015 MODIFICATIONS/REVISIONS

- REVISION: Added requirement for compliance to ND015, Section 7.4
- Referenced ND015, Section 2
- Added Definition of Metallic Hardware, Section 3
- Added season of use and date requirement in Labels and Warnings section 9.4.1 and 9.5.

APRIL 2015 MODIFICATIONS/REVISIONS

- Updated NOCSAE seal/logo artwork
- Added useful life of certification statement to Section 6 Certification
- Added procedure to evaluate potential risk of injury by internal projections, section 7.3
- Changed reference to ‘logo” and/or “seal” to “seal/logo”
- Removed text box on NOCSAE seal/logo artwork, Appendix 3
- Added NOCSAE seal/logo artwork for ND024

JULY 2015 MODIFICATIONS/REVISIONS

- Updated NOCSAE seal/logo artwork

JANUARY 2017 MODIFICATIONS/REVISIONS

- REVISION: Changed sections 9.4.1, 9.5 and 6.1.2
- Added NOCSAE seal/logo artwork to Appendix 3
- Added peak rotational acceleration to reporting requirements in 14.1.7

FEBRUARY 2017 MODIFICATIONS/REVISIONS

- Combined bullet points 2 and 3 in section 9.5 for clarity.
- Changed section 6.2 from future tense to present tense.

DECEMBER 2017 MODIFICATIONS/REVISIONS

- Added Field Hockey Headgear and Ball NOCSAE seal/logo artwork to Appendix 3.
- Removed material skin disease language.

DECEMBER 2019 MODIFICATIONS/REVISIONS

- Updated NOCSAE seal/logo artwork

JUNE 2020 MODIFICATIONS/REVISIONS

- Updated NOCSAE seal/logo artwork

- **JANUARY 2023 MODIFICATIONS/REVISIONS**

- Added the words 1 inch to the description of the Front Boss impact location

JANUARY 2024 MODIFICATIONS/REVISIONS

- Changed references to the NOCSAE Board to the NOCSAE Standards Committee where appropriate
- Updated the number of at-large board members from 1 to 2 in Footnote 1
- Updated certification bodies and standards information in Section 6

FEBRUARY 2024 MODIFICATIONS/REVISIONS

- Replaced “seal/logo” with “mark”
- Formatting updates

JUNE 2024 MODIFICATIONS/REVISIONS

- Added specifications for digital Severity Index analyzers
- Removed Figure 1 which indicated impact area on a football helmet and replaced it with a figure indicating impact area on the headform
- Corrected referenced section numbers

DECEMBER 2025 MODIFICATIONS/REVISIONS

- Added Headrop test software as the preferred digital severity index analyzer