

**STANDARD TEST METHOD AND  
PERFORMANCE SPECIFICATION  
USED IN EVALUATING THE  
PERFORMANCE CHARACTERISTICS OF  
CHEST PROTECTORS FOR COMMOTIO CORDIS**

**NOCSAE DOC (ND) 200-16**

Prepared By



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

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PROPOSED

## 1. Scope

- 1.1 This standard test method describes laboratory equipment and basic requirements pertinent to projectile testing of chest protectors using the NOCSAE Commotio Cordis Surrogate. It is believed that compliance with this test method will lead to improved chest protector performance, thus a reduced risk of commotio cordis. The chest protector shall be supplied as offered for sale with required hardware and fitting instructions along with required accessories if any are required for the protector to function as designed. The requirements of this standard shall be subject to Level 3 compliance criteria, unless otherwise stated herein.
- 1.2 *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 plus determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

- 2.1. NOCSAE DOC ND 001: *Standard Test Method and Equipment Used in Evaluating the Performance Characteristics of Headgear/Equipment*
- 2.2. NOCSAE DOC ND 021: *Standard Projectile Impact Test Method and Equipment Used in Evaluating the Performance Characteristics of Protective Headgear/Projectiles*

## 3. Significance and Use

- 3.1. The purpose of this test method is to provide reliable and repeatable measurements for the evaluation of various types of chest protectors. The pass/fail criteria are based on peak force (lbf, N) and within specified tolerances for other measures.

## 4. Terminology

- 4.1. NOCSAE Commotio Cordis Surrogate (NCCS): A device consisting of a damped loading surface, three load cells capable of measuring peak force, and a rigid back plate. The three load cells are positioned in between the loading surface and the back plate and represent the upper chest, lower chest, and cardiac silhouette.
- 4.2. Load Cell: A transducer that converts a mechanical force input to an electrical output signal.
- 4.3. Cardiac Load: The peak force measured by the load cell intended to represent the cardiac silhouette.
- 4.4. Distributed Load: The sum of the peak force measured by the upper chest and lower chest load cells.
- 4.5. Linear Bearing Table: A sliding table-top fitted with the necessary supports to position the thoracic surrogate at various positions in order to facilitate impacts at the designated locations. This table may be mounted to a separate device that allows for rapid elevation adjustments.

## 5. Test Samples

- 5.1. See Sections 6 and 11, NOCSAE DOC.001, for QC/QA protocol testing.

- 5.2. For any standalone test report, a minimum of two samples per model in the smallest size offered for sale must be submitted. Larger model/sizes must be proportionally identical to the submitted sample and may be requested if the submitted sample size does not adequately fit the surrogate.
- 6. Sample Preparation**
- 6.1. See NOCSAE DOC ND 001 Section 10.
- 7. Certification**
- 7.1. See section 6 of NOCSAE DOC 001 for certification requirements.
- 8. Summary of Test Method**
- 8.1. A chest protector is positioned on the NOCSAE Commotio Cordis Surrogate, which is rigidly mounted to a linear bearing table to allow post impact kinematics. The projectile is propelled at the surrogate such that the impact velocity is within 3% of the specified velocity. At impact, the peak force is measured by each of the three load cells.
- 9. Test Instruments and Equipment {TC "Test Instruments and Equipment " \f C \l "1"}**
- 9.1. Projectile launching device capable of propelling the specified projectile to the specified velocity within 3% and having a targeting device that allows impacts within a ¼ inch radius within 18 inches from the muzzle or the point at which the projectile is first in “free flight.”
- 9.2. Recommended Air Cannon Assembly Including Linear Bearing Table Assembly (See Figures 1 and 2).
- 9.3. NOCSAE Commotio Cordis Surrogate comprising three 750 lb-f maximum capacity single axis load cells. \*
- 9.4. A linear bearing table that is capable of providing some post impact motion with a weight not to exceed 12.5 lbs (5.7 kg).
- 9.5. Data sampling rate shall be a minimum of 10,000 Hz per channel.
- 9.6. Data shall be filtered with a CFC120 low pass filter.
- 9.7. Data shall be collected for no less than 200 milliseconds. Time starts at light gate trigger.
- 9.8. Impact shall be recorded on a device capable of capturing the three individual load cell traces.
- 10. System Check**
- 10.1. See section 18, NOCSAE DOC. 001
- 10.2. Three impacts with a lacrosse ball or baseball that complies with the requirements of section 12 shall be performed on the unprotected NOCSAE Commotio Cordis Surrogate. The impact velocity shall be 30 mph +/- 3% and shall impact the center (+/- ¼ inch) of

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\* Note: NOCSAE compliant surrogate available from Southern Impact Research Center

the cardiac silhouette (Figure 3). The peak force measured by the cardiac load cell shall be no less than 130 lbf (578 N) for each of the system check impacts. The projectile chosen shall be the same type of projectile designated by the manufacturer to be used during testing.

## 11. Impact Locations

- 11.1. Cardiac Silhouette: Projectile shall impact the surrogate in the center of the cardiac silhouette (+/- ¼ inch) as shown in Figure 1. The NCC Surrogate shall be positioned so the base of the surrogate is perpendicular (+/- 2.5 degrees) to the line of travel of the projectile.
- 11.2. Random Location Impacts may be directed at any point located on the padded impact area as shown in Figure 1. The initial point of contact for Random Impact #2 must be a minimum of 4 inches away from the initial point of contact for Random Impact #1. The NCC Surrogate shall be positioned so the base of the surrogate is perpendicular (+/- 2.5 degrees) to the line of travel of the projectile.

**TABLE 1**  
Impact Locations  
Velocity – mph (m/s) +/- 3%

	Center of Cardiac Silhouette +/- ¼ inch	Random Location #1	Random Location #2
Sample 1	30 (13.4)	30 (13.4)	30 (13.4)
Sample 2	50 (22.4)	50 (22.4)	50 (22.4)

## 12. Impact Attenuation Tests

- 12.1. The manufacturer shall designate the projectile, baseball or lacrosse ball, to be used during testing. Testing shall be conducted in accordance with TABLE 1.
- 12.1.1. Baseball: The baseball (s) used shall weigh 5 – 5.25 ounces (142 – 149 grams), have a circumference of 9 – 9.25 inches, have a Coefficient of Restitution of 0.5 – 0.55 and have a C-D at .25 inches of 200 – 300 lbs and be of the construction specified and used by Major League Baseball.
- 12.1.2. Lacrosse Ball: The lacrosse ball(s) used shall weigh 5.0 to 5.25 ounces (141.8–148.8 grams), have a circumference of 7.75–8.0 inches and have a C-D at 25% of 115-150 lbs.
- 12.2. Chest protector repositioning during testing is anticipated.

## 13. Test Requirements

- 13.1. 30 mile per hour condition
- 13.1.1. For any impact, the peak force measured by the cardiac load cell shall not exceed 90 lbf (400N).
- 13.1.2. For any impact, the peak force measured by the upper chest load cell or lower chest load cell shall not exceed a number that is 25% higher than the measured peak force generated for the cardiac silhouette impact condition.

## 13.2. 50 mile per hour condition

- 13.2.1. For any impact, the peak force measured by the cardiac load cell shall not exceed 180 lbf (800N).
- 13.2.2. For any impact, the peak force measured by the upper chest load cell or lower chest load cell shall not exceed a number that is 25% higher than the measured peak force generated for the cardiac silhouette impact condition.

## 14. Labels and Warnings

- 14.1. Each chest protector shall be permanently and legibly labeled or marked in a manner such that the following information can be easily read and must not be obscured in any manner.
  - 14.1.1. Name of manufacturer or a logo or recognizable mark that is registered and/or trademarked to the manufacturer.
  - 14.1.2. Model designation
  - 14.1.3. Size
  - 14.1.4. Month and year of manufacture
  - 14.1.5. Notice that indicates additional information is available to the wearer. Such additional information may be on the packaging, insert, or removable tag.
  - 14.1.6. A permanent, exact replica of the appropriate sport specific seal must appear legibly on the exterior of the chest protector.



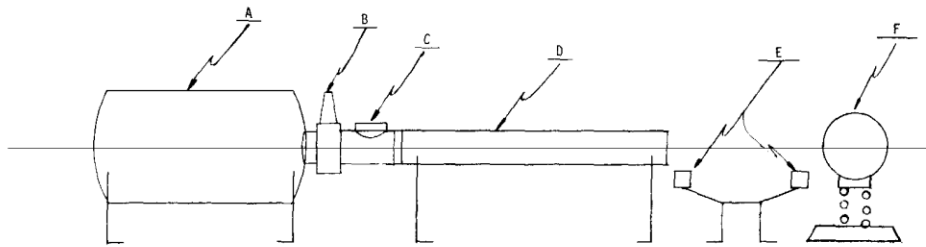
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- 14.2. Packaging and/or instructional literature for chest protectors shall be permanently and legibly marked in a manner such that the following information can be easily read.
  - 14.2.1. Information that warns the user that the chest protector can be damaged by contact with common substances (for example, certain solvents, cleaners, etc.) and that this damage may or may not be visible to the user. This information should also list any recommended cleaning agents and/or procedures.

- 14.2.2. Information that warns the user that for maximum performance the manufacturers fitting instructions must be followed.
- 14.3. Each chest protector shall have permanently affixed to the exterior of the protector a clearly legible statement which can be easily read without removal of any tape or other temporary or permanent part, which contains language which effectively communicates to the purchaser and user the following information, using the same or similar language:
- WARNING:**
- NO THORACIC OR CHEST PROTECTOR CAN PREVENT CARDIAC OR OTHER INJURY. CATASTROPHIC INJURY AND DEATH MAY OCCUR TO THE WEARER DESPITE USING THIS PROTECTOR.**
- 14.4. Additional information to be included with the protector shall describe proper fitting and use of the protector.

*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 either for revision, modification or creation of additional standards and should be addressed to NOCSAE's Executive Director. Check the web at [www.nocsae.org](http://www.nocsae.org) to obtain the latest version of a standard.*

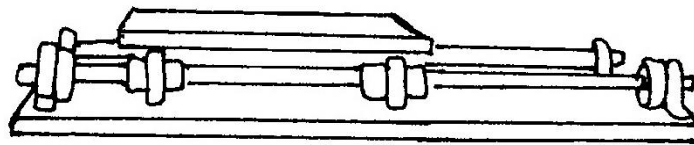
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This is an exemplary system; any system that provides the required test parameters is acceptable.

- A = air reservoir
- B = air solenoid
- C = loading breech
- D = interchangeable barrel
- E = velocity measurement sensors
- F = head form—fully adjustable 3 axis and rotation

**FIG. 1 Ball Propelling Device**



Linear Bearing Table - Figure 2

PROOF



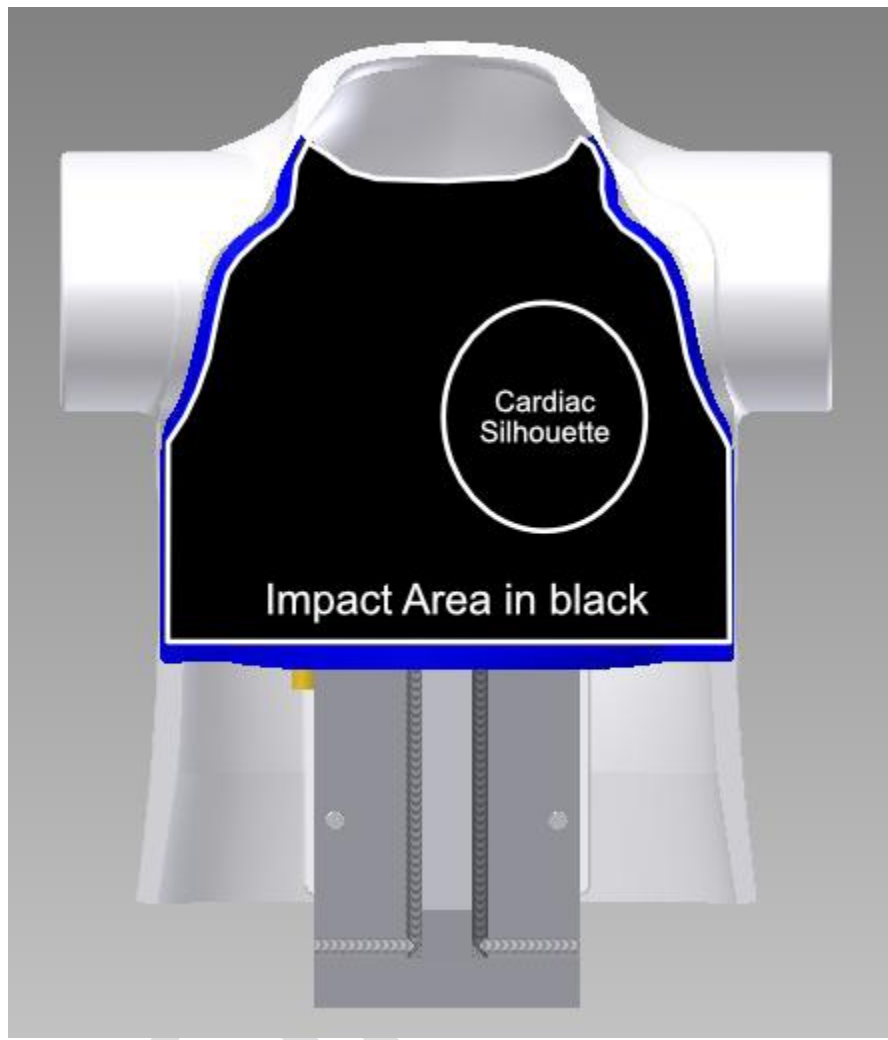


Figure 3