EQUIPMENT CALIBRATION PROCEDURES

NOCSAE DOC (ND) 101-00m14a

Prepared By

NOCSAE

NATIONAL OPERATING COMMITTEE
ON STANDARDS FOR ATHLETIC EQUIPMENT

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1 Scope

1.1 This procedural guide establishes recommended practices for the calibrating the equipment used in NOCSAE testing.

1.2 **All testing and requirements of this standard specification must be in accordance with NOCSAE DOC.001 and NOCSAE DOC.100.**

1.3 *This recommended practice 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 recommended practice to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2 Referenced Documents

2.1 STANDARD TEST METHOD AND EQUIPMENT USED IN EVALUATING THE PERFORMANCE CHARACTERISTICS OF HEADGEAR/EQUIPMENT, NOCSAE DOC.001.

2.2 TROUBLESHOOTING GUIDE FOR TEST EQUIPMENT AND IMPACT EQUIPMENT, NOCSAE DOC.100.

3 Instrument Calibration - KME 200

3.1 See Section 16, NOCSAE DOC.001.

NOTE: It is recommended that a high quality, true sine wave, uninterruptible power supply (UPS) be used into which you should plug your SI Analyzer. Not only will this allow you time to complete and save an analysis in the event there is a power failure, a good quality UPS will also smooth out the peaks and brownouts so frequently associated with electricity supplied by most public utilities. ***This equipment must be capable of yielding a true sine wave.***

3.2 The following steps describe the procedure used to verify that the SI analyzer is operating at optimal performance. Ideally, no adjustments to the SI Gain Knob, Peak g potentiometer or SI Power potentiometer will be necessary. After following these steps correctly, the SI analyzer will produce the correct SI and Peak g readings.

3.2.1 Turn on SI Analyzer power switch and allow the unit at least 15 minutes to warm-up. SI Analyzer should be left on continuously after it is setup in the location that it will be used for NOCSAE testing. This procedure will need to be conducted each time you turn the SI analyzer on or to validate readings obtained during product testing.

3.2.2 Disconnect accelerometer (if connected).

3.2.3 Switch FILTER off.

3.2.4 Connect banana-to-banana plugs from Dycal to CHANNEL Y of signal conditioner with ***correct polarity***: black connectors to black connectors and red connectors to red (sometimes yellow, depending on your SI analyzer).

3.2.5 Set Dycal PULSE WIDTH to 5.

3.2.6 Switch Dycal mode switch left to ADJUST.

3.2.7 Connect digital volt meter (DVM) to Dycal with correct polarity, DVM power on, and DC volts mode.

3.2.8 Set DVM to Direct Current and set decimal places to at least three (3).

3.2.9 Unlock and then adjust Dycal AMPLITUDE knob until DVM reads 1.420v (this is equivalent to 142g).

3.2.10 Remove DVM from Dycal and connect DVM to Vector Analyzer ANALOG OUTPUT with correct polarity.

3.2.11 Confirm that the voltage output from the Y channel is the same as the voltage set on the Dycal. If not, adjust the CHANNEL Y Attenuation Potentiometer (pot), the little brass screw to left of banana plug, with a tweaking tool until the voltages are the same.

3.2.12 Switch Dycal mode to PULSE.

3.2.13 Push RESET button on SI computer (reset bulb should light).

3.2.14 Push PULSE button on Dycal.

3.2.15 SI computer should read 1200 ± 2% (between 1176 and 1224). Regardless of readings, go to the next step.

3.2.16 Push PEAK g button, SI computer should read 142 g ± 2% (between 138 and 146).

3.2.17 Repeat steps 3.2.13 through 3.2.16 several times to verify repeatability and that the readings are consistent. If readings are within the specified range no adjustments are necessary, go to step 3.2.21.

Note: This first portion of the calibration procedure can be used as a quick check to verify the SI analyzer for validating readings obtained during product testing.

3.2.18 If either SI or peak g is out of range, go to steps 3.2.19 and 3.2.21 to make adjustments. Once these adjustments have been made, return to 3.2.13 and repeat the steps until the SI and Peak g is within range.

3.2.19 If Peak g's is out of range, adjust bottom of 3 pot adjustments (small brass screw to left of RESET button) on left face of SI computer with a tweaking tool.

3.2.20 If SI is out of range, adjust the GAIN control potentiometer of the Severity Index computer. Lock into place. Return to step 3.2.13.

3.2.21 Switch Dycal mode to ADJUST and reconnect DVM to Dycal with correct polarity.

3.2.22 Adjust Dycal amplitude to read 0.815v on DVM. This is equivalent to 81.5g.

3.2.23 Remove DVM from Dycal and connect to Vector Analyzer ANALOG OUTPUT with correct polarity.

3.2.24 Confirm that the voltage output from the Y channel is the same as the voltage set on the Dycal.

3.2.25 If not, adjust the channel Y attenuation potentiometer with a tweaking tool until the voltages are the same.

3.2.26 Switch Dycal mode switch right to PULSE.

3.2.27 Push RESET button on SI computer.

3.2.28 Push pulse button on Dycal.

3.2.29 SI computer should read 300 ± 3% (between 291 and 309)

3.2.30 SI computer peak g should read 81.5 ± 3% (between 79 and 84) when g's button is pressed.

3.2.31 Repeat steps 3.2.26 through 3.2.30 several times to verify repeatability and that the readings are consistent. If the 300 SI reading is not in range, do not make any adjustments at this time, go on to the next step.

3.2.32 Switch Dycal mode to ADJUST and reconnect DVM to Dycal with correct polarity.

3.2.33 Adjust Dycal amplitude to read 1.74v on DVM. This is equivalent to 174g.

3.2.34 Remove DVM from Dycal and connect to Vector Analyzer ANALOG OUTPUT with correct polarity.

3.2.35 Confirm that the voltage output from the Y channel is the same as the voltage set on the Dycal.

3.2.36 If not, adjust the channel Y attenuation potentiometer with a tweaking tool until the voltages are the same.

3.2.37 Switch Dycal mode switch right to PULSE.

3.2.38 Push RESET button on SI computer.

3.2.39 Push pulse button on Dycal.

3.2.40 SI computer should read 1997 ± 3% (between 1937 and 2057)

3.2.41 SI computer peak g should read 174 ± 3% (between 169 and 179) when g's button is pressed.

3.2.42 Repeat steps 3.2.37 through 3.2.41 several times to verify repeatability and that the readings are consistent.

3.2.43 If the 300 SI and 1997 SI range is out of tolerance, the top potentiometer on left side of SI computer can be adjusted slightly to bring them into range. **Important:** Make a note of the adjustments that are made on this potentiometer so that you can reset it back to its original state if the adjustments you make do not result in favorable results. This potentiometer affects the power that the peak g is raised to for the SI computation and should not be adjusted by an inexperienced person.

3.2.44 The potentiometer will balance the SI readings between the low 300 SI and the high 1997 SI levels, particular emphasis should be placed on the 1200 SI pass/fail level and under no circumstances should the KME SI analyzer be placed into service unless the 1200 SI is within acceptable tolerance. Use care when making these adjustments, you will have to make several adjustments to both the SI gain potentiometer as well as this top potentiometer until the 300 SI, 1200 SI and the 1997 SI are within acceptable limits. Use only the Gain control to adjust the 1200 SI level and only the top potentiometer for making adjustments to the 300 SI level. Once the 1200 SI and 300 SI levels are within tolerance, check the 1997 SI level. This may take some time and experience and is not done very often, if you are having difficulty making these adjustments or the tolerance cannot be achieved within acceptable limits, contact the NOCSAE Technical Advisor[1] for assistance.

4 Headform Calibration

4.1 Signal Conditioner

4.1.1 Set Dycal to adjust position.

4.1.2 Connect DVM to the Dycal output.

4.1.3 Adjust Dycal AMPLITUDE knob until DVM reads 1.000v.

4.1.4 Move DVM leads to Vector Analyzer ANALOG OUTPUT.

4.1.5 This 1.000v reference voltage can be used to check the values of the channel potentiometers. Before calibrating a headform, you should set each output voltage to the value obtained the last time the headform was calibrated, see the voltage log (chart 1) you created in step 4.11. If the headform voltages were not recorded or unknown, set each value to 1.000 as a starting point.

4.1.6 Connect a banana plug from the Dycal output (1.000v ± .002v) to Channel X. Adjust the channel X potentiometer until the voltage reading is either the last voltage obtained after calibrating the headform or 1.000v.

[1] Currently SIRC at 865-523-1662 or email mcook@soimpact.com

4.1.7 Disconnect banana plug from Channel X and connect to Channel Y. Adjust the channel Y potentiometer until the voltage reading is either the last voltage obtained after calibrating the headform or 1.000v.

4.1.8 Disconnect banana plug from Channel Y and connect to Channel Z. Adjust the channel Z potentiometer until the voltage reading is either the last voltage obtained after calibrating the headform or 1.000v.

4.1.9 Turn the filter on

4.1.10 Remove the banana plugs and the DVM connections.

NOTE: If a power failure occurs on the system, or the system is shut down for any reason after starting or completing a headform calibration, this entire section must be repeated before product may be tested. It is for this reason that many users leave their system up overnight.

4.2 Refer to Section 17, NOCSAE DOC.001.

4.3 Before mounting the headform to the carriage, check that the torque of the headform mounting bolt (the Allen bolt in the center of the mounting interface) is 180 in/lbs, ± 5 in/lbs (15 ft/lbs, ± 0.5 ft/lbs) and that the collar is secure.

4.4 For the KME 200, start with each potentiometer (X, Y & Z) set to the last known values according to the voltage log (chart 1) or unity gain as described under Signal Conditioner as in 4.1 above.

For The NOCSAE Software for Reconditioners, follow instructions on screen.

4.5 Mount the triaxial accelerometer in headform and connect to Signal Conditioner. Make certain that there is absolutely no debris what so ever under the accelerometer mounting plate or on the headform's accelerometer mount, clean the area thoroughly before inserting the accelerometer. Disconnect Dycal from Signal Conditioner when drop testing. Make sure the accelerometer is mounted firmly in the headform in the correct orientation.

4.6 This step should be used if you are seeing a lot of 'false triggering" that occurs due to static electricity discharges. Connect a thin ground wire to the headform-mounting collar. It is also advisable to ground the base plate. Many times just isolating the technician with a rubber mat will help cut down on the number of false triggers.

4.7 Adjust the headform to the front position (see Figure 1); tighten all bolts and the collar in the correct position. Tension in the guide wires should be such that the drop carriage moves as smoothly as possible throughout its travel. Tighten the turnbuckles at the top of the guide wires to reduce the amount of play, front to back, when the drop carriage is located at the mid-point of the guide wires. Caution: Do not over tighten the turnbuckles; this may result in mechanical failure and personal injury.

4.8 Mount the Headform Calibration (3") MEP pad on the anvil.

4.9 Check the "Front" alignment with the MEP pad to ensure there is no nose contact but the headform is still as close to the center of the pad as is practical (See

paragraph 10, NOCSAE DOC.100 for achieving more consistent results).

4.10 Connect the carriage release assembly in the appropriate position making sure that the carriage is as balanced as possible. Drop on the front from the drop velocity specified by position and headform size identified in the NOCSAE Calibration Pad Qualification (or Re-Qualification) Report for the particular MEP Calibration Pad you are using.

4.11 For the KME 200, adjust the X attenuation pot (*) on the signal conditioner as necessary to obtain 1200 SI, ±2% after a drop. Record the SI and peak G. Be certain that the Dycal is adjusted for reading of 1.000v. Then reconnect with banana plugs to Channel X and Dycal; record voltage with the DVM connected to the analog output with Dycal in adjust mode, this is the voltage you will use as a starting point the next time you calibrate.

* Typically, 180° rotation equals about 100 SI.

For The NOCSAE Software for Reconditioners, follow instructions on screen.

NOTE: For the KME 200, maintain a log of voltages observed after each calibration of a headform and location. This data will be used for ongoing compliance and troubleshooting (see Chart 1 for an example). These will be the voltages you use in step 4.1 above to set the potentiometer values to the last settings used for a calibrated headform.

CHART 1
Voltages Found for Each Headform

HEADFORM S/N	Date of Calibration	CHANNEL X Volts	CHANNEL Y Volts	CHANNEL Z Volts

For the KME 200, disconnect the Dycal from Channel X

4.12 For the KME 200, repeat for side impacts (see Figure 1), adjust Y attenuation pot on the Signal Conditioner as necessary to obtain 1200 SI, ±2%, from the drop velocity specified by position and headform in the NOCSAE Calibration Pad Qualification (or Re-Qualification) Report for the particular MEP Calibration Pad you are using.; the headform should strike the MEP pad as close to the center as practical (See section 10, NOCSAE DOC.100-96 for achieving more consistent results). Then connect the DVM to analog output and banana plug to Channel Y and record voltage with the Dycal in adjust mode.
For The NOCSAE Software for Reconditioners, side impacts, follow instructions on screen.

4.13 For the KME 200 Disconnect the Dycal from Y channel.

4.14 For the KME 200, repeat for top impacts (see Figure 1), adjust Z attenuation pot on the Signal Conditioner as necessary to obtain 1200 SI, ±2%, from the drop velocity specified by position and headform size in the NOCSAE Calibration Pad Qualification (or Re-Qualification) Report for the particular MEP Calibration Pad you are using.; the headform should strike the MEP pad as close to the center as practical (See section 10, NOCSAE DOC.100 for achieving more consistent results). Then connect the DVM to analog output and banana plug to Channel Z and record voltage with the Dycal in adjust mode.

For The NOCSAE Software for Reconditioners, follow instructions on screen.

4.15 Go back to the front position and conduct impacts. Verify that any adjustments made to channel Y, and Z did not disrupt the adjustments previously made to channel X.

4.16 Be certain to remove the banana plugs from all of the channels when doing headform drop impacts.

5 Post-calibration System Check

5.1 See Section 18, NOCSAE DOC.001.

5.2 Exchange the calibration MEP pad (3") for the test MEP pad (½").

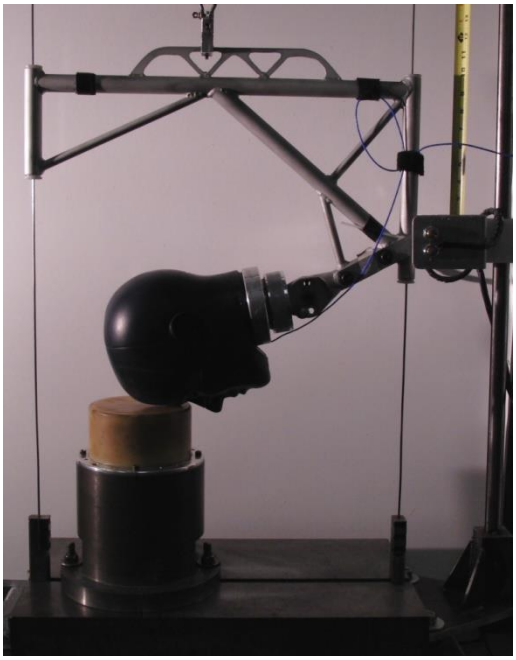
5.3 Position the calibrated headform to the front boss (see Figure 1).

5.4 Perform three (3), 18" drops to the center of the MEP pad (½").

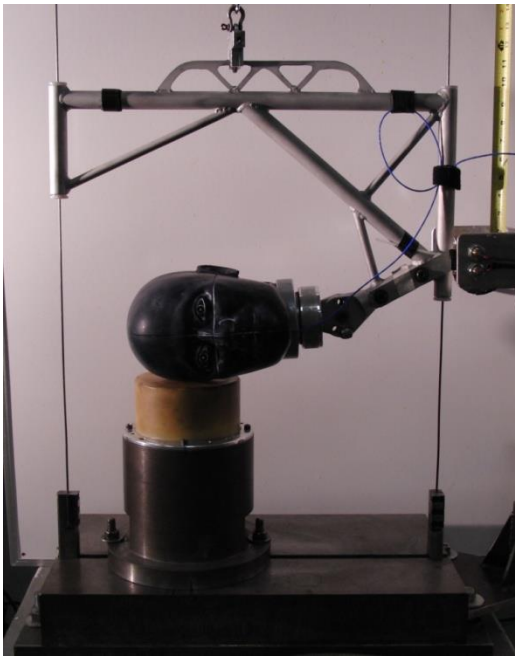
5.5 Record the three (3) impacts and then find the average SI and g

5.6 Perform product testing.

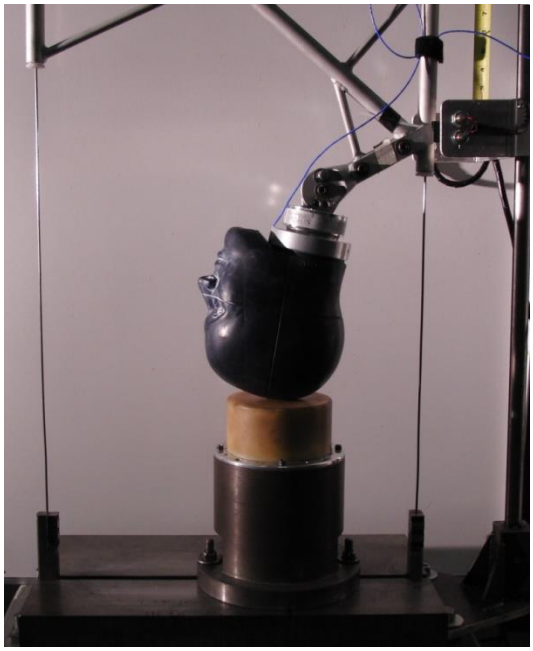
5.7 After completing your product test series for a size, before calibrating another headform, repeat 5.3 through 5.5 above and check to make sure the average results are no greater than ± 7% different than they were the first time. If the difference is greater than ± 7%, the product test series just completed ***cannot be considered valid!*** Because of this potential it is advisable to perform a post-calibration system check frequently. Even if the headform isn't changed.
Ideally, this step is done at the end of the day (or the beginning). If the system has stayed in calibration there is no need to re-calibrate.



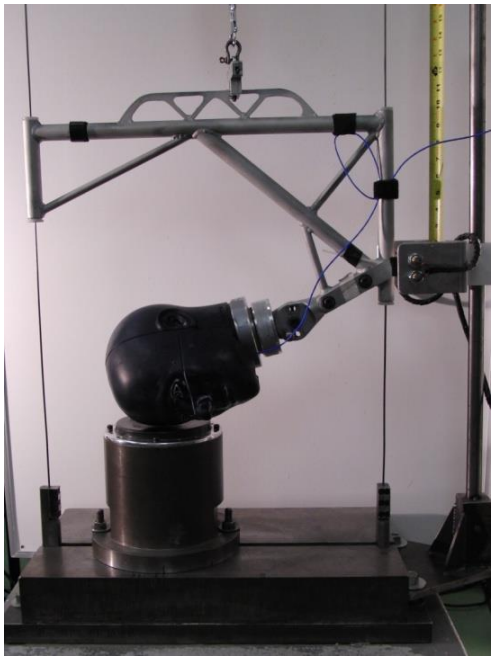
Calibrate Front (Channel X)



Calibrate Side (Channel Y)



Calibrate Top (Channel Z)



Front Boss System Check

Figure 1

APRIL, 1998 MODIFICATIONS/REVISIONS

- Correction in 3.2.12: voltages should have been 1.10v, not 1.0v.
- Corrected paragraph numbering for Section
- Added Figure 1.
- Referenced Figure 1 in 4.6, 4.12, 4.15 and 5.3.

DECEMBER, 1999 MODIFICATIONS/REVISIONS

- 2 - Added a reference to NOCSAE DOC.100-96
- 4.8 - Added a recommendation and altered the paragraph somewhat to accommodate that recommendation.
- 4.12 - Added a recommendation and altered the paragraph somewhat to accommodate that recommendation.
- 4.15 – Cautioned readers to attempt to make impact in the center of the MEP pad; added a recommendation and altered the paragraph somewhat to accommodate that recommendation.

MAY, 2000 MODIFICATIONS/REVISIONS

- ***Revision*** – Changed 4.9 and 4.10 to reflect the new requirements for drop heights being related to a specific MEP Calibration pad; deleted original Chart 1.

APRIL, 2002 MODIFICATIONS/REVISIONS

- Simplified document references within document.

JANUARY, 2003 MODIFICATIONS/REVISIONS

- Change calibration impact order

APRIL, 2003 MODIFICATIONS/REVISIONS

- Modified naming convention and added NOCSAE logo to cover page.

APRIL, 2007 MODIFICATIONS/REVISIONS

- Clarified tensioning of guide wires.

DECEMBER, 2008 MODIFICATIONS/REVISIONS

- Corrected typo in section 5.7 identifying steps repeated before calibrating another headform.

MAY, 2010 MODIFICATIONS/REVISIONS

- Changed warm-up time for KME for consistency
- Corrected voltage references for consistency
- Deleted reference to figure 4 in DOC ND001

OCTOBER, 2012 MODIFICATIONS/REVISIONS

- Changed KME 200 instrument calibration method to include verification of the low 300 SI and high 1200 SI pass/fail limits.
- Corrected references from drop height to velocity
- Clarified use of voltage log

AUGUST, 2013 MODIFICATIONS/REVISIONS

- Clarified Instrument Calibration - KME 200 procedure
- Corrected typos

SEPTEMBER, 2013 MODIFICATIONS/REVISIONS

- Corrected typos
- Added photos for clarity

OCTOBER, 2014 MODIFICATIONS/REVISIONS

- Updated title name of NOCSAE DOC. 001

NOVEMBER, 2014 MODIFICATIONS/REVISIONS

- Corrected typos
- Clarified Instrument Calibration - KME 200 procedure