

EQUIPMENT CALIBRATION PROCEDURES

NOCSAE DOC (ND) 101-00m10

Prepared By



**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

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

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 SI Analyzer

- 3.2.1 Turn on SI Analyzer power switch and allow the unit at least 15 minutes to warm-up.
- 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.
Some old battery powered DVMs will give inaccurate readings even if the "low battery" indicator has not come on; be sure batteries are fresh.
- 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 1.100v (this is equivalent to 1.10g); re-lock the amplitude knob.
- 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 Repeat 3.2.9 to verify that DVM still reads 1.100v; if not adjust Dycal AMPLITUDE knob again and get it back to 1.100v. Next, repeat 3.2.10 and 3.2.11.
- If voltage held at 1.100v, go on to 3.2.13
- 3.2.13 Switch Dycal mode to PULSE.
- 3.2.14 Push RESET button on SI computer (reset bulb should light).
- 3.2.15 Push PULSE button on Dycal.
- 3.2.16 SI computer should read $634 \pm 2\%$ (between 621 and 646). Regardless of readings, go to the next step.
- 3.2.17 Push PEAK g button, SI computer should read $110 \text{ g} \pm 2\%$ (between 108 and 112).
- 3.2.18 If either SI or peak g is out of range, go to steps 3.2.29 and 30 to make adjustments. Once these adjustments have been made, return to 3.2.19 and continue.
- 3.2.19 Repeat steps 3.2.14 through 17 several times to verify repeatability.
- 3.2.20 Switch Dycal mode to adjust, connect DVM to Dycal, and adjust Dycal AMPLITUDE knob until DVM reads 1.905v.
- 3.2.21 Remove DVM from Dycal and connect DVM to Vector Analyzer ANALOG OUTPUT with correct polarity.
- 3.2.22 Confirm that the voltage output from the Y channel is the same as the voltage set on the Dycal.
- 3.2.23 If not, adjust the channel Y attenuation potentiometer with a tweaking tool until the voltages are the same.

- 3.2.24 Switch Dycal to pulse mode.
- 3.2.25 Push RESET on SI computer.
- 3.2.26 Push PULSE on Dycal.
- 3.2.27 SI computer should read $2500 \pm 2\%$ (between 2450 and 2550)
- 3.2.28 Push SI computer Peak g's switch; it should read $190.5 \pm 2\%$ (between 186 and 194)
- 3.2.29 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.
- 3.2.30 If SI is out of range, adjust the GAIN control knob of the Severity Index computer. Lock into place.
- 3.2.31 Switch Dycal mode to ADJUST and reconnect DVM to Dycal with correct polarity.
- 3.2.32 Adjust Dycal amplitude to read 1.420v on DVM. This is equivalent to 1.42g since $1.000v = 100g$.
- 3.2.33 Remove DVM from Dycal and connect to Vector Analyzer ANALOG OUTPUT with correct polarity.
- 3.2.34 Confirm that the voltage output from the Y channel is the same as the voltage set on the Dycal.
- 3.2.35 If not, adjust the channel Y attenuation potentiometer with a tweaking tool until the voltages are the same.
- 3.2.36 Push RESET button on SI computer.
- 3.2.37 Switch Dycal mode switch right to PULSE.
- 3.2.38 Push pulse button on Dycal.
- 3.2.39 SI computer should read $1201 \pm 1\%$ (between 1189 and 1213)
- 3.2.40 SI computer peak g should read $142 \pm 1\%$ when g's button is pressed.
- 3.2.41 Repeat several times.
- 3.2.42 If out of range, repeat steps 3.2.29 and 30 again.
- 3.2.43 If lower (634) and upper (2500) SI readings are still out of range, the top pot on left side of SI computer can be adjusted slightly. Then start over at Step 3.2.8 again.

Repeat this procedure to get in range as close as possible. This may take some time and experience and is not done very often. Go back and repeat steps 3.2.6 through 3.2.41 to get accurate reading for the Standard cutoff

score: 1200 SI. If adjustment compromises are necessary on SI, favor the 1200 SI, 142 g adjustment.

3.3 Signal Conditioner

- 3.3.1 Connect banana plugs from Dycal to Channel Y on Signal Conditioner.
- 3.3.2 Set Dycal to adjust position.
- 3.3.3 Connect DVM across Channel Y also.
- 3.3.4 Adjust Dycal AMPLITUDE knob until DVM reads 1.000v.
- 3.3.5 Move DVM leads to Vector Analyzer ANALOG OUTPUT.
- 3.3.6 The voltage reading from Channel Y should be $1.000v \pm .002v$.
- 3.3.7 Disconnect banana plug from Channel Y and connect to Channel X. The voltage reading from Channel X should be $1.000v \pm .002v$.
- 3.3.8 Disconnect banana plug from Channel X and connect to Channel Z. The voltage reading for Channel Z should also be $1.000v \pm 0.002v$ on analog output.
- 3.3.9 If these readings are out of range, adjust attenuation pots on signal conditioner with a tweaking tool as necessary, using the DVM on analog output.
- 3.3.10 Turn the filter on
- 3.3.11 Remove the banana plugs and the DVM connections.

4 Headform Calibration

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.

- 4.1 Refer to Section 17, NOCSAE DOC.001.
- 4.2 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.
- 4.3 For the KME 200, start with each potentiometer (X, Y & Z) set to unity gain as described under Signal Conditioner as in 3.3 above.

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

- 4.4 Mount the triaxial accelerometer in headform and connect to Signal Conditioner. Disconnect Dycal from Signal Conditioner when drop testing. Make sure the accelerometer is mounted firmly in the headform in the correct orientation.

- 4.5 Connect a thin ground wire to the headform-mounting collar. It is also advisable to ground the base plate.
- 4.6 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 through out its travel. Hand tighten the turnbuckles at the top of the guide wires as tight as possible, this will 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 use a tool to tighten the turnbuckles; this may result in mechanical failure and personal injury.
- 4.7 Mount the Headform Calibration (3") MEP pad on the anvil.
- 4.8 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).
- 4.9 Drop on the front from the drop height specified by position and headform size as identified in the NOCSAE Calibration Pad Qualification (or Re-Qualification) Report for the particular MEP Calibration Pad you are using.
- 4.10 For the KME 200, adjust the X attenuation pot (*) on the signal conditioner as necessary to obtain 1200 SI, $\pm 2\%$. Record the SI and peak G. Recheck the Dycal for reading of 1.000v (see 3.3.7).

Then reconnect DVM to analog output and banana plug to Channel X and Dycal; record voltage with Dycal in adjust mode.

* 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 trouble shooting (see Chart 1 for an example).

CHART 1

Voltages Found for Each Headform

Date - _____ Time - _____

HEADFORM S/N	CHANNEL X	CHANNEL Y	CHANNEL Z

- 4.11 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, $\pm 2\%$, from the drop height specified by position and headform size in Chart 1; the headform should strike the MEP pad as close to the center as practical (See paragraph 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.

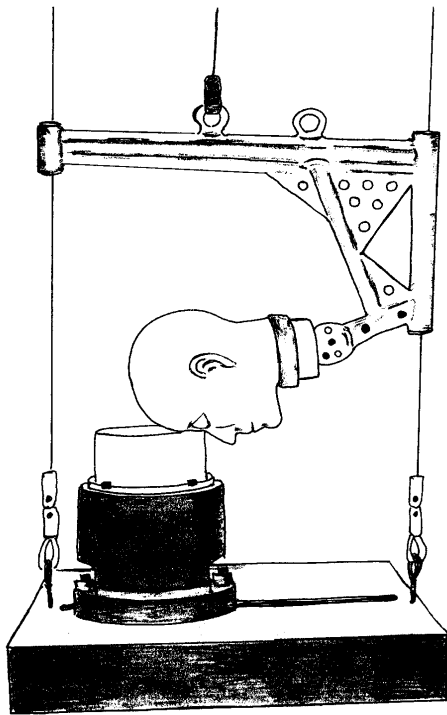
- 4.13 For the KME 200 Disconnect the Dycal from Y channel.
- 4.14 For the KME 200, repeat for top impacts (see Figure 1), adjust Z attenuation pot on the Signal Conditioner as necessary to obtain 1200 SI, $\pm 2\%$, from the drop height specified by position and headform size in NOCSAE Chart 1; the headform should strike the MEP pad as close to the center as practical (See paragraph 10, NOCSAE DOC.100-96 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.

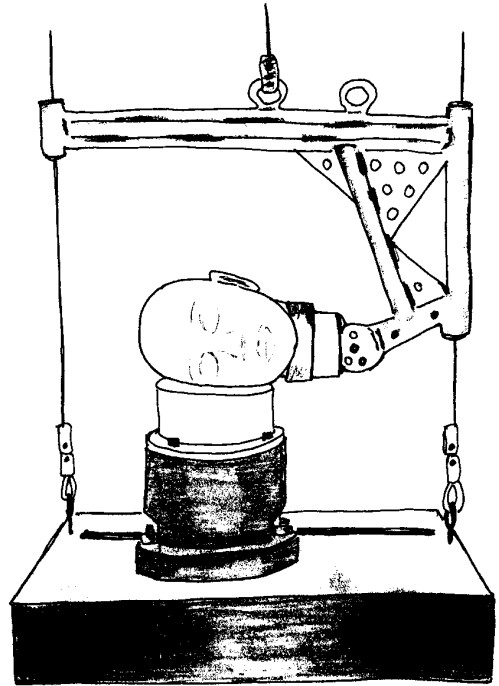
- 4.15 Go back to the front position and conduct impacts. Verify that any adjustments made to channel Y, and Z did not disrupt the adjustments previously made to channel X.

5 Post-calibration System Check

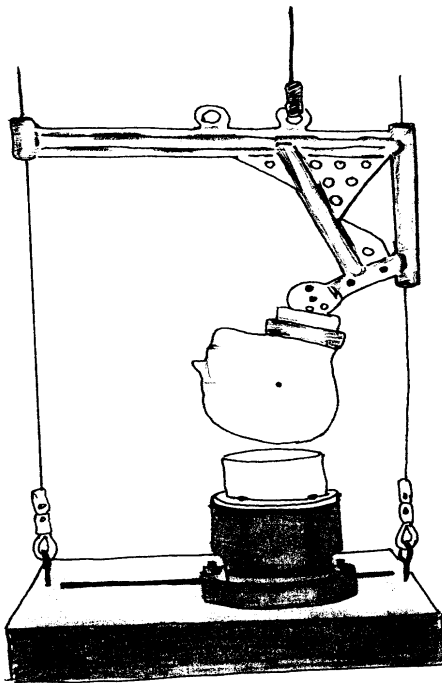
- 5.1 See Section 18, NOCSAE DOC.001.
- 5.2 Exchange the calibration MEP pad (3") for the test MEP pad ($\frac{1}{2}$ ").
- 5.3 Position the just calibrated headform to the front boss (see Figure 1).
- 5.4 Perform three (3), 18" drops to the center of the MEP pad ($\frac{1}{2}$ ").
- 5.5 Record the three (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 $\pm 7\%$ different than they were the first time. If the difference is greater than $\pm 7\%$, 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.



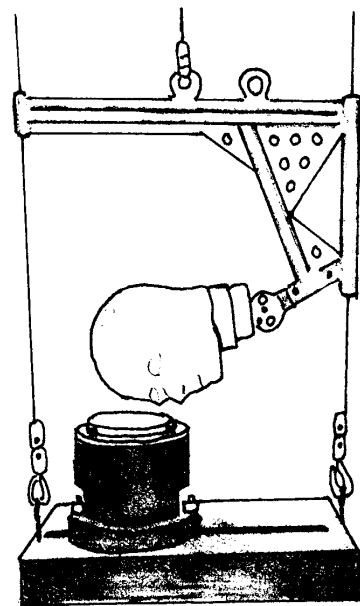
Calibrate Front (Channel X)



Calibrate Side (Channel Y)



Calibrate Top (Channel Z)



System Check (Post-Cal.) - Front Boss

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