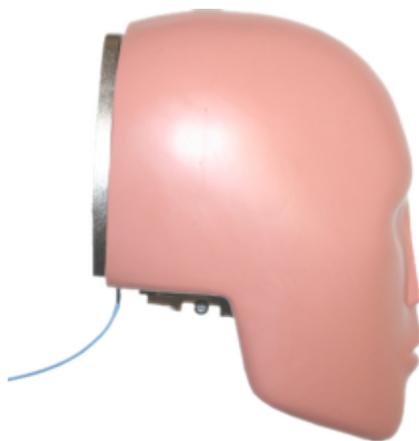


**U.S. DEPARTMENT OF TRANSPORTATION**  
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION  
LABORATORY TEST PROCEDURE  
FOR  
Part 572, SUBPART L  
PERFORMANCE CALIBRATION REQUIREMENTS



**ENFORCEMENT**  
**Office of Vehicle Safety Compliance**  
**Mail Code: NEF-240**  
1200 New Jersey Ave., SE  
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## **1. PURPOSE AND APPLICATION**

The purpose of this laboratory procedure is to provide independent testing laboratories under contract with the Office of Vehicle Safety Compliance with standard test procedures for performing receiving-inspection and performance calibration tests on the Part 572, Subpart L, Free Motion Headform (FMH) so that repetitive and correlative test results can be obtained. The following test was developed to establish a uniform calibration procedure to verify the performance of the FMH.

## **2. GENERAL REQUIREMENTS**

The code of Federal Regulations (49 CFR), Parts 571 and 572, was amended to adopt the FMH to test motor vehicle upper interior components in accordance to Federal Motor Vehicle Safety Standard (FMVSS) No. 201 "Occupant Protection in Interior Impact." Each FMH must meet the specifications and performance criteria of Part 572, Subpart L, before and after each compliance test.

## **3. SECURITY**

The FMHs delivered to the contract laboratory as Government Furnished Property (GFP) will be stored in a safe and secure area such as the dummy calibration laboratory. The contractor is financially responsible for any acts of theft and/or vandalism which occur during the storage of GFP. Any security problems shall be reported by telephone to the Industrial Property Manager (IPM), Office of Contracts and Procurement, within two working days after the incident. A letter containing specific details of the security problem will be sent to the IPM (with copy to the COR) within 48 hours.

The contractor is responsible for maintaining the FMHs in good working order, and shall protect and segregate the data that evolves from conducting calibration tests before and after each FMVSS No. 201 FMH impact test.

No information concerning the FMH calibration data shall be released to anyone except the COR, unless specifically authorized by the COR.

## **4. GOOD HOUSEKEEPING**

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

## **5. TEST SCHEDULING AND MONITORING**

The Part 572, Subpart L, FMHs are being calibrated to be used in a vehicle component test to determine compliance with the requirements of FMVSS 201. The schedule for these performance calibration tests must be correlated with that of the vehicle component tests. Upon request, all testing shall be coordinated to allow monitoring by the COR.

## **6. TEST DATA DISPOSITION**

The contractor shall make all FMH calibration data available to the COR for review and analysis as required. Calibration test data for each FMH will be included as part of the final test report in the format indicated in this test procedure.

## 7. GOVERNMENT FURNISHED PROPERTY (GFP)

The Government shall furnish FMHs to the contract laboratory. The FMHs shall be stored in a secured room which is kept between 55°F and 85°F. The contractor will check FMH components for damage after each test and complete a damage checklist that shall be included with the posttest FMH calibration data report. The COR will be kept informed of the FMH's condition in order that replacement parts can be provided.

## 8. CALIBRATION AND TEST INSTRUMENTATION

Before the contractor initiates the performance calibration test program, a test instrumentation calibration system must be implemented and maintained in accordance with established calibration practices. The calibration system shall be set up and maintained as follows:

- A. Standards for calibrating the measuring and test equipment shall be stored and used under appropriate environmental conditions to assure their accuracy and stability.
- B. All measuring instruments and standards shall be calibrated by the contractor, or a commercial facility, against a higher order standard at periodic intervals not exceeding 12 months for instruments and 12 months for calibration standards. Records, showing the calibration traceability to the National Institute of Standards and Technology (NIST), shall be maintained for all measuring and test equipment.
- C. All measuring and test equipment and measuring standards shall be labeled with the following information:
  - (1) Date of calibration
  - (2) Date of next scheduled calibration
  - (3) Name of the technician who calibrated the equipment
- D. The contractor shall provide a written calibration procedure that includes, as a minimum, the following information for all measurement and test equipment.
  - (1) Type of equipment, manufacturer, model number, etc.
  - (2) Measurement range
  - (3) Accuracy
  - (4) Calibration interval
  - (5) Type of standard used to calibrate the equipment (calibration traceability of the standard must be evident)
  - (6) The actual procedures and forms used to perform calibrations.
- E. The contractor shall keep records of calibrations for all test instrumentation in a manner that assures the maintenance of established calibration schedules. All such records shall be readily available for inspection when requested by the COR. The calibration system will need the written acceptance of the COR before testing begins.

- F. Test equipment shall receive a calibration check immediately prior to and after each test. This check shall be recorded by the test technician(s) and submitted with the draft copy of the final report.
- G. FMHs shall be calibrated before and after each test. The calibration data shall be submitted with the draft copy of the final report.

## 9. PHOTOGRAPHIC DOCUMENTATION

Provide digital still photographs showing any damage that occurred to the FMH as a result of the component test. Provide copies of the photographs in the draft copy of the final test report.

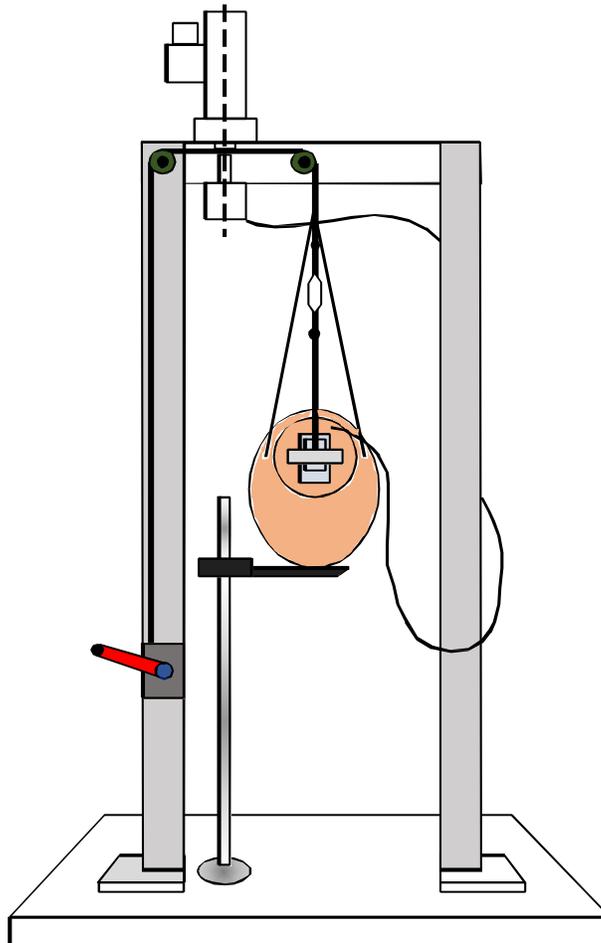
## 10. PRETEST REQUIREMENTS

### 10.1 TEMPERATURE CONTROLLED TEST ENVIRONMENT

A temperature controlled test environment capable of being maintained at a temperature range from 19°C to 26°C at any relative humidity from 10% to 70% for an extended period of not less than 4 hours.

### 10.2 HEAD DROP TEST FIXTURE

A head drop test fixture is used to conduct the head drop tests. The schematic below illustrates a test fixture capable of successfully performing the tests.

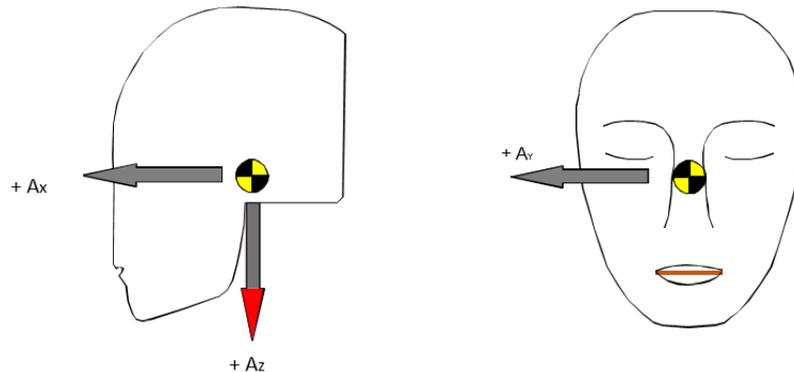


### 10.3 TRANSDUCER REQUIREMENTS

Three Endevco 7264-2000 accelerometers with 1% Transverse Sensitivity shall be mounted in the head cavity of the FMH to measure orthogonal accelerations ( $A_x$ ,  $A_y$ ,  $A_z$ ) at the center of gravity (CG) of the head assembly. The accelerometers shall have dimensions, response characteristics and sensitive mass locations as specified in drawing SA 572-S4 and be mounted in the head as shown in drawing 92041-001. The accelerometer mounts shall have no resonant frequency within a range of 3 times the frequency range of the applicable channel class.

The sign convention for outputs of transducers mounted within the FMH must conform to the sign convention shown below;

#### Free Motion Headform Accelerometer Sign Convention



### 10.4 DATA ACQUISITION SYSTEM

The outputs of acceleration devices installed in the FMH specified by this part are recorded with individual data channels. Each data channel will be comprised of a sensor, signal conditioner, data acquisition device, and all interconnecting cables, and must conform to the requirements of SAE Recommended Practice J211, MAR 95, "Instrumentation for Impact Test," Class 1000.

All filter classes should be of the "phaseless" type to be compatible with the "time" dependent test parameters.

## 11. CALIBRATION TEST EXECUTION

### 11.1 PERFORMANCE SPECIFICATIONS (S572.102 (a))

- A. The peak resultant acceleration shall not be less than 225 g and not more than 275 g.
- B. The resultant acceleration vs. time history curve shall be unimodal to the extent that oscillations occurring after the main pulse shall not exceed 10% of the peak resultant acceleration.
- C. The lateral acceleration shall not exceed 15 g.

### 11.2 CONDUCT THE HEAD DROP CALIBRATION TEST(S)

See Section 14 - Check Sheet No. L1

## **12. POST TEST REQUIREMENTS**

The contractor shall verify all required data has been collected and recorded on the tables provided in Section 14. The contractor shall perform instrumentation checks necessary to validate data results.

## **13. REPORTS**

### **13.1 APPARENT NONCONFORMANCE**

During the posttest calibration, any indication of apparent nonconformance to the requirements of Regulation P572 shall be communicated by telephone to the COTR within 24 hours with written notification mailed within 48 hours (Saturdays and Sundays excluded). Written notification shall be submitted with a copy of the particular test data sheet(s) and preliminary data plot(s).

In the event of an apparent nonconformance, a post test calibration check of some critically sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration shall be at the COTR's discretion and shall be performed without additional costs to the OVSC.

### **13.2 FINAL PERFORMANCE CALIBRATION REPORTS**

The pre-test calibration and posttest calibration verification data for each Part 572, Subpart L Free Motion Headform used in the vehicle compliance test shall be submitted with the final test report for the vehicle tested.

## 14. CHECK SHEETS

**CHECK SHEET No. L1**  
HEAD DROP TEST (572.102)

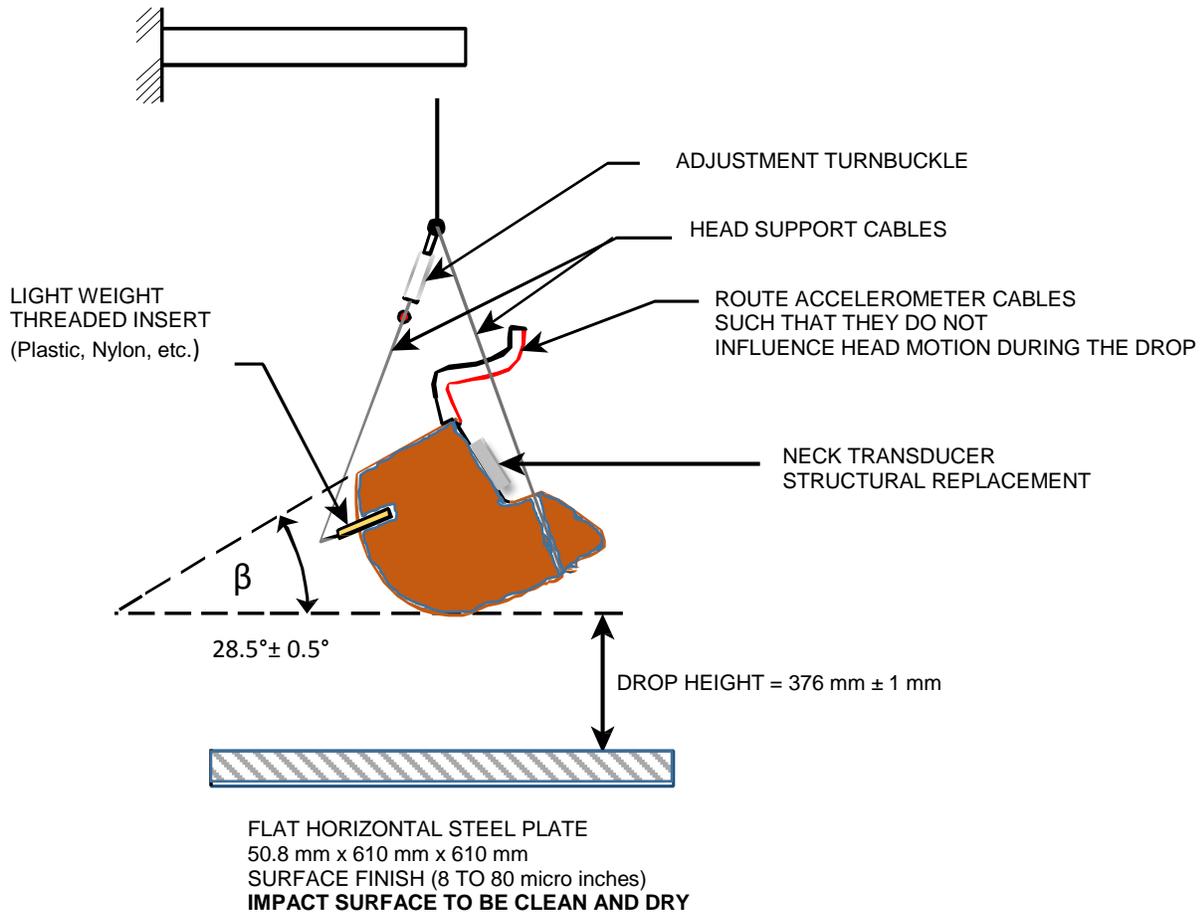
FMH Serial Number \_\_\_\_\_

Test Date \_\_\_\_\_

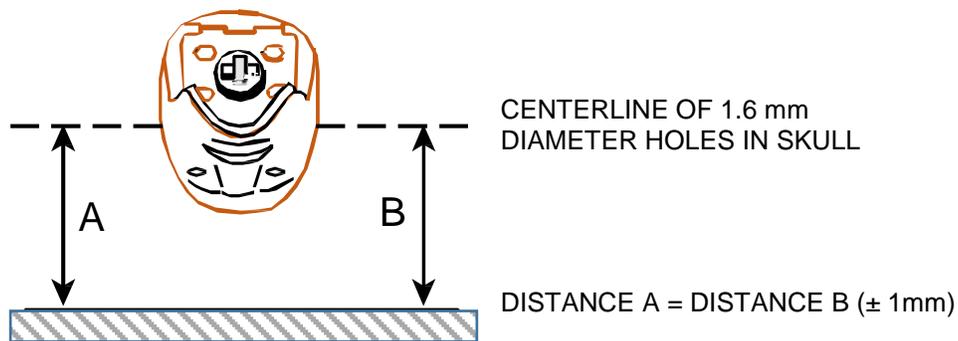
Technician \_\_\_\_\_

**Pretest Preparation**

- \_\_\_1. Inspect the FMH skin for cracks, tears or other damage. Replace parts if necessary.  
**Note:** If the damage results from the vehicle test, the damaged area is to be documented on the FMH Damage Inspection Check Sheet (see Check Sheet No. L2)) and include photos of the damage. The posttest calibration verification testing shall be completed before any replacement or repairs are made.
- \_\_\_2. Weigh the FMH and record FMH mass in Table L1. Verify that the weight meets specification by indicating "Pass" or "Fail" in the far right column.
- \_\_\_3. Soak the FMH at a temperature between 19°C and 26°C and at a relative humidity from 10% to 70% for a period of at least four (4) hours prior to a test. Record the length of time for the soak and the maximum and minimum temperatures and humidity levels achieved during the soak in Table L1. Verify that each measurement meets specification by indicating "Pass" or "Fail" in the far right column.
- \_\_\_4. Configure the FMH for the head drop test by mounting three (3) accelerometers (SA572- S4) in the head and installing a 6-axis upper neck load simulator.
- \_\_\_5. Assure accelerometers and their respective mounts are smooth and clean.
- \_\_\_6. Torque the skull cap screws (1/4-20) to 18.1 N-m.
- \_\_\_7. The data acquisition system, including transducers, conforms to the requirements of SAE Recommended Practice J211, MAR95.
- \_\_\_8. Clean the FMH skin with isopropyl alcohol, 1,1,1-Trichloroethane or equivalent and allow it to dry thoroughly prior to the test (572.102(b)(2)).
- \_\_\_9. Install a lightweight threaded insert into the top of the FMH and support cables to suspend and orient the FMH as shown in the figure below. Position the forehead below the chin such that the skull cap plate is at an angle  $28.5^{\circ} \pm 0.5^{\circ}$  with the impact surface when the midsagittal plane is vertical.



- \_\_10. Attach the FMH assembly to the head drop test fixture. Raise (or lower) the FMH assembly so that it is  $376 \pm 1$  mm from the impact surface to the lowest point on the FMH. Record the actual distance \_\_\_\_\_
- \_\_11. Align the FMH assembly such that the centerline of the 1.6 mm diameter holes located on either side of the FMH are equidistant within 1 mm from the impact surface.



Record the right side distance \_\_\_\_\_ mm      Record the left side distance \_\_\_\_\_ mm

- \_\_12. Clean the impact surface with isopropyl alcohol, 1,1,1-Trichloroethane or equivalent and allow it to dry thoroughly prior to the test (572.102(b)(2)).

**Conduct the Test, Collect Data and Verify Performance**

- \_\_\_13. Record the room temperature and humidity in Table L1. Verify that the temperature and relative humidity meet specification by indicating “Pass” or “Fail” in the far right column.
- \_\_\_14. Drop the head assembly from a height of  $376.0 \pm 1.0$  mm by a means that ensures a smooth, instant release onto the impact surface. (572.102(b)(4))
- \_\_\_15. Record head accelerations and filter using a Channel Class 1000 phaseless filter. Time zero is defined as the time of contact between the head and the impact surface. All channels should be at a zero level at this point.
- \_\_\_16 Calculate the resultant head acceleration using the formula:  
$$\mathbf{a}_{res} = [(\mathbf{a}_x)^2 + (\mathbf{a}_y)^2 + (\mathbf{a}_z)^2]^{1/2}$$
- \_\_\_17 Plot x, y, z and resultant accelerations (see Sample Acceleration Plots)
- \_\_\_18 Record the peak head resultant acceleration and peak lateral acceleration in Table L1. Verify that each measurement meets specification by indicating “Pass” or “Fail” in the far right column.
- \_\_\_19 If the test results are not within specification, wait at least 3 hours, then conduct another head drop test.
- \_\_\_20 Record and report the results of each additional test in a separate table.

**Table L1. Head Drop Test (S572.102)**

| Tested Parameter                 |     | Units   | Specification | Result | Pass/<br>Fail |
|----------------------------------|-----|---------|---------------|--------|---------------|
| Head Assembly Soak Time          |     | Minutes | 240           |        |               |
| Temperature -<br>During Soak     | Max | °C      | 19 to 26      |        |               |
|                                  | Min | °C      |               |        |               |
| Humidity -<br>During Soak        | Max | %       | 10.0 to 70.0  |        |               |
|                                  | Min | %       |               |        |               |
| Temperature – During test        |     | °C      | 19 to 26      |        |               |
| Humidity – During test           |     | % RH    | 10.0 to 70.0  |        |               |
| FMH Mass                         |     | kg      | 4.54 ± 0.05   |        |               |
| Peak Head Resultant Acceleration |     | G       | 225 to 275    |        |               |
| Peak Lateral Acceleration        |     | G       | <15           |        |               |
| Uni-modal (Oscillation)?         |     | Yes/No  | <10%          |        |               |

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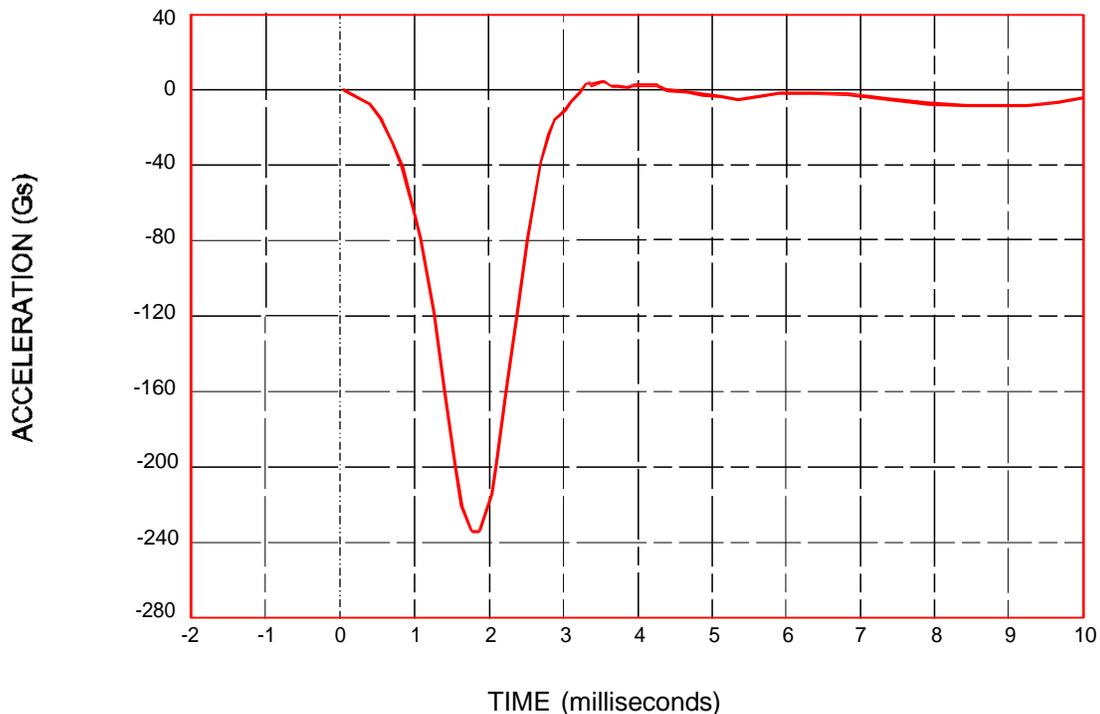
 Signature

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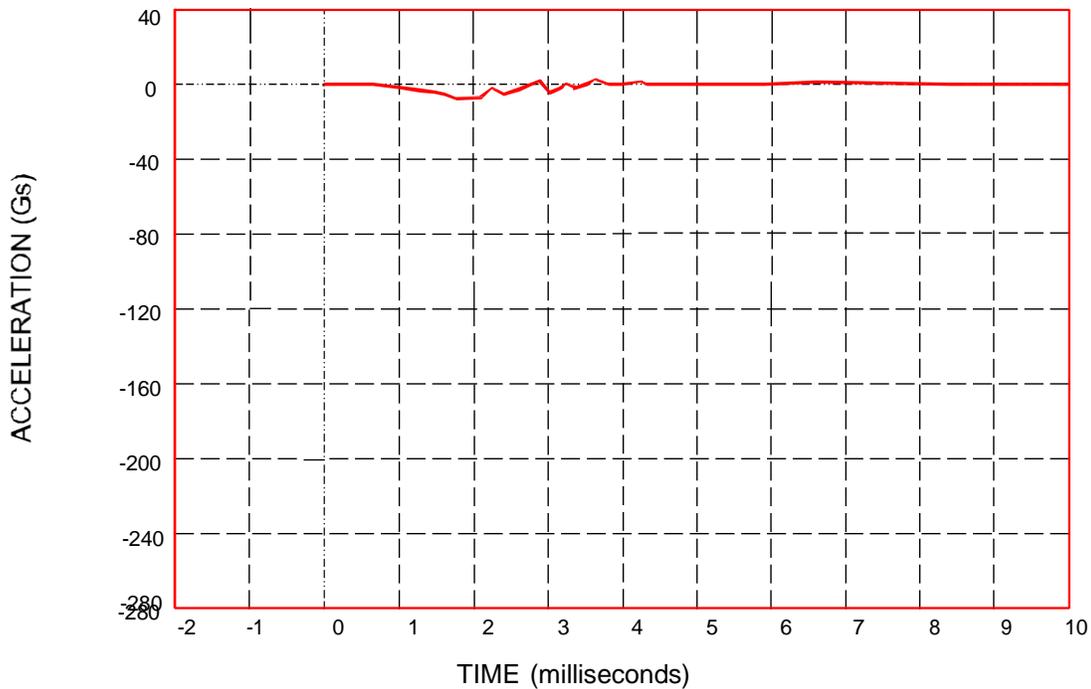
 Completion Date

### SAMPLE ACCELERATION PLOTS

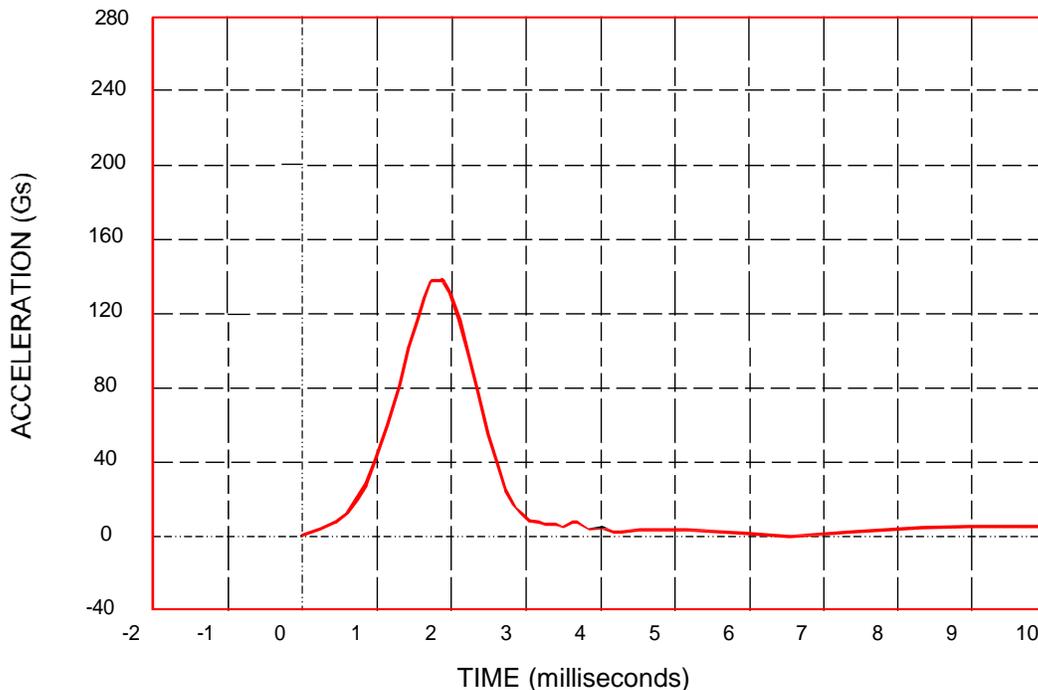
PART 572L FMH HEAD CALIBRATION - HEAD ACCELERATION X AXIS



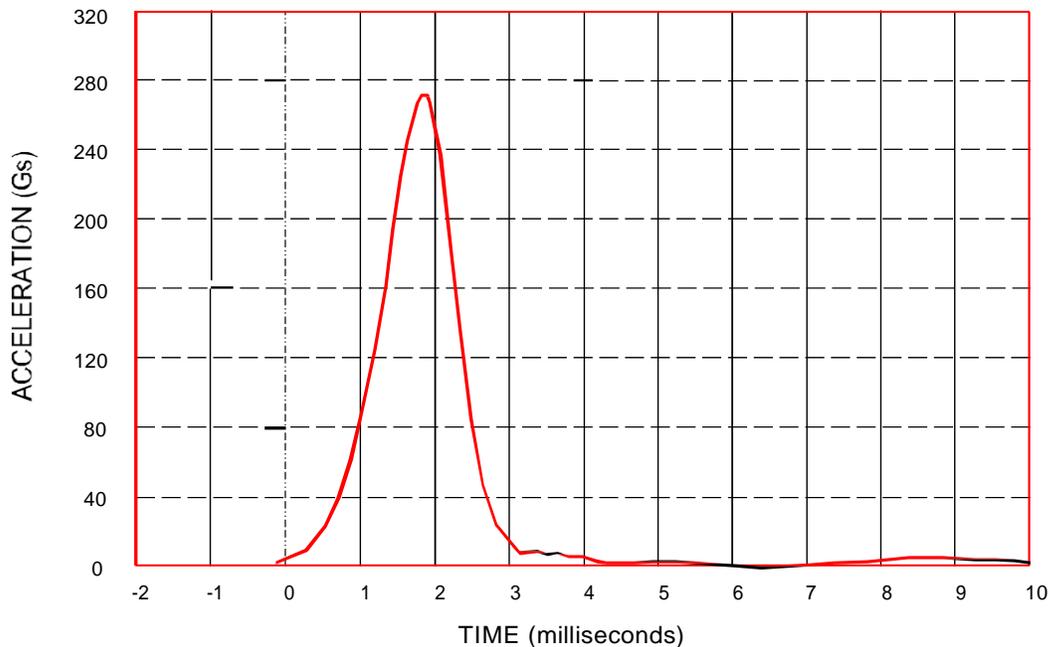
PART 572L FMH HEAD CALIBRATION - HEAD ACCELERATION Y AXIS



PART 572L FMH HEAD CALIBRATION - HEAD ACCELERATION Z AXIS



PART 572L FMH HEAD CALIBRATION - HEAD RESULTANT ACCELERATION



**CHECK SHEET NO. L2**  
**FMH DAMAGE INSPECTION**

FMH Serial Number \_\_\_\_\_

Date \_\_\_\_\_

Technician \_\_\_\_\_

| FMH part                | OK | Damaged | Description |
|-------------------------|----|---------|-------------|
| Outer Skin              |    |         |             |
| Head                    |    |         |             |
| Transducer Leads        |    |         |             |
| Accelerometer mountings |    |         |             |
| Other                   |    |         |             |

COMMENTS ON REPAIR OR REPLACEMENT OF PARTS:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Repair or Replacement approved by:

\_\_\_\_\_;  
 Signature

\_\_\_\_\_  
 Date

Attach photos: