



SURFACE VEHICLE INFORMATION REPORT

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H-III5F Spine Box Update to Eliminate Noise

RATIONALE

The document is being revised to update formatting and update missing figure references in 4.2.3.1.

FOREWORD

In the late 1980s, the Centers for Disease Control (CDC) awarded The Ohio State University a grant to develop multi-sized test dummies based on the Hybrid III design. To aid in this endeavor, the Mechanical Human Simulation Subcommittee of the Society of Automotive Engineers (SAE) formed a Task Group to define the specifications for an adult size small female dummy which would have, at least, the same level of biofidelity and measurement capacity as the 50th Hybrid III dummy. Throughout the 1990s, this small female dummy was revised and improved until it was finally fully defined by a drawing package by NHTSA and adopted in U.S. Federal Regulations as a part of the Code of Federal Regulations Part 572. The 2002 version of this drawing package defines the currently regulated version of this dummy today.

At the December 11, 2007, meeting of the SAE Hybrid III Dummy Family Task Force, data was presented showing that there was a problem with the 2002 version of the design of the spine box for the small female dummy which could cause mechanical noise artifacts in sled and crash test data. Possible solutions to this problem were discussed, and it was agreed to develop a new spine box design to eliminate the possibility of this noise being generated. A new design was discussed, prototypes built and tested, and the design revised until—at the January 13, 2009, meeting—it was agreed to document the design in an SAE Information Report so that it can be recommended by the Task Force.

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Documents

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1. SCOPE

1.1 Purpose

This SAE Information Report documents the problems with the 2002 regulated version of the spine box and defines a recommended solution to resolve the problem.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J2862 User's Manual for the Small Adult Female Hybrid III Test Dummy

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 Code of Federal Regulations (CFR) Publications

Available from the United States Government Printing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-1800, www.gpo.gov.

49 CFR 572 Test Dummies Specifications - Anthropomorphic Test Dummy for Applicable Test Procedures

49 CFR 572 Subpart O Hybrid III 5th Percentile Female Test Dummy, Alpha Version

3. ABBREVIATIONS

H-III5F Hybrid III 5th percentile small female crash test dummy

Hybrid-III AF05 (in Figure 13) Hybrid III 5th percentile small female crash test dummy

SHCS Socket head cap screw

FHCS Flat head cap screw

NHTSA National Highway Traffic Safety Administration of the United States Department of Transportation

4. TECHNICAL REQUIREMENTS

4.1 2002 Regulation Spine Box

The H-III5F dummy in federal regulation was first adopted into 49 CFR Part 572 via 65 FR 10968 on March 1, 2000, and subsequently amended via 67 FR 46413 on July 15, 2002. These regulations define drawings for the construction of the dummy as well as dynamic performance criteria through certification tests in Part 572 Subpart O. The 2002 version of the H-III5F drawing package defines the current version of the dummy. Drawings 880105-000 (page 3 of 8), 880105-300, 880105-328, 880105-1000 (sheet 3 of 3) from this drawing package are most relevant to this issue and are included in [Appendix A](#).

4.1.1 Description of Problem

In the thorax region of the H-III5F, the spine box (880105-1000) is attached to the thorax load cell simulator (880105-328) by six 5/16-18 x 1/2 inch SHCS (item 29 on 880105-300). Since the holes in the spine box are 0.323 inch in diameter and the screws have a maximum diameter of 0.313 inch, there is always clearance between the screws and the spine box wall. As the H-III5F is exposed to the accelerations involved in sled or crash testing, the screws can loosen and the spine box will slip under the screw heads until it hits the sides of the screws. This motion produces high amplitude, high frequency mechanical noise on accelerometers within the dummy, which is an artifact of the dummy. A secondary effect of this rocking motion is that the spine box can move approximately ± 1 degree relative to the thorax load cell structural replacement (see [Figure 1](#)). This moves the head position relative to the pelvis fore and aft based on how the spine box is in contact with the screws.

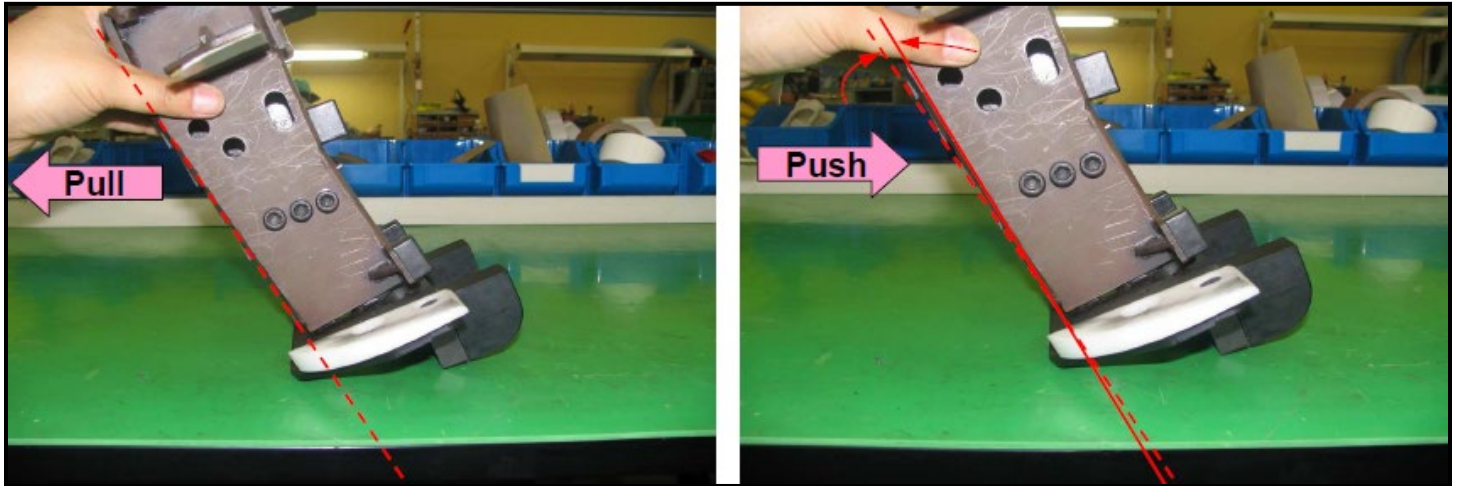


Figure 1 - Spine rocking on screws

4.1.2 Tests Demonstrating Problem

The data in [Figure 2](#) was presented at the December 11, 2007, meeting showing the noise spikes that were thought to be produced by the spine rocking during the impact event. This data was produced from a 35 mph belted sled test. [Figure 3](#) shows data that was presented at the same meeting showing noise spikes in 35 mph frontal rigid barrier tests that are hypothesized to be from the spine rocking as well.

The test data in green was obtained initially (with an unknown bolt torque) and we could not understand the cause of the abnormal peak-G. We tried to reproduce the phenomenon as shown with the resulting plots in red.

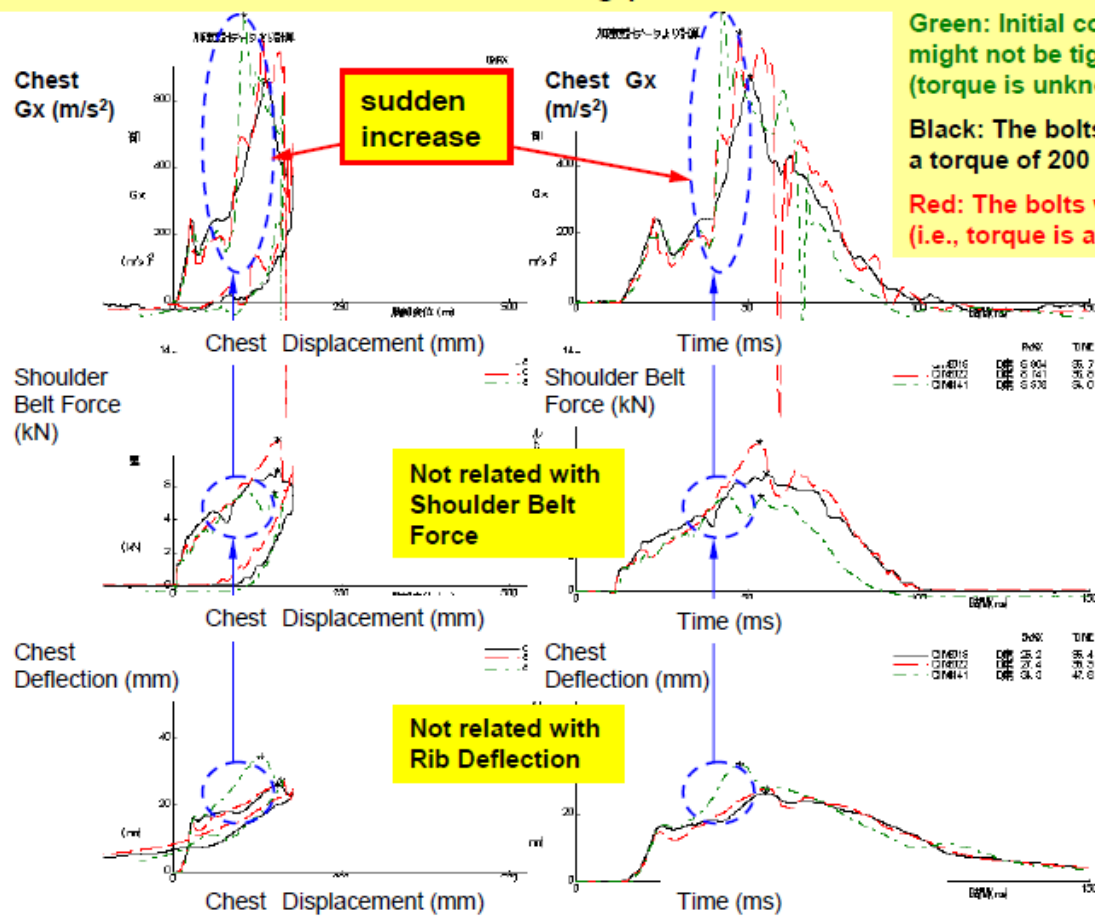
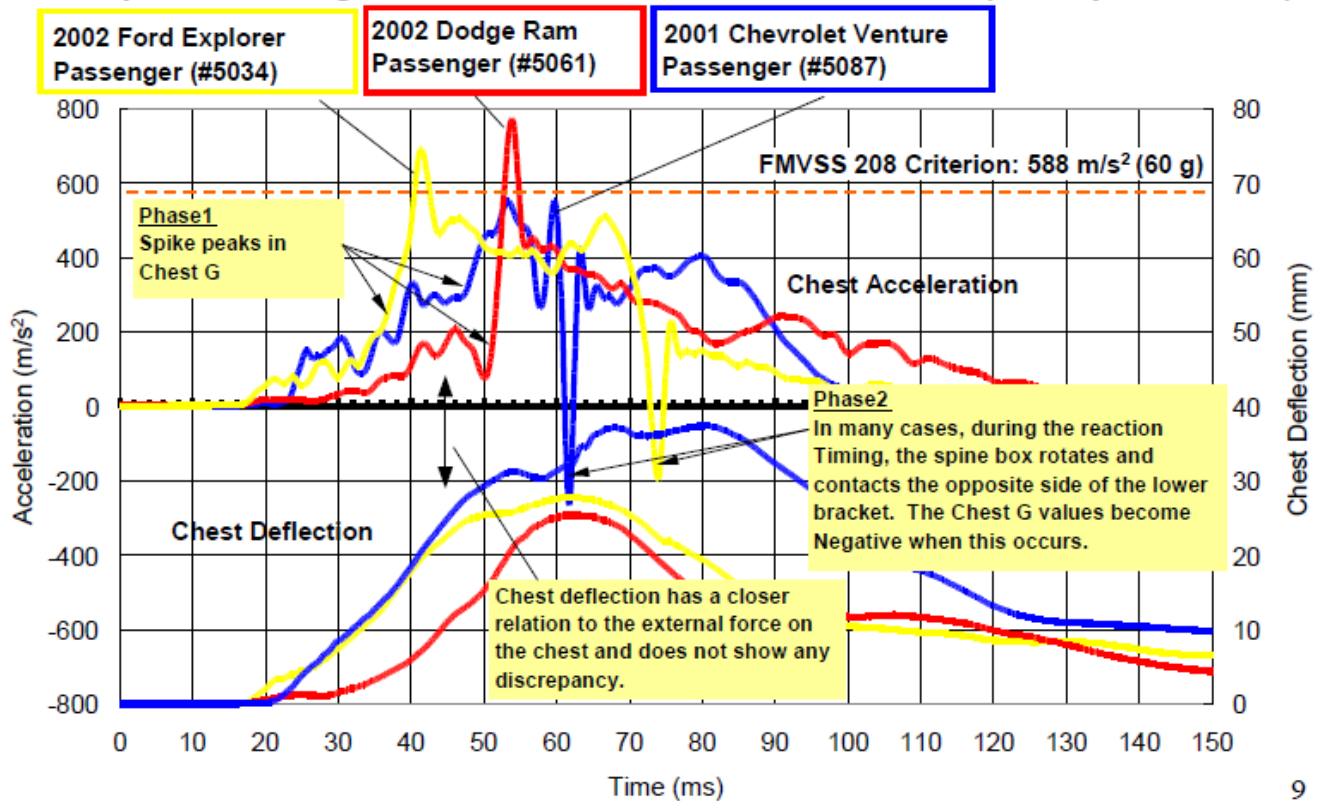


Figure 2 - Sled data demonstrating problem

NHTSA Research Test Results: We could find 3 similar wave patterns in the NHTSA test results (from the web) from 8 vehicles; H-III AF05 was positioned on the driver and passenger sides (16 cases in total).

35 mph Frontal Rigid Barrier Test Results w/ Belted AF05 (w/ respect to time)



9

Figure 3 - Barrier crash data demonstrating the problem

4.1.3 Interim Measure

An interim stop-gap measure to minimize the problem until the spine box can be permanently fixed is to re-tighten the six SHCS before every test. The six screws must be loosened and then re-tightened to the proper torque between every sled or crash test. It has been found that keeping the screws tight in this manner will usually prevent the slippage and mechanical noise from occurring. A sample tightening procedure that can be followed is included in [Appendix B](#).

4.2 Recommended Spine Box Update

4.2.1 Description of Solution

To eliminate the possibility of motion, the screws that attach the spine box to the load cell structural replacement are changed from standard SHCS to 5/16-18 SHCS that have a 90 degree chamfer (45 degrees per side) like a FHCS as seen in [Figure 4](#). These screws are already used in the DOT-SID dummy in Part 572 Subpart F. To have sufficient wall thickness to add the countersink to the spine box, a steel plate is welded on each side. The screw holes have 90 degree countersinks added. This allows the screws to lock the spine box into a unique position, and lets the chamfer of the screw grip to the countersink in the spine box. The screws are torqued to 28 N·m.

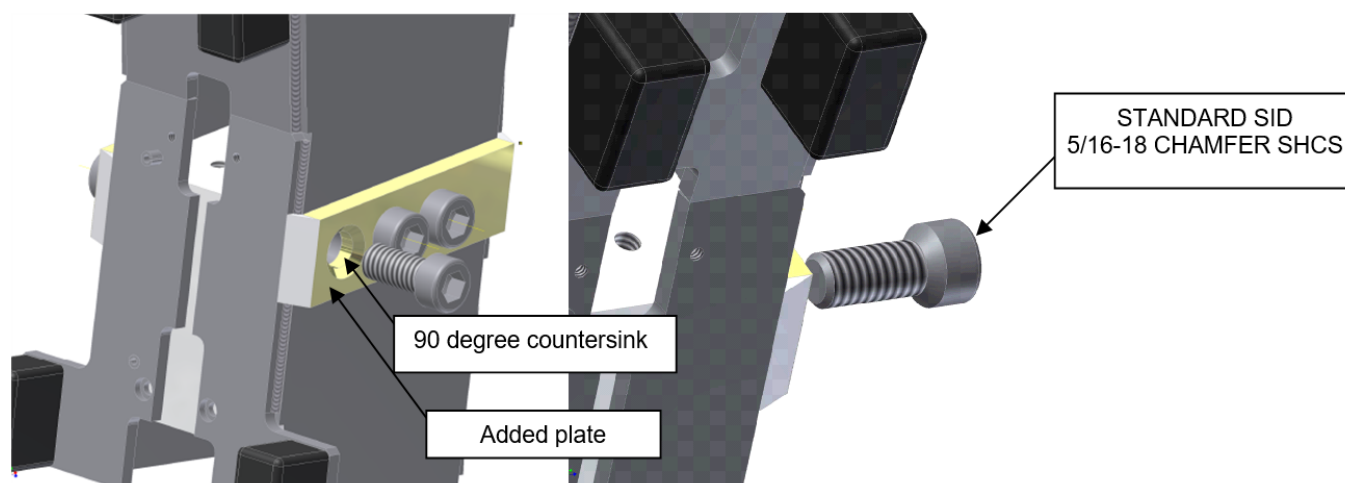


Figure 4 - Design of upgraded spine box

4.2.2 Drawings

Drawings are provided to construct the spine box either from scratch when building a new dummy or to upgrade an existing dummy by updating the spine box and screws.

4.2.2.1 To Make a New Spine Box

To make a new spine box from scratch, drawings 880105-1045, 880105-1047, and SID-076-6 are used as shown in [Figures 5](#) through [9](#), as well as the drawings listed on 880105-1045 that are used directly from the 2002 drawing package.

4.2.2.2 To Upgrade a 2002 Regulation Spine Box

An existing spine box can be modified by using drawings 880105-1045-MOD ([Figure 10](#)), 880105-1048 ([Figure 11](#)), and 880105-1049 ([Figure 12](#)) shown in the corresponding figures.

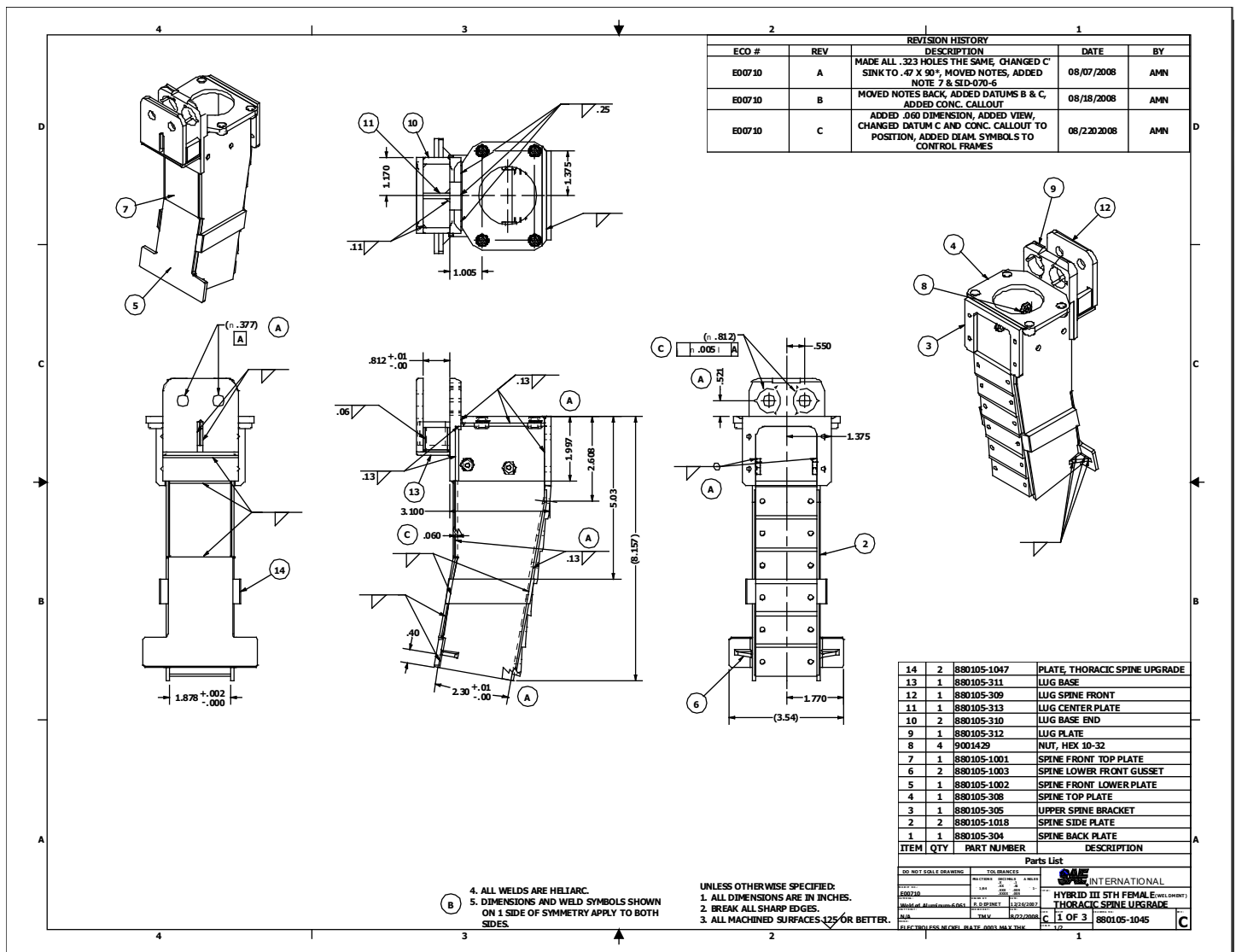


Figure 5 - 880105-1045 sheet 1 of 3