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Development of the HH-60 Fuel Probe Container

403 SCMS/GUEB
AIR FORCE PACKAGING TECHNOLOGY & ENGINEERING FACILITY
WRIGHT PATTERSON AFB, OH 45433-5540
23 November 2009
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AFPTEF PROJECT NO. 09-P-107
TITLE: Development of the HH-60 Fuel Probe Container

ABSTRACT

The Air Force Packaging Technology Engineering Facility (AFPTEF) was tasked with the design of a new shipping and storage container for the HH-60 Fuel Probe in April of 2009. The current wood container is difficult to handle, falls apart easily, provides minimal physical protection of the item, and offers no environmental protection against corrosion. To solve these issues AFPTEF used proven design techniques IAW SAE ARP1967A to develop an aluminum, long-life, controlled breathing, reusable shipping and storage container which will protect the fuel probe both mechanically and environmentally. The container passed all qualification tests per SAE ARP1967A, ASTM D4169, and MIL-STD-648.

This container not only meets user requirements but will also provide a significant economic savings, per refueling probe, for the Air Force over the twenty-year life span of the container.

Total man-hours: 475

PROJECT ENGINEER:  
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Mechanical Engineer  
AFPTEF

TEST ENGINEER:  
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Mechanical Engineer  
AFPTEF

APPROVED BY:  
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Chief, Air Force Packaging Technology Engineering Facility

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23 Nov 09
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INTRODUCTION

BACKGROUND – HH-60 personnel at Robins AFB (411 SCMS/GULD) contacted AFPTEF to request the design of a reusable container for the HH-60 Fuel Probe that would eliminate shipping and storage risks. The Fuel Probe is currently shipped in a wood box, which is difficult to handle and falls apart frequently. The box does not have environmental controls and is not sealed by the nature of its construction. These two factors allow the container to “breathe” with continuously changing environmental conditions. There is no means to control breathing or remove the excess moisture that results, which could cause a corrosion problem on the Probe.

REQUIREMENTS – AFPTEF developed a list of requirements based on the SPI and discussions with the customer. Many of these requirements were not met by the wood box. The requirements are as follows:

- Sealed/controlled-breathing container that protects against varied environmental conditions and weather during either inside or outside shipping and storage
- Reusable and designed for long life (20 years)
- Corrosion resistant container and hardware allow for extended storage outdoors
- Low maintenance
- Field replaceable hardware
- 2-way forklift capability
- Mechanical or hand lifting (4-6 people) of cover
- Probe shock/vibration limited to 110 Gs
- Clamp spacing similar to original container, will not interfere with wire harnesses
- Orient probe with extend/retract lines upward to avoid spillage of residual fuel
- Drip pan to catch residual fuel at forward end of probe
- No loose packing material
- End restraint to prevent forward/aft motion of the probe

DEVELOPMENT

DESIGN – The HH-60 Fuel Probe Shipping and Storage Container design meets all the users’ requirements. The container is a sealed, welded aluminum, controlled breathing, reusable container (Appendix 2, Figure 1). The container is engineered for the physical and environmental protection of the Fuel Probe during worldwide transportation and storage. The container consists of a low-profile base and completely removable cover equipped with the special features listed below. The base is a double walled extrusion with 2-way forklift openings and a humidity indicator. A silicone rubber gasket and quick release cam-over-center latches create a water/air-tight seal at the base-cover interface. The cover is a double walled extrusion with a pressure equalizing valve (0.5 psi pressure/ 0.5 psi vacuum) and desiccant port for easy replacement of up to 48 units of desiccant (controls dehumidification). Container external dimensions are 179.5 inches
length, 25.0 inches width, and 22.4 inches height. Container empty weight is 548.5 pounds.

An aluminum cradle system is integrated into the base walls. The Probe is secured in the cradle by placing it into the HDPE-lined aluminum clamps (Appendix 2, Figures 2 & 3), inserting the alignment pin (Appendix 2, Figure 4) and then tightening the clamps (Appendix 2, Figure 5). There are no detachable parts on the container other than the container lid, which eliminates FOD risks.

### HH-60 FUEL PROBE CONTAINER FEATURES

<table>
<thead>
<tr>
<th>Feature</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Equalizing Valve</td>
<td>1</td>
</tr>
<tr>
<td>Humidity Indicator</td>
<td>1</td>
</tr>
<tr>
<td>Desiccant Port</td>
<td>1</td>
</tr>
<tr>
<td>Internal Document Receptacle</td>
<td>None</td>
</tr>
<tr>
<td>Forkliftable</td>
<td>Yes</td>
</tr>
<tr>
<td>Cover Latches</td>
<td>22</td>
</tr>
<tr>
<td>Cover Lift Handles</td>
<td>6</td>
</tr>
<tr>
<td>Cover Lift Rings</td>
<td>4</td>
</tr>
<tr>
<td>Cover Tether Rings</td>
<td>None</td>
</tr>
<tr>
<td>Base Lift Handles</td>
<td>None</td>
</tr>
<tr>
<td>Base Tie-down Rings</td>
<td>4</td>
</tr>
<tr>
<td>Stacking Capability</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**PROTOTYPE** – AFPTEF fabricated one prototype container in house for testing. The prototype container was fabricated in accordance with (IAW) all requirements and tolerances of the container drawing package. The drawing package used for prototype fabrication has been released for the manufacture of production quantities of the container. Each face of the container was uniquely identified for testing identification as shown below.

### DESIGNATED SIDE | CONTAINER FEATURE
--- | ---
Top | Cover Top
Aft | Desiccant Port
Right | Right Side from Aft
Left | Left Side from Aft
Forward | Opposite Aft
Bottom | Base Bottom

**QUALIFICATION TESTING**

**TEST LOAD** – The test load was a non-reparable HH-60 Fuel Probe, to which weights were added to ensure a correct test weight (Appendix 2, Figure 7). The primary triaxial
accelerometer used to record actual accelerations sustained by the Probe was mounted on the outer shell of the item. The test load weight was 156 pounds.

TEST PLAN – The test plan primary references were SAE ARP 1967, ASTM D 4169 and MIL-STD-648 (Appendix 1). The test methods specified in this test plan constituted the procedures for performing the tests on the container. The performance criteria for evaluation of container acceptability were specified at 110 Gs maximum and an initial and final leak rate of 0.25 psi per 30 minutes. These tests are commonly applied to special shipping containers providing rough handling protection to sensitive items. The tests were performed at AFPTEF, Building 70, Area C, Wright-Patterson AFB.

ITEM INSTRUMENTATION – The test load was instrumented with a piezoelectric triaxial accelerometer mounted on the outer shell of the Probe as close to the center of mass as possible (Appendix 2, Figure 6). Primary accelerometer axis orientations were as follows:

- X Axis - Directed through container Left and Right sides.
- Y Axis - Directed through container Forward and Aft (desiccant port) sides.
- Z Axis - Directed through container Top and Bottom sides (Vertical motion).

See Appendix 4 for detailed accelerometer and other instrumentation information.

TEST SEQUENCES – Note: All test sequences were performed at ambient temperature and humidity, unless otherwise noted in the test procedure.

TEST SEQUENCE 1 – Leak Test

Procedure – The desiccant port cover was removed and replaced with a port cover modified for attachment of the digital manometer and vacuum/pressure pump lines. The container was closed and sealed. The leak test was conducted at ambient temperature and pressure. The pneumatic pressure leak technique was used to pressurize the container to a minimum test pressure of 1.5 psi. Maximum allowable leak rate is 0.025 psi per 30 minutes. (Appendix 2, Figure 8).

Results – The container passed the leak test with a leak rate less than the maximum allowed rate of 0.025 psi per 30 minutes.

TEST SEQUENCE 2 – Vacuum Retention Test

Procedure – The desiccant port cover was removed and replaced with a port cover modified for attachment of the digital manometer and vacuum/pressure pump lines. The container was closed and sealed. The vacuum retention test was conducted at ambient temperature and pressure. The air inside the container was evacuated to a minimum vacuum of -1.0 psi. Maximum allowable pressure increase rate is 0.025 psi per 30 minutes. (see Appendix 2, Figure 8).

Results – The container passed the vacuum retention test with a pressure increase rate less than the maximum allowed rate of 0.025 psi per 30 minutes.
**TEST SEQUENCE 3 – Rotational Drops**

Procedure – An Assurance Level I drop height of 12 inches was used to perform four corner and four edge drops onto a 1-inch thick steel plate, and the impact levels were recorded. The maximum allowed impact level for the item was 110 Gs. (Appendix 2, Figures 9 - 11)

Results – All of the recorded impact peak G data (unfiltered) was less than the maximum allowed 110 Gs. Unfiltered impact shock pulses were exaggerated by noise resulting from the hollow structure of the fuel probe. In addition, placement of the accelerometer on the probe was not ideal since the structure of the probe easily transmitted noise.

Because of this noise, each impact waveform was filtered at frequencies ranging from 93 Hz to 178 Hz as appropriate for each shock pulse, to permit truer analysis. The filter frequency for these complex shock pulses was conservatively calculated as 10 times the base frequency of the shock pulse. The filtered peak G data was at least 50% less than the unfiltered data for all but one waveform. Nothing in the shock pulses indicated unusual item behavior. There was no damage to either the container or the item. The container met the test requirements. (Appendix 3, Tables 1 & 3 and Waveforms.)

**TEST SEQUENCE 4 – Lateral Impact (Pendulum Impact)**

Procedure – The container was placed on the pendulum test apparatus and impacted once on the forward and aft sides (the left and right sides were too long for impact testing). The container impact velocity was 7.3 ft/s. (Appendix 2, Figure 12)

Results – All of the recorded impact peak G data (unfiltered) was less than the maximum allowed 110 Gs. For the reasons stated in Test Sequence 3, this data was also filtered to remove as much extraneous noise as possible. After filtering, the forward impact was reduced by 17% and the aft impact by slightly more than 50%. There was no damage to either the container or the item. Nothing in the shock pulses indicated unusual item behavior. The container met the test requirements. (Appendix 3, Tables 1 & 3 and Waveforms.)

**TEST SEQUENCE 5 – Vibration Test, Resonance Dwell**

Procedure – The container was rigidly attached to the vibration platform. A sinusoidal vibration excitation was applied in the vertical direction and cyclically swept for 7.5 minutes at 2 minutes per octave to locate the resonant frequency. Input vibration from 5 to 12.5 Hz was at 0.125-inch double amplitude. Input vibration from 12.5 to 50.0 Hz was at 1.0 G (0 to peak). All signals were electronically filtered using a two-pole Butterworth filter with a 600 Hz cutoff frequency. The peak transmissibility values during the up and down frequency
sweeps were noted for use in determining the frequency search range for the 
resonance dwell test.

The vibration controller swept up the frequency range until the resonant 
frequency was reached. This frequency was manually tracked for a 30 minute 
resonance dwell test. The test was conducted at ambient temperature. (Appendix 
2, Figure 13)

Results - The most significant resonant frequency of the packaged item occurred 
initially at 46.89 Hz, and increased during the dwell period to 49.44 Hz. By the 
end of the 30 minute test, the resonant frequency had decreased to 45.53 Hz. The 
maximum transmissibility throughout the test ranged between 4 and 5 (data 
filtered as described above at 434 Hz and 230 Hz), which is less than the design 
goal of 10 when the resonant frequency is between 25 and 50 Hz. All waveforms 
were filtered prior to analysis due to noise levels. At the end of the test period, 
there was no damage to the container or item. The container met the test 
requirements. (Appendix 3, Tables 2 & 4 and Waveforms)

TEST SEQUENCE 6 – Leak Test
Procedure – Test Sequence 1 was repeated.

Results – The container passed the leak test with a leak rate less than the 
maximum allowed rate of 0.025 psi per 30 minutes.

TEST SEQUENCE 7 – Vacuum Retention Test
Procedure – Test Sequence 2 was repeated.

Results – The container passed the vacuum retention test with a pressure increase 
rate less than the maximum allowed rate of 0.025 psi per 30 minutes.

TEST CONCLUSIONS – No damage occurred during the above testing to the final 
container design, isolation system or test item. All impact levels are at or below the item 
fragility limit of 110 Gs. Therefore, the container and mounting system do provide 
adequate protection for the fuel probe.

FIT & FUNCTION TESTING

Fit and function testing was completed on site at AFPTEF with the HH-60 fuel probe that 
was supplied for prototype testing.

CONCLUSIONS

No damage occurred during the above testing to the final container design, mounting 
system or test item. There was no evidence of any contact or impact between the fuel
probe and the container walls or lid. All impact levels are below the item fragility limit of 110 G’s. The container met all the user’s requirements. The container can protect the HH-60 Fuel Probe during world-wide transportation and storage and will save the Air Force tens of thousands of dollars in O&M costs.

RECOMMENDATIONS

AFPTEF recommends that new containers be procured and delivered to avoid damage to probes currently in the logistics cycle, thus mitigating overall shipping risks. All wood boxes for the probe should be replaced.
APPENDIX 1: Test Plan
AF PACKAGING TECHNOLOGY AND ENGINEERING FACILITY (Container Test Plan)

CONTAINER SIZE (L x W x D) (IN)
INTERIOR:     175.5 x 21.2 x 15.5
EXTERIOR:     179.5 x 25.0 x 22.4
WEIGHT (LB)   GROSS: 704
               TARE: 548
CUBE (CU. FT) 58.2
QUANTITY:     1
DATE:          Aug 09

ITEM NAME: HH-60 Refueling Probe Assembly
MANUFACTURER: United Technologies Sikorsky Aircraft

CONTAINER NAME: Reusable Shipping & Storage Container
CONTAINER COST: $

PACK DESCRIPTION: Extruded Aluminum Container, Test Load of an HH-60 Refueling Probe

CONDITIONING: Ambient Conditions

TEST NO.    REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S    TEST TITLE AND PARAMETERS    CONTAINER ORIENTATION    EQUIPMENT & INSTRUMENTATION
1.          Product examination. SAE ARP 1967 Par. 4.5.1 Table I, Para. 4.5.8.3.7 Container shall be weighed and carefully examined to determine conformance with material, workmanship, and requirements as specified in Table and drawings. Shipping Visual Inspection (VI), tape measure; Scale
2.          Leak Check SAE ARP 1967 Par. 4.5.2.1 Use pneumatic pressure of 1.5 psi and vacuum retention at -1.0 psi. After temperature stabilization, pressure drop shall not exceed 0.025 psi per 30 minutes. Perform leak test again at end of test series. Shipping Digital Manometer, Clock
3.          Rotational Drops SAE ARP 1967 Par. 4.5.3 ASTM D 4169 ASTM D 6179 Methods A&B Drop height shall be 12”. Item shall not sustain more than 110G’s. Perform one drop on all bottom corners (4 drops) and one drop on all edges (4 drops). Shipping VI and Tri-axial Accelerometer, quick release, blocks, hoist

PASS/FAIL CRITERIA FOR ALL TESTS

There shall be no damage, deformation or degradation of the packaging or components that would permit damage to contents, prevent installation of components, reduce container strength or cause stacking instability, permit water to enter, adversely affect safety during transport or storage, or interfere with container use. All components shall remain in place throughout testing.

PREPARED BY: Michael R. Harff, Mechanical Engineer
APPROVED BY: Robbin L. Miller, Chief AFPTEF
<table>
<thead>
<tr>
<th>ITEM NAME:</th>
<th>HH-60 Refueling Probe Assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>MANUFACTURER:</td>
<td>United Technologies Sikorsky Aircraft</td>
</tr>
<tr>
<td>CONTAINER NAME:</td>
<td>Reusable Shipping &amp; Storage Container</td>
</tr>
<tr>
<td>CONTAINER COST:</td>
<td>$</td>
</tr>
<tr>
<td>PACK DESCRIPTION:</td>
<td>Extruded Aluminum Container, Test Load of an HH-60 Refueling Probe</td>
</tr>
</tbody>
</table>

### CONDITIONING:

**Ambient Conditions**

<table>
<thead>
<tr>
<th>TEST NO.</th>
<th>REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S</th>
<th>TEST TITLE AND PARAMETERS</th>
<th>CONTAINER ORIENTATION</th>
<th>EQUIPMENT &amp; INSTRUMENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Vibration SAE ARP 1967 Para. 4.5.6 (ASTM D 4169 ASTM D 999 Method B); MIL-STD-648D Para. 5.3.1 b and 5.3.3.1</td>
<td>The container shall be vibrated from 5 Hz to 50 Hz at a sweep rate of one half octave per minute with a total sweep time of 7.5 minutes. Container shall then be vibrated for 30 minutes at the predominant resonance. Input excitation shall be 0.125 in double amplitude or 1 G limits.</td>
<td>Rigidly attach container to exciter.</td>
<td>VI and Tri-axial Accelerometer</td>
</tr>
<tr>
<td>5.</td>
<td>Lateral Impact SAE ARP 1967 Para. 4.5.6 (ASTM D 4169 ASTM D 880 Procedure B); MIL-STD-648D, Para. 5.2.7</td>
<td>Use impact velocity 7.3 ft/s. Item shall not sustain more than 110G’s. Perform one impact on each end (2 impacts).</td>
<td>Shipping</td>
<td>VI and Tri-axial Accelerometer, quick release, winch</td>
</tr>
<tr>
<td>6.</td>
<td>Leak Check SAE ARP 1967 Para. 4.5.2.1</td>
<td>Use pneumatic pressure of 1.5 psi and vacuum retention at -1.0 psi. After temperature stabilization, pressure drop shall not exceed 0.025 psi per 30 minutes</td>
<td>Shipping</td>
<td>Digital Manometer, Clock</td>
</tr>
</tbody>
</table>

**Comments:**

PREPARED BY: Michael R. Harff, Mechanical Engineer

APPROVED BY: Robbin L. Miller, Chief AFPTEF
APPENDIX 2: Fabrication & Testing Photographs
Figure 1. Closed Container.

Figure 2. Probe in container base.
Figure 3. HDPE-Lined Clamps Open.

Figure 4. Aft Alignment Pin Secured.
Figure 5. HDPE-Lined Clamps Closed.

Figure 6. Placement of accelerometer on probe.
Figure 7. Weight added to probe.

Figure 8. Pressure Test Set-up (for both pressure and vacuum).
Figure 9. Rotational Edge Drop, End.

Figure 10. Rotational Edge Drop, Side.
Figure 11. Rotational Corner Drop.

Figure 12. Pendulum Impact Test.
Figure 13. Resonance Sweep and Dwell Test.
APPENDIX 3: Test Data
### Table 1. HH-60 Fuel Probe Impact Test Summary (filtered data)

<table>
<thead>
<tr>
<th>IMPACT TYPE</th>
<th>TEST TEMPERATURE</th>
<th>IMPACT LOCATION</th>
<th>RESULTANT PEAK G</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROTATIONAL - EDGE</td>
<td>ambient</td>
<td>forward-bottom</td>
<td>31</td>
</tr>
<tr>
<td>ROTATIONAL - EDGE</td>
<td>ambient</td>
<td>aft-bottom</td>
<td>53</td>
</tr>
<tr>
<td>ROTATIONAL - EDGE</td>
<td>ambient</td>
<td>left-bottom</td>
<td>32</td>
</tr>
<tr>
<td>ROTATIONAL - EDGE</td>
<td>ambient</td>
<td>right-bottom</td>
<td>28</td>
</tr>
<tr>
<td>ROTATIONAL - CORNER</td>
<td>ambient</td>
<td>forward-left</td>
<td>31</td>
</tr>
<tr>
<td>ROTATIONAL - CORNER</td>
<td>ambient</td>
<td>forward-right</td>
<td>30</td>
</tr>
<tr>
<td>ROTATIONAL - CORNER</td>
<td>ambient</td>
<td>aft-left</td>
<td>34</td>
</tr>
<tr>
<td>ROTATIONAL - CORNER</td>
<td>ambient</td>
<td>aft-right</td>
<td>41</td>
</tr>
<tr>
<td>LATERAL IMPACT - FACE</td>
<td>ambient</td>
<td>forward</td>
<td>60</td>
</tr>
<tr>
<td>LATERAL IMPACT - FACE</td>
<td>ambient</td>
<td>aft</td>
<td>50</td>
</tr>
</tbody>
</table>

### TABLE 2. Container Resonant Frequency and Transmissibility Values (from filtered waveforms).

<table>
<thead>
<tr>
<th>TEST TEMPERATURE</th>
<th>DWELL TIME</th>
<th>RESONANT FREQUENCY</th>
<th>TRANSMISSIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient</td>
<td>1 min</td>
<td>46.89 Hz</td>
<td>4</td>
</tr>
<tr>
<td>Ambient</td>
<td>15 min</td>
<td>49.44 Hz</td>
<td>5</td>
</tr>
<tr>
<td>Ambient</td>
<td>30 min</td>
<td>45.53 Hz</td>
<td>4</td>
</tr>
</tbody>
</table>
**Table 3.** HH-60 Fuel Probe Impact Test Summary (unfiltered data)

<table>
<thead>
<tr>
<th>IMPACT TYPE</th>
<th>TEST TEMPERATURE</th>
<th>IMPACT LOCATION</th>
<th>RESULTANT PEAK G</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROTATIONAL - EDGE</td>
<td>ambient</td>
<td>forward-bottom</td>
<td>88</td>
</tr>
<tr>
<td>ROTATIONAL - EDGE</td>
<td>ambient</td>
<td>aft-bottom</td>
<td>101</td>
</tr>
<tr>
<td>ROTATIONAL - EDGE</td>
<td>ambient</td>
<td>left-bottom</td>
<td>70</td>
</tr>
<tr>
<td>ROTATIONAL - EDGE</td>
<td>ambient</td>
<td>right-bottom</td>
<td>53</td>
</tr>
<tr>
<td>ROTATIONAL - CORNER</td>
<td>ambient</td>
<td>forward-left</td>
<td>62</td>
</tr>
<tr>
<td>ROTATIONAL - CORNER</td>
<td>ambient</td>
<td>forward-right</td>
<td>71</td>
</tr>
<tr>
<td>ROTATIONAL - CORNER</td>
<td>ambient</td>
<td>aft-left</td>
<td>93</td>
</tr>
<tr>
<td>ROTATIONAL - CORNER</td>
<td>ambient</td>
<td>aft-right</td>
<td>100</td>
</tr>
<tr>
<td>LATERAL IMPACT - FACE</td>
<td>ambient</td>
<td>forward</td>
<td>73</td>
</tr>
<tr>
<td>LATERAL IMPACT - FACE</td>
<td>ambient</td>
<td>aft</td>
<td>103</td>
</tr>
</tbody>
</table>

**NOTE:** The first set of the following waveforms are filtered data, with the filtering frequency shown at the top of the waveform traces. The second set of waveforms is the unfiltered data provided for comparison. Unfiltered vibration waveforms are not included because the extreme levels of noise make them indecipherable.
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:42  Impact Orient.: Forward bottom edge
Test Engineer: Evans  Drop Height: 12 in.
Container: Al/probe  Accelerometer: 2228C, S/N 16471

V. Angle: 51.34; H.Angle: 163.74; Filter: = 140 Hz

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div</th>
<th>Hexp</th>
<th>Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>919.</td>
<td>mS</td>
<td>0.06 g's</td>
<td>18.18 g's</td>
<td>17.30 In/s</td>
<td>131 mS</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>919.</td>
<td>mS</td>
<td>-0.07 g's</td>
<td>-26.78 g's</td>
<td>-49.19 In/s</td>
<td>131 mS</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>919.</td>
<td>mS</td>
<td>0.02 g's</td>
<td>4.98 g's</td>
<td>10.87 In/s</td>
<td>131 mS</td>
<td>1</td>
</tr>
<tr>
<td>R</td>
<td>919.</td>
<td>mS</td>
<td>0.10 g's</td>
<td>30.54 g's</td>
<td>53.27 In/s</td>
<td>131 mS</td>
<td>1</td>
</tr>
</tbody>
</table>

Remarks

Peak G X: 18  Y: 5  Z: 27  Peak G Resultant: 31
Filtered at 140 Hz.
Ch.1=X(left-rt); *Ch.2=Z(vert); *Ch.3=Y(frwd-aft); Ch. 4=Resultant
*Reversed leads.
Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM

21
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:28  Impact Orient.: Aft bottom edge
Test Engineer: Evans  Drop Height: 12 in.
Container: Al/probe  Accelerometer: 2228C, S/N 16471

V. Angle: 13.16°; N. Angle: 290.56°; Filter: = 187 Hz

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div Hexp Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>431</td>
<td>mS</td>
<td>1.45 g's</td>
<td>16.76 g's</td>
<td>-11.01 In/s</td>
</tr>
<tr>
<td>2</td>
<td>431</td>
<td>mS</td>
<td>0.12 g's</td>
<td>-52.13 g's</td>
<td>-18.57 In/s</td>
</tr>
<tr>
<td>3</td>
<td>431</td>
<td>mS</td>
<td>-0.32 g's</td>
<td>-9.52 g's</td>
<td>-18.52 In/s</td>
</tr>
<tr>
<td>4</td>
<td>431</td>
<td>mS</td>
<td>1.60 g's</td>
<td>53.08 g's</td>
<td>28.45 In/s</td>
</tr>
</tbody>
</table>

Remarks
Peak G X: 17  Y: 10  Z: 52  Peak G Resultant: 53
Filtered at 187 Hz.
Ch.1=X(left-rt); *Ch.2=Z(vert); *Ch.3=Y(frwd-aft); Ch. 4=Resultant
*Reversed leads.
Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:53
Impact Orient.: Left bottom edge
Test Engineer: Evans
Drop Height: 12 in.
Container: Al/probe
Accelerometer: 2228C, S/N 16471

V. Angle: 67.36°/A. Angle: 86.25°; Filter = 115 Hz

Ch. Time Curr Amp Peak Amp 1st Int Time/Div Hexp Vexp
1 993. mS 0.16 g's 24.55 g's 200.11 In/s 131 mS 1 2
2 993. mS 0.02 g's 4.74 g's 14.39 In/s 131 mS 1 2
3 993. mS 0.37 g's 25.45 g's 190.61 In/s 131 mS 1 2
4 993. mS 0.41 g's 31.84 g's 276.74 In/s 131 mS 1 2

Remarks
Peak G X: 25  Y: 5  Z: 25  Peak G Resultant: 32
Filtered at 115 Hz.
Ch.1=X(left-rt); Ch.2=Y(fwd-aft); Ch.3=Z(vert); Ch. 4=Resultant

Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:56 Impact Orient.: Right bottom edge
Test Engineer: Evans Drop Height: 12 in.
Container: Al/probe Accelerometer: 2228C, S/N 16471

V. Angle: 169.61; H.Angle: 69.44; Filter: = 93 Hz

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div Hexp Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>919. mS</td>
<td>-0.71 g's</td>
<td>-15.34 g's</td>
<td>-424.87 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>2</td>
<td>919. mS</td>
<td>0.05 g's</td>
<td>4.29 g's</td>
<td>82.02 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>3</td>
<td>919. mS</td>
<td>0.12 g's</td>
<td>22.88 g's</td>
<td>130.51 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>R</td>
<td>919. mS</td>
<td>0.72 g's</td>
<td>27.53 g's</td>
<td>451.96 In/s</td>
<td>131 mS 1 2</td>
</tr>
</tbody>
</table>

Remarks

Peak G X: 15 Y: 4 Z: 23 Peak G Resultant: 28
Filtered at 93 Hz.
Ch.1=X(left-rt); Ch.2=Y(frwd-aft); Ch.3=Z(vert); Ch. 4=Resultant

Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:49  Impact Orient.: Forward-left corner
Test Engineer: Evans  Drop Height: 12 in.
Container: Al/probe  Accelerometer: 2228C, S/N 16471

V. Angle: 10.72° H. Angle: 30.26°  Filter: 115 Hz

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr. Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div Res/Exp Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.24 S</td>
<td>0.13 g's</td>
<td>23.22 g's</td>
<td>-15.44 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>2</td>
<td>1.24 S</td>
<td>0.04 g's</td>
<td>-3.28 g's</td>
<td>-7.05 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>3</td>
<td>1.24 S</td>
<td>0.02 g's</td>
<td>30.22 g's</td>
<td>-23.42 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>R</td>
<td>1.24 S</td>
<td>0.13 g's</td>
<td>30.79 g's</td>
<td>28.92 In/s</td>
<td>131 mS 1 2</td>
</tr>
</tbody>
</table>

Remarks

Peak G X: 23  Y: 3  Z: 31  Peak G Resultant: 31
Filtered at 115 Hz.
Ch.1=X(left-rt); Ch.2=Y(fwrd-aft); Ch.3=Z(vert); Ch. 4=Resultant

Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:46  Impact Orient.: Forward-right corner
Test Engineer: Evans  Drop Height: 12 in.
Container: Al/probe  Accelerometer: 2228C, S/N 16471

V. Angle: 110.64°; N. Angle: 02.41°; Filter: = 178 Hz

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div Hexp Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>908. mS</td>
<td>-0.15 g's</td>
<td>-20.81 g's</td>
<td>-5.31 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>2</td>
<td>908. mS</td>
<td>0.04 g's</td>
<td>-3.65 g's</td>
<td>0.40 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>3</td>
<td>908. mS</td>
<td>0.27 g's</td>
<td>29.21 g's</td>
<td>-1.31 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>4</td>
<td>908. mS</td>
<td>0.32 g's</td>
<td>30.28 g's</td>
<td>5.48 In/s</td>
<td>131 mS 1 2</td>
</tr>
</tbody>
</table>

Remarks
Peak G X: 21  Y: 4  Z: 30  Peak G Resultant: 30
Filtered at 178 Hz.
Ch.1=X(left-rt); Ch.2=Y(forw-aft); Ch.3=Z(vert); Ch. 4=Resultant

Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:35  Impact Orient.: aft left corner
Test Engineer: Evans  Drop Height: 12 in.
Container: Al/probe  Accelerometer: 2228C, S/N 16471

V. Angle: 38.33/E. Angle: 71.57; Filter: = 130 Hz

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div Hexp Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.29</td>
<td>0.09 g's</td>
<td>17.86 g's</td>
<td>-12.46 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>2</td>
<td>1.29</td>
<td>0.02 g's</td>
<td>-33.94 g's</td>
<td>-15.14 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>3</td>
<td>1.29</td>
<td>0.06 g's</td>
<td>-4.97 g's</td>
<td>0.19 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>4</td>
<td>1.29</td>
<td>0.11 g's</td>
<td>34.43 g's</td>
<td>19.61 In/s</td>
<td>131 mS 1 2</td>
</tr>
</tbody>
</table>

Remarks
Peak G X: 18  Y: 5  Z: 34  Peak G Resultant: 34
Filtered at 130 Hz.
Ch. 1=X(left-rt); *Ch. 2=Z(vert); *Ch. 3=Y(frwd-aft); Ch. 4=Resultant
*Reversed leads.
Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:33  Impact Orient.: Aft right corner
Test Engineer: Evans  Drop Height: 12 in.
Container: Al/probe  Accelerometer: 2228C, S/N 16471

V. Angle: 141.79; H.Angle: 150.35; Filter: 115 Hz

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div Hexp Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>893. ms</td>
<td>-0.29 g's</td>
<td>-16.33 g's</td>
<td>-11.51 in/s</td>
<td>131 ms 1 2</td>
</tr>
<tr>
<td>2</td>
<td>893. ms</td>
<td>-0.20 g's</td>
<td>-37.36 g's</td>
<td>-35.63 in/s</td>
<td>131 ms 1 2</td>
</tr>
<tr>
<td>3</td>
<td>893. ms</td>
<td>0.11 g's</td>
<td>-5.11 g's</td>
<td>27.56 in/s</td>
<td>131 ms 1 2</td>
</tr>
<tr>
<td>4</td>
<td>885. ms</td>
<td>0.37 g's</td>
<td>40.74 g's</td>
<td>46.49 in/s</td>
<td>131 ms 1 2</td>
</tr>
</tbody>
</table>

Remarks

Peak G X: 16  Y: 5  Z: 37  Peak G Resultant: 41
Filtered at 115 Hz.
Ch.1=X(left-rt); *Ch.2=Z(vert); *Ch.3=Y(frwd-aft); Ch. 4=Resultant
*Reversed leads.
Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe
PENDULUM IMPACTS

Time: Oct 1 2009 14:38    Impact Orient.: Forward side
Test Engineer: Evans     Velocity: 7.3 ft/sec
Container: Al/probe     Accelerometer: 2228C, S/N 16471

V. Angle: 111.54; H. Angle: 306.98; Filter: = 150 Hz

Ch.  Time   Curr Amp    Peak Amp     1st Int    Time/Div Hexp Vexp
  1  1.29 s    -0.13 g's    12.88 g's    19.73 In/s    131 mS     .1    2
  2  1.29 s    0.20 g's     -58.57 g's   30.19 In/s    131 mS     1    2
  3  1.29 s    -0.26 g's    -16.03 g's   0.46 In/s    131 mS     1    2
  R  1.29 s    0.35 g's     60.28 g's    36.07 In/s    131 mS     1    2

Remarks
Peak G X: 13   Y: 59   Z: 16   Peak G Resultant: 60
Filtered at 150 Hz.
Ch.1=X(left-rt); Ch.2=Y(forwd-aft); Ch.3=Z(vert); Ch. 4=Resultant

Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM

29
HH60 Fuel Probe
PENDULUM IMPACTS

Time: Oct 1 2009 14:32 Impact Orient.: aft side
Test Engineer: Evans Velocity: 7.3 ft/sec
V. Angle: 76.02° H. Angle: 241.48° Filter: 140 Hz

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div</th>
<th>Hexp</th>
<th>Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 924. mS</td>
<td>0.15 g's</td>
<td>-7.81 g's</td>
<td>-35.48 In/s</td>
<td>131 mS 1 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 924. mS</td>
<td>-0.29 g's</td>
<td>49.20 g's</td>
<td>-26.52 In/s</td>
<td>131 mS 1 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 924. mS</td>
<td>-0.53 g's</td>
<td>-21.69 g's</td>
<td>-32.85 In/s</td>
<td>131 mS 1 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R 924. mS</td>
<td>0.62 g's</td>
<td>49.56 g's</td>
<td>55.15 In/s</td>
<td>131 mS 1 2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks
Peak G X: 8 Y: 22 Z: 49 Peak G Resultant: 50
Item Wt. 153 lb. Filtered at 140 Hz.
Ch.1=X(left-rt); Ch.2=Z(vert); Ch.3=Y(forw-aft); Ch. 4=Resultant
*Reversed leads
Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH-60 Fuel Probe

RESONANCE SWEEP & DWELL

Time: Oct 2 2009 12:29  Test Engineer: Evans
Test Stage: Dwell  Frequency: 46.89 Hz
Test Item: AI/Probe  Time in Test: 1 minute

Filter: Ch.1 = 434 Hz  Ch.2 = 434 Hz  Ch.3 = 434 Hz

Ch.  Time  Curr Amp  Peak Amp  1st Int  Time/Div Hexp Vexp
1  309.  mS  0.13 g's  1.89 g's  0.67 In/s  66 mS  4  2
2  309.  mS  -0.52 g's  -1.26 g's  3.44 In/s  66 mS  4  2
3  417.  mS  -0.94 g's  7.58 g's  -4.09 In/s  66 mS  4  2
4  309.  mS  -0.63 g's  -1.59 g's  1.51 In/s  66 mS  4  2

Remarks

Transmissibility: Z-axis = 4.08
Peak G X: 2 Gs  Y: 1 Gs  Z: 8 Gs  Table Input(Ch.4): 2 Gs
Filtered at 434 Hz.

Ch.1=X(left-right); Ch.2=Y(forward-aft); Ch.3=Z(vertical).
Accelerometer: Model 2228C, S/N 16471
ASTM D4169, ASTM D999, SAE ARP 1967

GHI SYSTEMS, INC. CAT SYSTEM
**HH-60 Fuel Probe**

**RESONANCE SWEEP & DWELL**

**Time:** Oct 2 2009 12:44  **Test Engineer:** Evans  
**Test Stage:** Dwell  **Frequency:** 49.44 Hz  
**Test Item:** Al/Probe  **Time in Test:** 15 minutes

Filter: Ch.1 = 434 Hz  Ch.2 = 434 Hz  Ch.3 = 434 Hz

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div Hexp Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>614. mS</td>
<td>2.40 g's</td>
<td>-5.02 g's</td>
<td>-3.80 In/s</td>
<td>66 mS 4 2</td>
</tr>
<tr>
<td>2</td>
<td>614. mS</td>
<td>-0.69 g's</td>
<td>-1.50 g's</td>
<td>0.53 In/s</td>
<td>66 mS 4 2</td>
</tr>
<tr>
<td>3</td>
<td>638. mS</td>
<td>1.38 g's</td>
<td>-11.14 g's</td>
<td>-5.31 In/s</td>
<td>66 mS 4 2</td>
</tr>
<tr>
<td>4</td>
<td>620. mS</td>
<td>1.33 g's</td>
<td>1.76 g's</td>
<td>2.70 In/s</td>
<td>66 mS 4 2</td>
</tr>
</tbody>
</table>

**Remarks**

Transmissibility: Z-axis = 5  
Peak G X: 5 Gs  Y: 2 Gs  Z: 11 Gs  
Table Input (Ch.4): 2 Gs  
Filtered at 434 Hz.

Ch.1=X(left-right); Ch.2=Y(forward-aft); Ch.3=Z(vertical).  
Accelerometer: Model 2228C, S/N 16471  
ASTM D4169, ASTM D999, SAE ARP 1967

GHI SYSTEMS, INC. CAT SYSTEM
HH-60 Fuel Probe

RESONANCE SWEEP & DWELL

Time: Oct 2 2009 12:59
Test Stage: Dwell
Test Item: Al/Probe

Test Engineer: Evans
Frequency: 45.53 Hz
Time in Test: 30 minutes

Filter: Ch.1 = 230 Hz, Ch.2 = 230 Hz, Ch.3 = 230 Hz

Ch. Time Curr Amp Peak Amp 1st Int Time/Div Hexp Vexp
1 327. ms 0.99 g's -1.94 g's 4.05 In/s 66 ms 4 2
2 638. ms 0.04 g's 0.81 g's 4.16 In/s 66 ms 4 2
3 614. ms -1.35 g's 4.04 g's -6.53 In/s 66 ms 4 2
4 622. ms -1.08 g's -1.26 g's -2.05 In/s 66 ms 4 2

Remarks
Transmissibility: Z-axis = 4
Peak G X: 2 Gs Y: 1 Gs Z: 4 Gs Table Input (Ch.4): 1 Gs
Filtered at 230 Hz.

Ch.1=X(left-right); Ch.2=Y(forward-aft); Ch.3=Z(vertical).
Accelerometer: Model 2228C, S/N 16471
ASTM D4169, ASTM D999, SAE ARP 1967

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:42
Test Engineer: Evans
Container: Al/probe; clamp mod.

Impact Orient.: forward bottom edge
Drop Height: 12 in.
Accelerometer: 2228C, S/N 16471
V. Angle: 52.45; H. Angle: 79.58;

Ch. Time Curr Amp Peak Amp 1st Int Time/Div Hexp Vexp
1 872. mS 0.21 g's 36.73 g's 26.47 In/s 131 mS 1 2
2 872. mS 0.05 g's 88.13 g's -51.20 In/s 131 mS 1 2
3 872. mS 0.27 g's -8.77 g's 9.79 In/s 131 mS 1 2
R 872. mS 0.34 g's 88.30 g's 59.39 In/s 131 mS 1 2

Remarks
Peak G X: 37 Y: 88 Z: 9 Peak G Resultant: 88
Item Wt. 153 lb. UNFILTERED
Ch.1=X(left-rt); Ch.2=Y(vert); Ch.3=Z(frwd-aft); Ch. 4=Resultant

Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:28  Impact Orient.: Aft bottom edge
Test Engineer: Evans  Drop Height: 12 in.

V. Angle: 142.29; H. Angle: 237.99;

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div Hexp Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.11 S</td>
<td>-0.19 g's</td>
<td>37.36 g's</td>
<td>-37.11 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>2</td>
<td>1.11 S</td>
<td>-0.08 g's</td>
<td>-99.49 g's</td>
<td>105.72 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>3</td>
<td>1.11 S</td>
<td>-0.12 g's</td>
<td>-13.40 g's</td>
<td>-58.30 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>R</td>
<td>1.11 S</td>
<td>0.24 g's</td>
<td>100.86 g's</td>
<td>126.30 In/s</td>
<td>131 mS 1 2</td>
</tr>
</tbody>
</table>

Remarks

Item Wt. 153 lb. UNFILTERED
Ch. 1=X(lef-t-rt); Ch. 2=Y(vert); Ch. 3=Z(frwd-aft); Ch. 4=Resultant

Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe
ROTATIONAL DROPS

Time: Oct 1 2009 15:53 Impact Orient.: left bottom edge
Test Engineer: Evans Drop Height: 12 in.

V. Angle: 78.96°; A. Angle: 98.35°

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div Hexp Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.11</td>
<td>0.13 g's</td>
<td>47.84 g's</td>
<td>192.90 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>2</td>
<td>1.11</td>
<td>-0.16 g's</td>
<td>9.81 g's</td>
<td>-11.79 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>3</td>
<td>1.11</td>
<td>0.67 g's</td>
<td>69.56 g's</td>
<td>26.59 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>R</td>
<td>1.11</td>
<td>0.69 g's</td>
<td>69.65 g's</td>
<td>195.08 In/s</td>
<td>131 mS 1 2</td>
</tr>
</tbody>
</table>

Remarks
Peak G X: 48 Y: 70 Z: 10 Peak G Resultant: 70
Item Wt. 153 lb. UNFILTERED
Ch.1=X(Left-right); Ch.2=Y(Vert); Ch.3=X(Forwd-aft); Ch. 4=Resultant
*Reversed leads
Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:56
Test Engineer: Evans
Container: Al/probe; clamp mod.

Impact Orient.: right bottom edge
Drop Height: 12 in.
Accelerometer: 2228C, S/N 16471

V. Angle: 133.15; H. Angle: 90.51

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr. Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div Hexp Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>875.</td>
<td>mS</td>
<td>-0.32 g's</td>
<td>-25.08 g's</td>
<td>-352.97 In/s</td>
</tr>
<tr>
<td>2</td>
<td>875.</td>
<td>mS</td>
<td>-0.00 g's</td>
<td>8.44 g's</td>
<td>46.20 In/s</td>
</tr>
<tr>
<td>3</td>
<td>875.</td>
<td>mS</td>
<td>0.34 g's</td>
<td>52.73 g's</td>
<td>-59.22 In/s</td>
</tr>
<tr>
<td>R</td>
<td>875.</td>
<td>mS</td>
<td>0.47 g's</td>
<td>52.98 g's</td>
<td>360.88 In/s</td>
</tr>
</tbody>
</table>

Remarks

Item Wt: 153 lb. UNFILTERED
Ch.1=X(left-rt); Ch.2=Y(vert); Ch.3=Y(frwd-aft); Ch. 4=Resultant
*Reversed leads
Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:49  Impact Orient.: Forward-left corner
Test Engineer: Evans  Drop Height: 12 in.

V. Angle: 78.78; R. Angle: 289.07;

<table>
<thead>
<tr>
<th>Ch.</th>
<th>Time</th>
<th>Curr Amp</th>
<th>Peak Amp</th>
<th>1st Int</th>
<th>Time/Div Hexp Vexp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.24 S</td>
<td>0.03 g's</td>
<td>46.00 g's</td>
<td>-17.08 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>2</td>
<td>1.24 S</td>
<td>0.09 g's</td>
<td>-6.85 g's</td>
<td>-24.23 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>3</td>
<td>1.24 S</td>
<td>-0.25 g's</td>
<td>61.42 g's</td>
<td>-124.25 In/s</td>
<td>131 mS 1 2</td>
</tr>
<tr>
<td>R</td>
<td>1.24 S</td>
<td>0.27 g's</td>
<td>61.50 g's</td>
<td>127.74 In/s</td>
<td>131 mS 1 2</td>
</tr>
</tbody>
</table>

Remarks

Item Wt. 153 lb.  UNFILTERED.
Ch.1=X(left-rt); *Ch.2=Z(vert); *Ch.3=Y(frwd-aft); Ch. 4=Resultant
*Reversed leads
Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM

38
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:46 Impact Orient.: forward-right corner
Test Engineer: Evans Drop Height: 12 in.

V. Angle: 124.47 H. Angle: 43.36;

Ch. Time Curr Amp Peak Amp 1st Int Time/Div Hexp Vexp
1 1.11 S -0.10 g's -28.67 g's -11.76 In/s 131 mS 1 2
2 1.11 S 0.11 g's 7.19 g's 5.36 In/s 131 mS 1 2
3 1.11 S 0.10 g's 70.95 g's 95.95 In/s 131 mS 1 2
4 R 1.11 S 0.19 g's 71.03 g's 96.81 In/s 131 mS 1 2

Remarks
Peak G X: 29 Y: 71 Z: 7 Peak G Resultant: 71
Item Wt. 153 lb. UNFILTERED
Ch.1=X(left-rt); Ch.2=Y(vert); Ch.3=Z(frwd-aft); Ch. 4=Resultant
*Reversed leads
Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:35  Impact Orient.: aft left corner
Test Engineer: Evans  Drop Height: 12 in.

V. Angle: 53.75; H. Angle: 183.50;

Remarks
Peak G X: 32  Y: 93  Z: 13  Peak G Resultant: 93
Item Wt. 153 lb. UNFILTERED
Ch.1=X(left-rt); Ch.2=Y(vert); Ch.3=Z(frwd-aft); Ch. 4=Resultant
Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

ROTATIONAL DROPS

Time: Oct 1 2009 15:33
Impact Orient.: Aft right corner
Test Engineer: Evans
Drop Height: 12 in.
Container: Al/probe
Accelerometer: 2228C, S/N 16471
V. Angle: 159.31; E. Angle: 76.43;

Remarks
Peak G X: 32 Y: 15 Z: 99 Peak G Resultant: 100

Ch.1=X(left-rt); Ch.2=Z(vert); Ch.3=Y(frwd-aft); Ch. 4=Resultant
*Reversed leads.
Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe

PENDULUM IMPACTS

Time: Oct 1 2009 14:38  Impact Orient.: Forward side
Test Engineer: Evans  Velocity: 7.3 ft/sec
V. Angle: 104.81 H. Angle: 319.99

Ch.  Time  Curr Amp  Peak Amp  1st Int  Time/Div Hexp Vexp
1  519. mS  -0.18 g's  -30.50 g's  -27.60 In/s  131 mS  1  2
2  519. mS  0.51 g's  -68.04 g's  -63.18 In/s  131 mS  1  2
3  519. mS  -0.43 g's  -45.74 g's  -124.17 In/s  131 mS  1  2
R  519. mS  0.69 g's  72.95 g's  142.02 In/s  131 mS  1  2

Remarks
Peak G X: 31  Y: 68  Z: 45  Peak G Resultant: 73
Item Wt. 153 lb. UNFILTERED
Ch.1=X(left-rt); *Ch.2=Y(vert); *Ch.3=Y(frwd-aft); Ch. 4=Resultant
*Reversed leads
Aft side = desiccant port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
HH60 Fuel Probe
PENDULUM IMPACTS

Time: Oct 1 2009 14:32  Impact Orient.: aft side
Test Engineer: Evans  Velocity: 7.3 ft/sec
Container: Al/probe  Accelerometer: 2228C, S/N 16471

V. Angle: 124.08; H. Angle: 245.91;

Ch.  Time  Curr Amp  Peak Amp  1st Int  Time/Div Hexp Vexp
1  998. mS  -0.19 g's  -32.76 g's  -0.66 In/s  131 mS  1  2
2  998. mS  -0.12 g's  61.31 g's  1.13 In/s  131 mS  1  2
3  998. mS  -0.26 g's  -100.60 g's  -127.18 In/s  131 mS  1  2
R  998. mS  0.34 g's  103.42 g's  127.19 In/s  131 mS  1  2

Remarks
UNFILTERED
Ch.1=X(left-rt); Ch.2=Y(frwd-aft); Ch.3=Z(vert); Ch. 4=Resultant

Aft side = desiccanct port end. Ambient temperature/humidity

GHI SYSTEMS, INC. CAT SYSTEM
APPENDIX 4: Test Instrumentation
PRESSURE TEST EQUIPMENT - Test sequences 1, 2, 6 & 7

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>MANUFACTURER</th>
<th>MODEL</th>
<th>SN</th>
<th>CAL. DATE</th>
</tr>
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<tbody>
<tr>
<td>Digital Manometer</td>
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<td>2655</td>
<td>82DJ6001</td>
<td>Sep 09</td>
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<tr>
<td>Digital Manometer</td>
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<td>2655</td>
<td>82DJ6009</td>
<td>Jul 09</td>
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</table>

ROUGH HANDLING TEST EQUIPMENT - Test sequences 3, 4, & 5

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>MANUFACTURER</th>
<th>MODEL</th>
<th>SN</th>
<th>CAL. DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shock Amplifier</td>
<td>Endevco</td>
<td>2775A</td>
<td>ER34</td>
<td>NA</td>
</tr>
<tr>
<td>Shock Amplifier</td>
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<td>ER33</td>
<td>NA</td>
</tr>
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<td>Shock Amplifier</td>
<td>Endevco</td>
<td>2775A</td>
<td>EL81</td>
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<td>Item Accelerometer</td>
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<td>2228C</td>
<td>16471</td>
<td>Jun 08</td>
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<td>Data Acquisition</td>
<td>GHI Systems</td>
<td>CAT</td>
<td>Ver. 2.7.1</td>
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</table>
APPENDIX 5: Distribution List
DISTRIBUTION LIST

DTIC/O
DEFENSE TECHNICAL INFORMATION CENTER
FORT BELVOIR VA 22060-6218

411 SCMS/GULD
ATTN STANLEY COLLINS
235 BYRON STREET STE 19A
ROBINS AFB, GA 31098

403 SCMS/CL
5215 THURLOW ST, STE 5
BLDG 70C
WRIGHT-PATTERSON AFB OH 45433-5547

418 SCMS/GULAAA
ATTN THELMA LOOCK
7973 UTILITY DR
BLDG 1135
HILL AFB UT 84056

420 SCMS/GUMAA
ATTN CAROL BAXTER
7701 ARNOLD ST
BLDG 1, RM 112
TINKER AFB OK 73145

406 SCMS/GUMA
ATTN WAYNE OSBORN
375 PERRY ST
BLDG 255
ROBINS AFB GA 31098
APPENDIX 6: Report Documentation
The Air Force Packaging Technology Engineering Facility (AFPTEF) was tasked with the design of a new shipping and storage container for the HH-60 Fuel Probe in April of 2009. The current wood container is difficult to handle, falls apart easily, provides minimal physical protection of the item, and offers no environmental protection against corrosion. To solve these issues AFPTEF used proven design techniques IAW SAE ARP1967A to develop an aluminum, long-life, controlled breathing, reusable shipping and storage container which will protect the fuel probe both mechanically and environmentally. The container passed all qualification tests per SAE ARP1967A, ASTM D4169, and MIL-STD-648.

This container not only meets user requirements but will also provide a significant economic savings, per refueling probe, for the Air Force over the twenty-year life span of the container.