REPORT NUMBER: 201-CAL-07-05

SAFETY COMPLIANCE TESTING FOR FMVSS 201
OCCUPANT PROTECTION IN INTERIOR IMPACT

GENERAL MOTORS DE MEXICO
2007 CHEVROLET HHR 4-DOOR

NHTSA NUMBER: C70107
CALSPAN TEST NUMBER: 8832-F201-05

CALSPAN
TRANSPORTATION SCIENCES CENTER
P.O. BOX 400
BUFFALO, NEW YORK  14225

Test Date: April 2, 2008

FINAL REPORT

PREPARED FOR:

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Enforcement
Office of Vehicle Safety Compliance
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Transportation Science Center

Approval Date:

APPROVED
By James Czarnecki at 2:05 pm, 6/10/08

FINAL REPORT ACCEPTANCE BY:

NHTSA, Office of Vehicle Safety Compliance

Date of Report Acceptance

6/11/08

8832-F201-05
Compliance tests were conducted on the subject vehicle, a 2007 Chevrolet HHR 4-door, in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure TP-201-02 for determination of FMVSS 201 compliance.

Test failures identified were as follows: The interior compartment door assembly (i.e., storage bin), located in the center of the instrument panel of the vehicle tested, did not remain closed, as required by S5.3 of FMVSS 201, when the instrument panel was tested in accordance with S5.1.
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SECTION 1

PURPOSE AND TEST PROCEDURE

This head impact compliance test is part of the FMVSS 201 Occupant Protection in Interior Impact Test Program sponsored by the National Highway Traffic Safety Administration (NHTSA) under Contract No. DTNH22-06-C-00031. The purpose of this impact compliance test was to determine whether the subject vehicle, a 2007 Chevrolet HHR 4-door, NHTSA No.C70107, meets the performance requirements of FMVSS 201, Occupant Protection in Interior Impact. The compliance test was conducted using the requirements found in the OVSC Laboratory Test Procedure No. TP-201-02 dated March 3, 1989.
SECTION 2

SUMMARY OF OCCUPANT PROTECTION IN INTERIOR IMPACTS

A 2007 Chevrolet HHR 4-door, NHTSA No. C70107, was impacted at various locations throughout its instrument cluster/dash panel and seat back area by a 6.8 kg (15 lb.), 165 mm (6.5 inch) diameter steel headform. A total of four (4) impacts were performed in this test series. The target area impacts were chosen by the NHTSA Contracting Officer’s Technical Representative (COTR). The four (4) chosen impact points were:

- Seat Back / Head Restraint Area
- Instrument Panel Cluster Area
- Airbag Cover / Dash Panel Area (2 impacts)

The selected impact areas on the test vehicle appeared to comply with the performance requirements of FMVSS 201.

The 165 mm (6.5 inch) diameter steel headform weighed 6.8 kg (15 lb.) and had an accelerometer mounted along the centerline of the head.

One (1) channel of data for each target impact test was recorded on a Keyser-Threde data acquisition system. Data plots can be found in Appendix C. Still photographs can be found in Appendix A.

To document each target area impact test, one 35mm camera picture was taken pre- and post-test at various locations to view the headform contact with the selected target areas. Real-time camera footage was taken during impacting the target locations with the head impact test device.
### TEST VEHICLE RECEIVING INSPECTION DATA SHEET

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>VEHICLE YEAR/MAKE/MODEL/STYLE:</td>
<td>2007 Chevrolet HHR 4-door</td>
</tr>
<tr>
<td>NHTSA NO.:</td>
<td>C70107</td>
</tr>
<tr>
<td>VIN:</td>
<td>3GNDA13D97S617345</td>
</tr>
<tr>
<td>DATE OF MANUFACTURE:</td>
<td>03/07 (SEE CERTIFICATION LABEL)</td>
</tr>
<tr>
<td>COLOR:</td>
<td>RED</td>
</tr>
<tr>
<td>ODOMETER READING:</td>
<td>45 km</td>
</tr>
<tr>
<td>LABORATORY:</td>
<td>Calspan</td>
</tr>
<tr>
<td>TEST DATE:</td>
<td>April 3, 2008</td>
</tr>
</tbody>
</table>

**NUMBER OF SEATING POSITIONS:**  
FRONT: 2  REAR: 3  

**INSTRUMENT PANEL:**  
NOTE UNUSUAL FEATURES: None  

**TYPE OF FRONT SEATS:**  
BENCH: -  BUCKET: X  SPLIT BACKS: -  

**TYPE OF HEAD RESTRAINTS:**  
FIXED: -  ADJUSTABLE: X  

**VEHICLE EQUIPPED WITH ARMRESTS?**  
NO: -  YES: X  NUMBER: 4  
LOCATION: Driver and Passenger side front and rear door panels  

**VEHICLE EQUIPPED WITH SUN VISORS?**  
NO: -  YES: X  

**VEHICLE EQUIPPED WITH INTERIOR DOOR LATCHES?**  
NO: -  YES: X  NUMBER: 2  
LOCATION: Glove Box and Instrument Panel Storage Bin
HEAD FORM IMPACT TEST RESULTS
INSTRUMENT PANEL

VEHICLE YEAR/MAKE/MODEL/STYLE: 2007 Chevrolet HHR 4-door
NHTSA NO.: C70107
VIN: 3GNDA13D97S617345
DATE OF MANUFACTURE: 03/07 (SEE CERTIFICATION LABEL)
COLOR: RED
ODOMETER READING: 45 km
LABORATORY: Calspan
TEST DATE: April 2, 2008

<table>
<thead>
<tr>
<th>IMPACT LOCATION AND NUMBER</th>
<th>X (mm)</th>
<th>Y (mm)</th>
<th>ANGLE (degrees)</th>
<th>VELOCITY (kph)</th>
<th>PEAK ACCELERATION (3 ms Clip) Gs</th>
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<tbody>
<tr>
<td>Trim Above Radio Cluster</td>
<td>645</td>
<td>15</td>
<td>57</td>
<td>18.54</td>
<td>50.71</td>
</tr>
<tr>
<td>Left Side of Airbag Cover</td>
<td>678</td>
<td>216</td>
<td>65</td>
<td>18.45</td>
<td>57.24</td>
</tr>
<tr>
<td>Right Dash Below Airbag Cover</td>
<td>656</td>
<td>468</td>
<td>58</td>
<td>18.37</td>
<td>61.41</td>
</tr>
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</table>

REFERENCE POINT:
Seating Reference Position (SGRP) on front passenger side is the reference point (x positive forward from SGRP and y positive to the right of the centerline of the vehicle).

REMARKS:
The interior compartment door assembly (i.e. storage bin), located in the center of the instrument panel of the vehicle tested, did not remain closed, as required by S5.3 of FMVSS 201, when the instrument panel was tested in accordance with S5.1.
HEAD FORM IMPACT TEST RESULTS
SEAT BACKS

VEHICLE YEAR/MAKE/MODEL/STYLE: 2007 Chevrolet HHR 4-door
NHTSA NO.: C70107
VIN: 3GNDA13D97S617345
DATE OF MANUFACTURE: 03/07 (SEE CERTIFICATION LABEL)
COLOR: RED
ODOMETER READING: 45 km
LABORATORY: Calspan
TEST DATE: April 2, 2008

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<tr>
<th>IMPACT LOCATION AND NUMBER</th>
<th>X (mm)</th>
<th>Y (mm)</th>
<th>ANGLE (degrees)</th>
<th>VELOCITY (kph)</th>
<th>PEAK ACCELERATION (3 ms Clip) Gs</th>
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</thead>
<tbody>
<tr>
<td>Passenger Side Front Seat Head Restraint</td>
<td>447</td>
<td>0</td>
<td>16</td>
<td>23.71</td>
<td>23.78</td>
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REFERENCE POINT:

SGRP on rear passenger side is the reference point (x positive forward from SGRP and y positive to the right of the SGRP).
### SUNVISOR AND ARMREST EVALUATION

<table>
<thead>
<tr>
<th>VEHICLE YEAR/MAKE/MODEL/STYLE:</th>
<th>2007 Chevrolet HHR 4-door</th>
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<tbody>
<tr>
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<td>ODOMETER READING:</td>
<td>45 km</td>
</tr>
<tr>
<td>LABORATORY:</td>
<td>Calspan</td>
</tr>
<tr>
<td>TEST DATE:</td>
<td>April 2, 2008</td>
</tr>
</tbody>
</table>

#### SUN VISOR INFORMATION:

1. Are sun visors constructed of or covered with energy absorbing material?
   
   **YES (PASS): X**  **NO (FAIL): -**

2. Are any edges statically contactable by a spherical 6.5 inch (165 mm) diameter head form of radius less than 0.125 inch (3.175 mm)?
   
   **YES (FAIL): -**  **NO (PASS): X**

#### ARMREST INFORMATION:

**A. FIXED ARMREST**

1. Is it constructed of energy absorbing material with the capability of laterally deflecting 2 inches (50.8 mm) without contacting any underlying rigid material?
   
   **YES: N/A**  **NO: N/A**

2. Is it constructed of energy absorbing material that deflects or collapses within 1.25 inches (3.175 mm) of the rigid test panel surface without contacting underlying rigid material between 0.50 inches (12.7 mm) and 1.25 inches (3.175 mm) from the panel which has a vertical height of less than 1 inch (25.4 mm)?
   
   **YES: N/A**  **NO: N/A**

3. Does it provide adequate pelvic area impact protection?
   
   **YES: X**  **NO: -**

4. Does it meet at least one of the criteria No. 1 to 3?
   
   **YES (PASS): X**  **NO (FAIL): -**

**B. FOLDING ARMREST**

Is it made of or covered with energy absorbing material? Or does it meet at least one of the criteria No. 1 to 3?

**YES (PASS): X**  **NO (FAIL): -**
# DOOR LATCH EVALUATION

<table>
<thead>
<tr>
<th>VEHICLE YEAR/MAKE/MODEL/STYLE:</th>
<th>2007 Chevrolet HHR 4-door</th>
</tr>
</thead>
<tbody>
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<td>NHTSA NO.:</td>
<td>C70107</td>
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<td>VIN:</td>
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<td>COLOR:</td>
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<td>ODOMETER READING:</td>
<td>45 km</td>
</tr>
<tr>
<td>LABORATORY:</td>
<td>Calspan</td>
</tr>
<tr>
<td>TEST DATE:</td>
<td>April 2, 2008</td>
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</table>

## LATCH ENGAGEMENT INTERFERENCE

<table>
<thead>
<tr>
<th>DESCRIPTION OF LATCH LOCATION</th>
<th>NO LOAD</th>
<th>10G HORIZONTAL TRANSVERSE</th>
<th>10G VERTICAL</th>
<th>30G HORIZONTAL LONGITUDINAL</th>
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</thead>
<tbody>
<tr>
<td>Glove Box</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Storage Compartment</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
</tbody>
</table>

(Appendix B contains calculation sheets which are based on manufacturer’s data)
**SUMMARY OF RESULTS**

<table>
<thead>
<tr>
<th></th>
<th>NUMBER OF IMPACTS</th>
<th>PASS/FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSTRUMENT PANEL</td>
<td>3</td>
<td>PASS / FAILURE *</td>
</tr>
<tr>
<td>SEAT BACK</td>
<td>1</td>
<td>PASS</td>
</tr>
<tr>
<td>SUN VISORS</td>
<td>N/A</td>
<td>PASS</td>
</tr>
<tr>
<td>ARMRESTS</td>
<td>N/A</td>
<td>PASS</td>
</tr>
<tr>
<td>INTERIOR COMPARTMENT DOORS</td>
<td>N/A</td>
<td>PASS</td>
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</table>

**REMARKS:**

The interior compartment door assembly (i.e. storage bin), located in the center of the instrument panel of the vehicle tested, did not remain closed, as required by S5.3 of FMVSS 201, when the instrument panel was tested in accordance with S5.1.

The instrument panel cover surrounding the air ducts, A/C and heating controls and radio separated along the upper perimeter exposing the edges of the cabin environment.
APPENDIX A

PHOTOGRAPHS
# PHOTOGRAPHS

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<td>A-2</td>
<td>RIGHT SIDE VIEW OF VEHICLE</td>
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<td>3/4 FRONTAL VIEW FROM LEFT SIDE OF VEHICLE</td>
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<td>3/4 REAR VIEW FROM RIGHT SIDE OF VEHICLE</td>
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<td>VEHICLE'S CERTIFICATION LABEL</td>
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<td>A-6</td>
<td>VEHICLE'S TIRE INFORMATION LABEL</td>
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</tr>
<tr>
<td>A-8</td>
<td>LINEAR IMPACTOR</td>
</tr>
<tr>
<td>A-9</td>
<td>SUN VISOR</td>
</tr>
<tr>
<td>A-10</td>
<td>SUN VISOR CONSTRUCTION</td>
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<td>A-11</td>
<td>ARMREST LEFT FRONT DOOR</td>
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<td>A-12</td>
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<td>Delineated Instrument Panel Impact Zone Pre-Test</td>
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<td>Instrument Panel Right Side Below Airbag Cover Impact Pre-Test</td>
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<td>Instrument Panel Right Side Below Airbag Cover Impact Post-Test</td>
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<td>A-19</td>
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<td>Head Restraint Impact Area Post-Test</td>
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<td>A-24</td>
<td>Interior Compartment Door Assembly (I.E. STORAGE BIN) Left Side View</td>
</tr>
<tr>
<td>A-25</td>
<td>Instrument Panel Cover Separation</td>
</tr>
</tbody>
</table>
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Figure A-6: VEHICLE'S TIRE INFORMATION LABEL
Figure A-7: HEAD IMPACT LOCATION FIXTURE

Figure A-8: LINEAR IMPACTOR
Figure A-9: SUN VISOR

Figure A-10: SUN VISOR CONSTRUCTION
Figure A-11: ARMREST LEFT FRONT DOOR

Figure A-12: ARMREST LEFT REAR DOOR
Figure A-17: INSTRUMENT PANEL RIGHT SIDE BELOW AIRBAG COVER IMPACT PRE-TEST

Figure A-18: INSTRUMENT PANEL RIGHT SIDE BELOW AIRBAG COVER IMPACT POST-TEST
APPENDIX B

INTERIOR COMPARTMENT DOOR CALCULATIONS
2007 Chevrolet HHR

FMVSS 201 S3.1

Instrument Panel Glove Box compartment

Latch Component Analysis

Manufacturer's latch component analysis
Latch component inertial analysis information for each interior compartment door assembly located in an instrument panel, console assembly, seat back, or side panel adjacent to a designated seating position in accordance with the procedure described in section 5 of SAE Recommended Practice J839b, "Passenger Car Side Door Latch Systems."

Such data shall include:

1. Geometric details of the latch/lock configuration.

2. Mass data for each element in the linkage.

3. Spring rates for each spring element in the configuration.

4. Any additional details unique to the design yet necessary to the calculations.
FMVSS 201 COMPLIANCE REPORT
OF GM CORPORATE “STAND ALONE
COMPONENT” LATCH ASSEMBLY GMT 001
PART # 25767142

OBJECTIVE:
To verify that the GM Corporate Glove Box Compartment Latch Assembly meets the
FMVSS 201 inertia load requirements.

RESULTS:

30 G's in Rearward Longitudinal direction:
The latch assembly mechanism complies with FMVSS 201 requirements. Analysis
indicates that a minimum total upward force of 4.81 N is acting to force the mechanism in
closed position.

30 G's in Forward Longitudinal direction:
The latch assembly mechanism complies with FMVSS 201 requirements. Analysis
indicates that a minimum total upward force of 5.71 N is acting to force the mechanism in
closed position.

10 G's in Downward Vertical direction:
The latch assembly mechanism complies with FMVSS 201 requirements. Analysis
indicates that a minimum total upward force of 4.72 N is acting to force the mechanism in
closed position.

10 G's in Upward Vertical direction:
The latch assembly mechanism complies with FMVSS 201 requirements. Analysis
indicates that the inertia and spring forces both are acting to force the mechanism in
closed position.

10 G's in Transverse Horizontal direction:
Since the latch hinge axis lies in the transverse direction, transverse deceleration loading
does not cause any additional opening moments on the latch mechanism assembly. The
lateral acceleration forces are along the rotational axis of the handle. These loads have
been set to zero in this analysis.

Conclusion:
Thus the Latch Complies with requirements S5.3.1 of FMVSS 201
REQUIRED DATA:

Mass of the Handle = 0.0168 Kg.
Mass of the Retainer = 0.0036 Kg.
Mass of the Retainer Spring = 0.00046 Kg.
Striker diameter = 4.09mm

Compression Spring:

Free Spring Length = 34.9 mm
Installed Spring Length = 32.5 mm
Compressed (Released) Spring Length = 20.9 mm
Compression Spring Rate = 0.760 N/mm

Computation of Compression Spring Force:

Spring Force, \( F_{\text{installation}} = (\text{initial length} - \text{installed length}) \times \text{spring constant} \)
\[ = (34.9 - 32.5)\text{mm} \times (0.760 \text{ N/mm}) \]
\[ = 1.824 \text{ N} \]
= Pre load on pawl.

Spring Force, \( F_{\text{release}} = (\text{installed length} - \text{released length}) \times \text{spring constant} \)
\[ = (32.5 - 20.9) \text{mm} \times (0.760 \text{ N/mm}) \]
\[ = 8.816 \text{ N} \]
= Force to release.

Spring Force, \( F_s = \frac{F_{\text{installation}} + F_{\text{release}}}{2} = \frac{10.64 \text{ N} + 8.816 \text{ N}}{2} = 9.728 \text{ N} \)
SOLUTION METHOD:

The 30G and 10G acceleration forces were converted to static forces by applying respective accelerations to the center of gravity of the handle and retainer-spring assembly. These forces are translated into moments about the handle hinge point and the net effective forces on the retainer-spring assembly are determined. The compressional retainer spring will be able to satisfy FMVSS 201 requirements i.e., to keep the latch closed in crash conditions.

COMPUTATION OF CENTER OF GRAVITY OF THE HANDLE:

Determination of the mass and center of gravity of the handle:
Density = 1.38 gm / c.c
Mass = Vol * Density = 9.0168 Kg.

The center of gravity location was determined from the UG model as:
Vertical offset, V = 8.0 mm
Horizontal offset, H = 2.8 mm
Distance of the center of gravity to hinge point, D = 8.4 mm
Distance: cg (Retainer + Spring)/Handle hinge point, H = 31.5 mm
in the installed Vehicle coordinate system.
Cg-Center of Gravity
CALCULATION OF THE EFFECT ON RETAINER DUE TO HANDLE INERTIA:

Let, \( F_H \) be the component of the inertia force normal to the handle surface.
So, effective moment about the handle hinge point:

\[
M_H = F_H \times d_{hec} / \cos(90 - 70.9')
\]

where \( d_{hec} \) is the distance of handle c.g. from the handle hinge point = 8.0 mm

70.9' is the angle of handle acting force direction and the line between handle hinge point and c.g.

Let \( F_R \) be the effective force on the retainer due to \( M_H \).
\( F_c \) be the force exerted to keep the latch closed.

So, \( F_R = F_c - M_H / d_h - F_{HC} \times (d_{hec} / d_h) \)

where \( d_h \) = horizontal distance of the approximate center of gravity of the retainer-spring assembly from the handle hinge point = 51.5 mm.
CASE 1 (VERTICAL LOAD 10G):

When the latch assembly is subjected to a 10G inertia load in the vertical directions, the downward/upward force balances are:

1. DOWNWARD

\[ F_d (\text{retainer + spring}) = - \left( \frac{M (\text{retainer + spring})}{10G \times \cos31.4 + 1G \times \cos31.4} \times \left[ 0.0036 + 0.00040 \right] \times 9.81 \times 10 \times 0.85 + 1 \times 9.81 \times 0.85 \right) \\
\]
\[ = -0.37 \text{ N} \]

Moment of Inertia of Handle \[ = -\left[ M(\text{handle}) \times 10G \times \cos(90-31.4) + M(\text{handle}) \times 1 \right] \times \cos(90-70.9) \]
\[ = -\left[ 0.0168 \times 10 \times 9.81 \times 8.0 \times \sin31.4 + 0.0168 \times 1 \times 9.81 \times 0.52 \times 8.0 \right] / 0.94 - \\
\[ = -7.1 \text{ Nmm} \]

\[ F_h (\text{handle inertia}) \}
\[ = \text{Moment of Inertia of Handle} / \text{dhl} \]
\[ = 7.1 / 31.5 \]
\[ = -0.23 \text{ N} \]

Net effective force = 5.32 - 0.23 - 0.37
\[ = 4.72 \text{ (upwards)} \]

So the Net Effective Force of 4.72 N acting upwards keeps the latch closed.

2. UPWARD

When the latch assembly is subjected to 10G inertia load in the vertical upward direction, the inertia and spring forces both try to keep the latch closed.

CASE 2 (TRANSVERSE LOAD 10G):

When the latch assembly is subjected to 10G inertia load in the horizontal/transverse direction, the force is normal to the direction of retainer actuation and does not open or close the latch.
CASE 3 (LONGITUDINAL LOAD 30G):

When the latch is subjected to 30G inertia load in the longitudinal direction, the force balances representing frontal and rear crashes are:

1. FORWARD

\[ F_f \ (\text{retainer + spring}) = \cdot M(\text{retainer + spring}) \times [30G \times \cos(90-31.4) - 1G \times \cos31.4] = (0.0036 - 0.0004) \times [30 \times 9.81 \times \sin31.4 + 9.81 \times \cos31.4] = -0.65 \text{ N} \]

\[
\text{Moment of Inertia of Handle} = M(\text{handle}) \times [30G \times \text{dheg x sin}(90-31.4) - 1G \times 8.4 \times \\
\text{cos58.6}/\text{cos}(90-70.9) - \\
0.0168 \times [30 \times 9.81 \times 8.4 \times \cos31.4 - 9.81 \times 4.38]/\sin70.9] = \\
32.82 \text{ Nmm} \]

\[ F_h \ (\text{handle inertia}) = \frac{\text{Moment of Inertia of Handle}}{dhl} = \\
32.82 / 31.5 = 1.04 \text{ N} \]

Net effective force = 5.32 + 1.04 - 0.65 = 5.71 N

Net Effective Force of 5.71 N acting upwards keeps the latch assembly closed.

2. REARWARD

\[ F_r \ (\text{retainer + spring}) = \cdot M(\text{retainer + spring}) \times [30G \times \cos(90-31.4) - 1G \times \cos31.4] = \\
(0.0036 + 0.0004) \times [30 \times 9.81 \times \sin31.4 - 9.81 \times \cos31.4] = \\
0.58 \text{ N} \]

\[
\text{Moment of Inertia of Handle} = -(M(\text{handle}) \times [30G \times \text{dheg x cos}(90-31.4) + 1G \times 8.4 \times \\
\text{cos58.6})/\text{cos}(90-70.9) = \\
-(0.0168 \times [30 \times 9.81 \times 8.4 \times \cos31.4 + 9.81 \times 4.38]/\sin70.9 = \\
-34.18 \text{ Nmm} \]

\[ F_h \ (\text{handle inertia}) = \frac{\text{Moment of Inertia of Handle}}{dhl} = \\
34.18 / 31.5 = 1.09 \text{ N} \]

Net effective force = 5.32 - 1.09 + 0.58 = 4.81 N

Net Effective Force of 4.81 N acting upwards keeps the latch assembly closed.
2007 Chevrolet HHR

FMVSS 201 S3.1

Instrument Panel Storage Bin

Latch Component Analysis
OBJECTIVE

To verify the GMT001 door bin assembly complies with FMVSS No. 201 set forth in paragraphs S3.3, S3.31 sections (a) & (c). Calculation procedures are followed as described in section 5 of SAE Recommended Practice J839b.

LATCH CHARACTERISTICS

Latch is design to pivot about an integrated arbor pin and a torsion spring is pre-loaded to maintain position. Said latch is not affected by traverse loads.

RESULTS

30 G’s Forward and Rearward Longitudinal Direction
The latch / bin assembly mechanism complies with FMVSS 201 requirements. Analysis indicates force of 9.47N in upward and 4.49N downward.

Shear forces at the screws, latch paw pivot, and striker prove the latching system can withstand and the forces with a large safety factor.

10 G’s Transverse Horizontal Direction
The latch / bin assembly mechanism complies with FMVSS 201 requirements. The latch is not affected

10G’s Upward Vertical Direction (Worst Case Condition)
The latch assembly mechanism complies with FMVSS 201 requirements. In worst case condition analysis indicates a 26N force

Shear forces at the screws, latch paw pivot, and striker prove the latching system can withstand the forces with a large safety factor.

10G’s Downward Vertical Direction
The latch assembly mechanism complies with FMVSS 201 requirements. Given worst case condition above analysis is redundant. Also, the two bumpers compressed at 3mm will have an upward opposing force of 35.84N

RESULTS FOR THE LATCH PAW INERTIA ANALYSIS

30 G’s Forward and Rearward Longitudinal Direction
The Latch Paw mechanism complies with FMVSS 201 requirements. Analysis indicates a force 5.72N at 30G forward and 4.57N at 30G rearward force will keep the paw engaged to the striker. In both cases 5.72N and 4.57N is forcing the paw against the striker
10G Vertical Upward & 10G Vertical Downward

The latch assembly mechanism complies with FMVSS 201 requirements. Worst case condition analysis indicates a 26N force as indicated above when the latch paw was evaluated as part of latch system. Lateral forces have no affect on the paw.

CONCLUSION:
The latch assembly mechanism complies with all FMVSS 201 requirements by calculation and/or component specifications.
Inertia Calculation – 30G Forward & Rearward Longitudinal Acceleration

GMT001 IP BIN

m | Mass Total | .384Kg
---|-------------|-----------
Lid Inner& Outer = | .364Kg
House for Button & Latch = | .012Kg
Button = | .002Kg
Latch = | .004Kg
Screws = | .002Kg

Fmg | Force of Gravity (m)(g) = (.384Kg)(9.81) | 3.77N
Fd | Force of Deceleration (m)(g)(D) = (.384) (9.81) (30) | 113N
Dd | Radial Arm of Deceleration in Meters = | .00815M
Dr | Radial Arm of Latch pivot arbor in Meters = | .193M
Dmg | Radial Arm of Fmg = | .113M
Sfm | Spring Force Moment at hinge Mpt = | .480NM
Sfv | Spring Vector Force at Dr (.48 / .193) | 2.49N
Bf | Bumper Force at Dr (3mm compression x2) | 35.84N
Fr | Force at latch pivot point | (Fr) (Dr) - ((Fmg) (Dmg) + (Fd) (Dd)) + Sfm = 0

Vector Force Conversion Analysis Forward 30G

Fr = ((Fmg) (Dmg) + (Fd) (Dd))/Dr - Sfv
Fr = (3.77) (.113) + (113) (.00815))/.193 - 2.49
Fr = (.426 + .921)/.193 + 2.49
Fr = 9.47N Upward

Vector Force Conversion Analysis Rearward 30G

Fr = (.426 + .921)/.193 - 2.49
Fr = 4.49N Downward
Vertical 10G Upward Force (Worst case condition)

\[ \text{Force in Vertical Moment} = (m)(g)(10g)(Dmg) = (.384) (9.81) (10)(.133) = 5.01 \text{ N/M} \]

\[ \text{Force at paw arbor} = 5.01 / .193 = 26 \text{N} \]

Since the weakest point of the latch will be the latch paw pivot arbor, and the two screws holding the latch assembly, both must withstand a 26N force and not fracture or shear.

**Screw pull out strength**

Attached here with please find the screw calculations showing one fastened screw for the latch assembly will withstand 939N. Said latch assembly is attached by two screws.

**Striker Pin**

The striker pin is a 3mm case hardened 1020 steel which will withstand a minimum 2000N force in shear

**Latch paw pivot arbor shear strength**

The shear modulus for Acetal material at 120 degrees F is 47 Mpa

\[ \text{F1 = Area x 2 (47Mpa)} \]
\[ \text{F1 = 25,13 x 47Mpa} \]
\[ \text{F1 = 1,1812 N} \]

**Vertical 10G Downward Force**

In this case no shear forces are exhibited on the stricter, paw pivot, or attachment screws.

The two bumpers with 3mm compression with provide an opposing upward force of 35.84N
Inertia Calculation of the effect of the isolated Latch Paw about its pivot arbor

\[ \text{Mass of paw} = 0.004 \text{Kg} \]
\[ T_i = \text{Torsion spring installed preload} = 0.051 \text{ Nm} \]
\[ T_r = \text{Torsion spring release load} = 0.081 \text{ Nn} \]
\[ V_o = \text{CG vertical offset to pivot} = 0.0065 \]
\[ V_h = \text{CG horizontal offset to pivot} = 0.0027 \]
\[ D_r = \text{Paw arbor pivot to striker} = 0.0099 \text{M} \]
\[ D_d = \text{CG of paw to paw pivot} = 0.00532 \]

Vector Force Conversion Analysis Forward 30G

\[ M_o = \text{Moment about paw pivot + Spring force} = 0 \]
\[ M_o = (0.004)(30)(9.8)(0.00532) + 0.051 \]
\[ M_o = 0.0057 \text{Nm} + 0.051 \text{Nm} \]
\[ F_1 = (0.0057 \text{Nm} + 0.051 \text{Nm}) / 0.0099 \text{M} \]
\[ F_1 = 5.72 \text{ N keeping the paw latched to the striker} \]

Vector Force Conversion Analysis Rearward 30G

\[ F_1 = ( -0.0057 \text{Nm} + 0.051 \text{Nm}) / 0.0099 \text{M} \]
\[ F_1 = 4.57 \text{N keeping the paw latched to the striker} \]

Conclusion:
The paw will stay affixed to the striker in at 30G forward of rearward. Also, worst case condition on a 10G vertical load upward was evaluated as a lid assembly. A 10G lateral load has no effect.
DETAIL A

SCALE 1

SH1 [DWG] WORK.
APPENDIX C

DATA PLOTS
Impactor Headform Ax

Max: 36.7 [g] at 0.042 [s]
Min: -57.1 [g] at 0.071 [s]
Impactor Headform Ax Velocity

Max: 18.5 [kph] at 0.060 [s]
Min: -6.0 [kph] at 0.086 [s]
FMVSS 201 Linear Impact - 2007 Chevrolet HHR - IP2 -65 Degrees

Impactor Headform Ax

Max: 36.5 [g] at 0.043 [s]
Min: -63.2 [g] at 0.072 [s]
FMVSS 201 Linear Impact - 2007 Chevrolet HHR - IP2 -65 Degrees

Impactor Headform Ax Velocity

Max: 18.4 [kph] at 0.061 [s]
Min: -5.5 [kph] at 0.085 [s]
Impactor Headform Ax Velocity

Max: 18.4 [kph] at 0.061 [s]
Min: -5.9 [kph] at 0.096 [s]
Impactor Headform Ax

Max:  47.3 [g] at 0.043 [s]
Min: -24.5 [g] at 0.098 [s]
Impactor Headform Ax Velocity

Max: 23.7 [kph] at 0.051 [s]
Min: -8.8 [kph] at 0.138 [s]