REPORT NUMBER: 201-VER-04-01

SAFETY COMPLIANCE TESTING FOR FMVSS 201
OCCUPANT PROTECTION IN INTERIOR IMPACT

GENERAL MOTORS OF CANADA LTD.
2004 PONTIAC GRAND PRIX 4-DOOR SEDAN

NHTSA NUMBER: C40101
GD TEST NUMBER: 8655-F201-24

ADVANCED INFORMATION ENGINEERING SERVICES
A GENERAL DYNAMICS COMPANY
TRANSPORTATION SCIENCES CENTER
P.O. BOX 400
BUFFALO, NEW YORK 14225

Test Date: July 13, 2004
FINAL REPORT

PREPARED FOR:

U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Enforcement
Office of Vehicle Safety Compliance
Mail Code: NVS-220, Room 6111
400 Seventh Street, SW
Washington, DC 20590
TECHNICAL REPORT STANDARD TITLE PAGE

VER-04-01

2. Government Accession No.  

3. Recipient's Catalog No.  

4. Title and Subtitle  

5. Report Date  
July 13, 2004

6. Performing Organization Code  
VER

7. Author(s)  
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8655-F201-24

9. Performing Organization Name and Address  
Advanced Information Engineering Services  
A General Dynamics Company  
4455 Genesee Street  
Buffalo, New York 14225

10. Work Unit No.  

11. Contract or Grant No.  
DTNH22-01-C-01025

12. Sponsoring Agency Name and Address  
U.S. Department of Transportation  
National Highway Traffic Safety Administration  
Office of Vehicle Safety Compliance  
Mail Code: NVS-220  
400 Seventh, SW, Room 6111  
Washington, D.C. 20590

13. Type of Report and Period Covered  
Final Report  
July 2004

NVS-220

15. Supplementary Notes

16. Abstract

Compliance tests were conducted on the subject vehicle, a 2004 Pontiac Grand Prix, 4-door Sedan, 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: None

17. Key Words

Compliance Testing  
Safety Engineering  
FMVSS 201

18. Distribution Statement

Copies of this report are available from:  
NHTSA Technical Reference Division  
400 Seventh St., SW  
Washington, DC 20590

19. Security Classif. (of this report)  
UNCLASSIFIED

20. Security Classif. (of this page)  
UNCLASSIFIED

21. No. of Pages

22. Price

Form DOT F1700.7 (8-69)
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</tbody>
</table>
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. DTNH22-01-C-01025. The purpose of this impact compliance test was to determine whether the subject vehicle, a 2004 Pontiac Grand Prix 4-door Sedan, NHTSA No. C40101, 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, 2004 Pontiac Grand Prix, 4-door Sedan, NHTSA No. C40101, was impacted at various locations throughout its instrument cluster/dash panel and seat back area by a 15 lb, 6.5 inch diameter steel headform. A total of four (4) impacts were performed in this test series. 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 6.5 inch diameter steel headform weighed 15 lb and had an accelerometer mounted along its centerline.

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 of this report.
## TEST VEHICLE RECEIVING INSPECTION DATA SHEET

<table>
<thead>
<tr>
<th>VEHICLE YEAR/MAKE/MODEL/STYLE:</th>
<th>2004 Pontiac Grand Prix 4-door Sedan</th>
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<tbody>
<tr>
<td>NHTSA NO.:</td>
<td>C40101</td>
</tr>
<tr>
<td>VIN:</td>
<td>2G2WS542X41171754</td>
</tr>
<tr>
<td>DATE OF MANUFACTURE:</td>
<td>08/03 (SEE CERTIFICATION LABEL)</td>
</tr>
<tr>
<td>COLOR:</td>
<td>White</td>
</tr>
<tr>
<td>ODOMETER READING:</td>
<td>37 miles</td>
</tr>
<tr>
<td>LABORATORY:</td>
<td>GD Engineering</td>
</tr>
<tr>
<td>TEST DATE:</td>
<td>July 13, 2004</td>
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</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: 3
  - LOCATION: Front and rear door panels and center console arm rest

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

### VEHICLE EQUIPPED WITH INTERIOR DOOR LATCHES?
- NO: -
- YES: X
- NUMBER: 2
  - LOCATION: Glove Box and Center Console Arm Rest
HEADFORM IMPACT TEST RESULTS
INSTRUMENT PANEL

VEHICLE YEAR/MAKE/MODEL/STYLE: 2004 Pontiac Grand Prix 4-door Sedan
NHTSA NO.: C40101
VIN: 2G2WS542X41171754
DATE OF MANUFACTURE: 08/03 (SEE CERTIFICATION LABEL)
COLOR: White
ODOMETER READING: 37 miles
LABORATORY: GD Engineering
TEST DATE: July 13, 2004

<table>
<thead>
<tr>
<th>IMPACT LOCATION AND NUMBER</th>
<th>X (inches)</th>
<th>Y (inches)</th>
<th>ANGLE (degrees)</th>
<th>VELOCITY (mph)</th>
<th>PEAK ACCELERATION (3 ms Clip) Gs</th>
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<tbody>
<tr>
<td>1 Dash Cluster</td>
<td>21.9</td>
<td>-3.0</td>
<td>-10</td>
<td>11.5</td>
<td>57.06</td>
</tr>
<tr>
<td>2 Left Side of Airbag Cover</td>
<td>24.75</td>
<td>10.25</td>
<td>-45</td>
<td>11.4</td>
<td>59.00</td>
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<tr>
<td>3 Right Side of Airbag Cover</td>
<td>24.75</td>
<td>18.1</td>
<td>-45</td>
<td>11.5</td>
<td>70.10</td>
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</tbody>
</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 Vehicle centerline).

REMARKS:
### HEADFORM IMPACT TEST RESULTS
#### SEAT BACKS

<table>
<thead>
<tr>
<th>VEHICLE YEAR/MAKE/MODEL/STYLE:</th>
<th>2004 Pontiac Grand Prix 4-door Sedan</th>
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<tr>
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<tr>
<td>LABORATORY:</td>
<td>GD Engineering</td>
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<td>TEST DATE:</td>
<td>May 3, 2004</td>
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#### IMPACT LOCATION AND NUMBER

<table>
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<tr>
<th>NUMBER</th>
<th>X (inches)</th>
<th>Y (inches)</th>
<th>ANGLE (degrees)</th>
<th>VELOCITY (mph)</th>
<th>PEAK ACCELERATION (3 ms Clip) Gs</th>
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</thead>
<tbody>
<tr>
<td>1 Seat Back</td>
<td>-13.25</td>
<td>0</td>
<td>-8</td>
<td>14.6</td>
<td>28.65</td>
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</tbody>
</table>

REFERENCE POINT: SGRP on rear passenger side is the reference point (x positive forward from the front SGRP and y positive to the right of the Seat centerline).
SUN VISOR AND ARMREST EVALUATION

<table>
<thead>
<tr>
<th>VEHICLE YEAR/MAKE/MODEL/STYLE:</th>
<th>2004 Pontiac Grand Prix 4-door Sedan</th>
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<tr>
<td>LABORATORY:</td>
<td>GD Engineering</td>
</tr>
<tr>
<td>TEST DATE:</td>
<td>July 13, 2004</td>
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</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 diameter headform of radius less than 0.125 inch?

   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 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 of the rigid test panel surface without contacting underlying rigid material between 0.50 and 1.25 inches from the panel which has a vertical height of less than 1 inch?

   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

VEHICLE YEAR/MAKE/MODEL/STYLE: 2004 Pontiac Grand Prix 4-door Sedan
NHTSA NO.: C40101
VIN: 2G2WS542X41171754
DATE OF MANUFACTURE: 08/03 (SEE CERTIFICATION LABEL)
COLOR: White
ODOMETER READING: 37 miles
LABORATORY: GD Engineering
TEST DATE: July 13, 2004

LATCH ENGAGEMENT INTERFERENCE

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<th>DESCRIPTION OF LATCH LOCATION</th>
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<th>10G VERTICAL</th>
<th>30G HORIZONTAL LONGITUDINAL</th>
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<tr>
<td>Glove Box</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Center Console Arm Rest</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
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(APPENDIX B CONTAINS CALCULATION SHEETS WHICH ARE BASED ON MANUFACTURER'S DATA)
SUMMARY OF RESULTS

<table>
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<tr>
<th>VEHICLE YEAR/MAKE/MODEL/STYLE:</th>
<th>2004 Pontiac Grand Prix 4-door Sedan</th>
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<tr>
<td>TEST DATE:</td>
<td>July 13, 2004</td>
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<table>
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<th>NUMBER OF IMPACTS</th>
<th>PASS/FAIL</th>
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<tr>
<td>SEAT BACK</td>
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<tr>
<td>SUN VISORS</td>
<td>n/a</td>
</tr>
<tr>
<td>ARMRESTS</td>
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<tr>
<td>INTERIOR COMPARTMENT DOORS</td>
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REMARKS:
APPENDIX A

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<td>A-2</td>
<td>RIGHT SIDE VIEW OF VEHICLE</td>
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<td>A-3</td>
<td>3/4 FRONTAL VIEW FROM LEFT SIDE OF VEHICLE</td>
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<td>A-4</td>
<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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<td>SUN VISOR CONSTRUCTION</td>
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<td>ARMREST LEFT FRONT DOOR</td>
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<td>A-9</td>
<td>ARMREST LEFT REAR DOOR</td>
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<td>ARMREST CENTER CONSOLE</td>
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<td>INSTRUMENT PANEL</td>
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<td>A-12</td>
<td>DELINEATED INSTRUMENT PANEL IMPACT ZONE PRE-TEST</td>
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<td>A-13</td>
<td>INSTRUMENT PANEL LEFT SIDE AIRBAG COVER IMPACT PRE-TEST</td>
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<td>A-14</td>
<td>INSTRUMENT PANEL LEFT SIDE AIRBAG COVER IMPACT POST-TEST</td>
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<td>A-15</td>
<td>INSTRUMENT PANEL RIGHT SIDE AIRBAG COVER IMPACT PRE-TEST</td>
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<td>A-16</td>
<td>INSTRUMENT PANEL RIGHT SIDE AIRBAG COVER IMPACT POST-TEST</td>
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<td>A-17</td>
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<td>A-18</td>
<td>INSTRUMENT PANEL CONSOLE VENT IMPACT POST-TEST</td>
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<td>A-20</td>
<td>HEAD RESTRAINT IMPACT AREA PRE-TEST</td>
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<tr>
<td>A-21</td>
<td>HEAD RESTRAINT IMPACT AREA POST-TEST</td>
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</table>
Figure A-17  INSTRUMENT PANEL CONSOLE VENT IMPACT PRE-TEST
FMVSS No. 201
Latch Component Analysis Information

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 5.0f SAE Recommended Practice J839b, "Passenger Car Side Door Latch Systems."

Such data shall include:

1. Geometric details of the latch/lock configuration.

Geometric details of the latch/lock configuration can be found in the attached FMVSS 201 Compliance Documentation for the 2004 Pontiac Grand Prix:

- Console Door: TWO 04WC0-593
- Glove Box Door: TWO 04WC0-594

2. Mass data for each element in the linkage.

Mass data for each element in the linkage can be found in the attached FMVSS 201 Compliance Documentation for the 2004 Pontiac Grand Prix:

- Console Door: TWO 04WC0-593
- Glove Box Door: TWO 04WC0-594

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

Spring rates for each spring element in the configuration linkage can be found in the attached FMVSS 201 Compliance Documentation for the 2004 Pontiac Grand Prix:

- Console Door: TWO 04WC0-593
- Glove Box Door: TWO 04WC0-594

4. Any additional details unique to the design yet necessary for the calculations.

Any additional details unique to the design linkage can be found in the attached FMVSS 201 Compliance Documentation for the 2004 Pontiac Grand Prix:

- Console Door: TWO 04WC0-593
- Glove Box Door: TWO 04WC0-594
Attachment 1

TWO 04WC0-594-00 – 2004 Pontiac Grand Prix Compliance to FMVSS 201 Lower Latching Requirements

2004 Grand Prix Glove Box Door Latch Calculations
# GM Evaluation Report

**Platform** | **Project/EWO No.** | **Requirement No.** | **Procedure No.** | **VPPVIAJPC** | **Model Year** | **Model No.** | **PER/Report No.**
---|---|---|---|---|---|---|---
FON'TAC GRAND | FMVSS 201L | 0000 | 1A 2B | 2004 | GMX367 | 04WCO-594-00

**Int. Reg. No.** | FMVSS 201L | **Category:** | VPA - Vehicle Product Assurance
---|---|---|---
**Date:** | 14/Oct/2002 | **Method:** | Final
**Title:** | OCCUPANT PROTECTION - COMPARTMENT DOOR LATCHING | Development | Final
**To (Requestor):** | ALICIA SOPALA | Math Based | Interim | No.
**From:** | ALICIA SOPALA | Hardware Based | Reissue | Date of Reissue:
**Date of Request:** | 14/Oct/2002 | **Doses of Evaluation:** | |

**Objective:** Report generated to document compliance of the 2004 GMX367 Pontiac Grand Prix car to FMVSS 201 lower latching requirements.

**Conclusions:** 2004 GMX367 Pontiac Grand Prix cars are in compliance with FMVSS 201 lower latching requirement.

**Recommendations:** None.

**Design Evaluated:**

<table>
<thead>
<tr>
<th>Part/Test Object Name(s)</th>
<th>GMUTS Rating:</th>
<th>Veh Mileage:</th>
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**Distribution:**

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</table>

**Author:** Alicia Sopala | Date: 16-Oct-2002
(Trial Phone) Validation Egr. 586-986-4066
(Location) 480-111-813

**Approver:** Keith Nelson | Date: 12-Nov-2002
(Trial) Validation EGM 586-986-5735
(Location) 480-111-828

**Approver:** Not Required | Date: |
(Trial)
(Location)

---

GM Engineering
GM Evaluation Report

Platform: PONTIAC
Model: GRAND

Project/EWO No.: FMVSS 201L
Procedure No.: 0000
VPP/VI/AUPC: 1A 2B
Model Year: 2004
Model No.: GMX367
PER/Report No.: 04WCD-594-00

Int. Reg. No.: FMVSS 201L

Category: VPA - Vehicle Product Assurance

Recommendations (Expanded): None.

Foreword: N/A

Requirements: NVSS Legal Requirement LV.201

Background: N/A

Assumptions/Limitations: N/A

Analysis Model: N/A

Equipment:

None

Procedure/Method:
L2-1A2B-201G

Results:
See attached

Reference Issue Report (PIMREP / PRTS): N/A

References/Files Storage: N/A

Calibration Report Information: N/A

Appendix:
The 2004 GMX367 Sedan Glove Box Door Latch Calculations.
Analysis of '04 GMX 367 Glove Compartment Latch

OBJECTIVE:
To verify that the '04 GMX 367 Glove Compartment Latch Assembly meets the MVSS-201 inertia load requirements.

RESULTS:
30 G's in Negative Longitudinal direction: The Latch mechanism complies with MVSS-201 requirements. Analysis indicates that a minimum total moment of 422 N•mm is acting to force the mechanism in the closed position.

30 G's in Positive Longitudinal direction: The Latch mechanism complies with MVSS-201 requirements. Analysis indicates that a minimum total moment of 213 N•mm is acting to force the mechanism in the closed position.

10 G's in Negative Vertical direction: The Latch mechanism complies with MVSS-201 requirements. Analysis indicates that a minimum total moment of 353 N•mm is acting to force the mechanism in the closed position.

10 G's in Positive Vertical direction: The Latch mechanism complies with MVSS-201 requirements. Analysis indicates that a minimum total moment of 283 N•mm is acting to force the mechanism in the closed position.

10 G's in Horizontal Transverse 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 rotating axis of the Handle. These Loads have been set to zero in this analysis.

SOLUTION METHOD:
The 30 G and 10 G acceleration forces were converted to static forces by applying the respective accelerations to the Center of Gravity. These forces, translated into moments about the hinge point and combined with the moment from the torsion spring, were used to perform a summation of moments about the hinge point. A resulting moment that leads to force the mechanism further into the latched position suggests that the latch-mechanism assembly complies with the MVSS-201 requirements.
The inertial effects on the Glove-Compartment door will generate some load on the pawl and will effect the moment summation calculation. Since the analysis showed that a passing condition was already present without considering friction contributors, it was not necessary to include them in the calculation. The Pawl was included but treated separately since the Pawl is suspended independent of the Handle-assembly. The Handle-motion is been captured within 2° by the Pawl and therefore had to be added to the Summation Calculation.

CUSTOMER CONCURRENCE:

Revised by Derek Burkhart
3M P/N: 10324874775
Glove-Box Latch Assembly

REVOLUTION: A 09/06/00
**DISCUSSION/CALCULATIONS:**

**Determination of the Mass and Center of Gravity.**

- Mass Handle = 19.3 g
- Mass Cylinder = 5.9 g
- Mass Handle Total = 25.2 g
- Mass Pawl = 3.22 g

The CG location of the Components and Mass properties were determined by CADKEY's and Solidmodeler.

**Note:**
Special consideration has been taken to cover all possible Build variations. 
Worst case X-Y CG displacement has been measured as the Radius of 12.93 mm, and 9.40 mm for the Pawl.
Computation of Torque generated by the Torsion Spring

\[ M = \frac{Ed^4T}{10.8ND} \]

Torque for a given single torsion spring can be found by:

- \( M = \) Moment of Torque (lb\cdot in)
- \( E = \) Modulus of Elasticity = 30xE6 PSI
- \( d = \) Diameter of Spring wire = 0.050\"
- \( T = \) Deflection (revolutions) = 11\(^\circ\)/360\(^\circ\)
  \( \{33\times360\}\)
- \( N = \) Number of Coils = 4.5 (3.5)
- \( D = \) Mean Coil Diameter = 0.200\"

This yields:

**Handle Torque**

\[ M = \frac{(30E6 \times 0.050^{-6} \times 0.03056)}{(10.8 \times 4.5) \times 0.200''} \]

\[ M = 0.59 \text{ Lbs}\cdot\text{in} \times 113 \]

\[ M = 66.67 \text{ N}\cdot\text{mm} \text{ acting clockwise onto Handle-assembly} \]

**Pawl Torque**

\[ M = \frac{(30E6 \times 0.050^{-6} \times 0.09167)}{(10.8 \times 3.5) \times 0.200''} \]

\[ M = 2.255 \text{ Lbs}\cdot\text{in} \times 113 \]

\[ M = 254.82 \text{ N}\cdot\text{mm} \text{ acting clockwise onto Pawl-assembly} \]
SUMMATION OF FORCES AND MOMENTS DUE TO ACCELERATION

HORIZONTAL LONGITUDINAL DIRECTIONS

Values in f refer to Pawl-section
30 G's - An inertial force generated by 30 G on the handle (Handle = 25.2 grams) can be found by:
\( F = m \times s \)
\( F = 25.2 \text{gr.} \times (3.22 \text{gr.}) \times (30 \text{G} \times 9.807 \text{m/s}^2) = 7414.09 \text{g} \cdot \text{m/s}^2 \times 947.36 \text{g} \cdot \text{m/s}^2 \)
\( F = 7414.09 \text{g} \cdot \text{m/s}^2 \times 947.36 \text{g} \cdot \text{m/s}^2 \times 0.001 \)
\( F = 7.41 \text{ Newtons} \) (0.95 Newtons)

1 G Negative Vertical Direction of Parts - 247.13 g \cdot \text{m/s}^2 \times 31.579 g \cdot \text{m/s}^2 \times 0.001 = 0.24 \text{Newton(0.032N)}

30 G's applied in Positive Longitudinal direction

Taking clockwise as positive, the inertial force, F is applied horizontally at the CG and generates a positive moment about the hinge point across the moment arm formed by the radial offset "R".

\( \Sigma M = [(F \times R) - M] + (1G_{\text{Handle}} \times R) \)
\( \Sigma M = [(7.41N \times 0.95N) \times 12.93mm(9.4mm)] - 66.67N \cdot \text{mm}(254.82N \cdot \text{mm}) + (0.24N(0.032N) \times 12.93mm(9.4mm)) \)
\( \Sigma M = 32.24N \cdot \text{mm} + (246.19N \cdot \text{mm}) \)
\( \Sigma M = -213.95 N \cdot \text{mm} \)

which translates into a net moment of 213 N•mm (CCW) forcing the Latch CLOSED.

30 G's applied in Negative Longitudinal direction

Taking clockwise as positive, the internal force, F is applied horizontally at the CG and generates a negative moment about the hinge point across the moment arm formed by the radial offset "R".

\( \Sigma M = -(F \times R) - M) + (1G_{\text{Handle}} \times R) \)
\( \Sigma M = [(7.41N \times 0.95N) \times 12.93mm(9.4mm)] - 66.67N \cdot \text{mm}(254.82N \cdot \text{mm}) + (0.24N(0.032N) \times 12.93mm(9.4mm)) \)
\( \Sigma M = -159.38N \cdot \text{mm} + (283.45N \cdot \text{mm}) \)
\( \Sigma M = -422.83 N \cdot \text{mm} \)

which translates into a net moment of 422 N•mm (CCW) forcing the Latch CLOSED.
**Summation of Forces and Moments Due to Acceleration**

**Vertical Directions**

Values in f/j relate to Pawl-section

10 G's - An inertial force generated by 10 G on the handle (Handle = 25.2 grams) can be found by:

\[ F = mx = \text{Pawl} \times 3.22 \]  
\[ F = 25.2 \text{gr} \times (3.22 \text{gr}) \times (10 \text{G} \times 9.807 \text{m/s}^2) = 2471.36 \text{g-m/s}^2 \times 315.787 \text{g-m/s}^2 \]  
\[ F = 2471.36 \text{g-m/s}^2 	imes (315.787 \text{g-m/s}^2) \times 0.001 \]  
\[ F = 2.47 \text{ Newtons (0.32 Newtons)} \]  

1 G Negative Vertical Direction of Parts – 247.13 g-m/s² (31.579 g-m/s²) x 0.001 = 0.24 Newton (0.032 N)

10 G's applied in **Positive Vertical direction**

Taking clockwise as positive, the internal force, F is applied vertically at the CG and generates a positive moment about the hinge point across the moment arm formed by the radial offset "R".

\[ \Sigma M = [(F \times R) - M] + (1G_{\text{Handle}} \times R) \]
\[ \Sigma M = [2.47N \times 0.32N \times 12.93mm(9.4mm)] - 66.67N \times mm(254.82N \times mm) + (0.24N \times 0.032N) \times 12.93mm(9.4mm) \]
\[ \Sigma M = -31.83N \times mm + (-251.51N \times mm) \]
\[ \Sigma M = -283.14N \times mm \]

which translates into a net moment of 283 N-mm (CCW) forcing the Latch CLOSED.

10 G's applied in **Negative Vertical direction**

Taking clockwise as positive, the internal force, F is applied vertically at the CG and generates a negative moment about the hinge point across the moment arm formed by the radial offset "R".

\[ \Sigma M = [(F \times R) - M] + (1G_{\text{Handle}} \times R) \]
\[ \Sigma M = [2.47N \times 0.32N \times 12.93mm(9.4mm)] - 66.67N \times mm(254.82N \times mm) + (0.24N \times 0.032N) \times 12.93mm(9.4mm) \]
\[ \Sigma M = -95.51N \times mm + (-257.53N \times mm) \]
\[ \Sigma M = -353.04N \times mm \]

which translates into a net moment of 353 N-mm (CCW) forcing the Latch CLOSED.
Attachment 2

TWO 04WC0-593-00 – 2004 Pontiac Grand Prix Compliance to FMVSS 201 Lower Latching Requirements

2004 Grand Prix Console Door Latch Calculations
GM Evaluation Report

Platform: PONTIAC
Project/EOO No.: GRAND
Requirement No.: FMVSS 201L
Procedure No.: 0000
VPP/VIA/UPC: 1C 13
Model Year: 2004
Model No.: GMX367
PER/Report No.: 04WCD-593-00

Inl. Reg. No.: FMVSS 201L
Category: VPA - Vehicle Product Assurance

Function: ☑ Validation
Method: ☑ Hardware Based

Date: 14/Oct/2002
Title: OCCUPANT PROTECTION-COMPARTMENT
       DOOR LATCHING
To (Requestor): N/R
From: ALICIA SOPALA

Objective: Report generated to document compliance of the 2004 GMX367 Pontiac Grand Prix to FMVSS 201 lower latching requirements.

Conclusions: 2004 GMX367 Pontiac Grand Prix are in compliance with FMVSS 201 lower latching requirement.

Recommendations: None.

Design Evaluated:

GMUTS Rating:

Part/Test Object Name(s):

Veh/Bcch/PT/PartNo/Rpo:

Veh Mileage:

Revision Data/Level:

Distribution:

Name: N/A
Loc: N/A

Name: 
Loc: 

Name: 
Loc: 

Name: 
Loc: 

Name: 
Loc: 

Co: 

Author: Alicia Sopala
Date: 16-Oct-2002
Title/Phone: Validation Egz. 586-986-4866
Location: 480-111-W15

Approver: Keith Nelson
Date: 17-Oct-2002
Title: Validation RGM 586-986-5735
Location: 480-111-828

Approver: Not Required
Date: N/A

GM Engineering
GM Evaluation Report

Platform: PONTIAC GRAND

Project/EWO No.: FMVSS 201L

Requirement No.: 0000

Procedure No.: 1C 1J

Model Year: 2004

Model No.: GMX367

PER/Report No.: 04WC0-593-00

Int. Reg. No.: FMVSS 201L

Category: VPA - Vehicle Product Assurance

Recommendations (Expanded): None.

Foreword: N/A

Requirements: MVSS Legal Requirement LV.201

Background: N/A

Assumptions/Limitations: N/A

Analysis Model: N/A

Equipment:

None

Procedure/Method: L2-1A2B-201G

Results:

See attached

Reference Issue Report (PIMREP / PRTS): N/A

References/File Storage: N/A

Calibration Report Information: N/A

Appendix:

The 2004 GMX367 Pontiac Grand Prix Console latch calculations.
2003 GMX367 Floor Console Bin Crash Calculations

And Latch Stress Analysis

1/23/2001

For Alicia

Gus Valiente

From
Bill Lee
JCI Validation
TAPERED LATCH SPRING

Neutral Loaded Position

t base t end

\[ y = 2\text{mm} \quad L = 40\text{mm} \quad t_{\text{base}} = 2.2\text{mm} \]

\[ E = 2590 \cdot 10^6\text{Pa} \quad w = 14.2\text{mm} \quad t_{\text{end}} = 1.3\text{mm} \]

Material is Acetal

\[ t(x) := t_{\text{base}} - \left( t_{\text{base}} - t_{\text{end}} \right) \frac{x}{L} \]

\[ l(x) := \frac{w \cdot t(x)^3}{12} \quad A(x) := w \cdot t(x) \quad c(x) := \frac{t(x)}{2} \]

\[ y = \int_{0\text{-mm}}^{L} \frac{F \cdot (L - x)^2}{E \cdot I(x)} \, dx \]

\[ F := \int_{0\text{-mm}}^{y} \frac{(L - x)^2}{E \cdot I(x)} \, dx \]
\[ M(x) := F \cdot (L - x) \]

The von Mises stress as a function of \( x \) is:

\[ \sigma_{\text{von M}}(x) := \sqrt{\frac{M(x)^2}{I(x)}} + 3 \left( \frac{F}{A(x)} \right)^2 \]

\[ \sigma_{\text{von M}}(0 \text{ mm}) = 7.317 \times 10^6 \text{ Pa} \]

\[ U = \int_0^L \frac{M(x)^2}{2 \cdot E \cdot I(x)} \, dx \quad U = \int_0^L \frac{[F \cdot (x - L)]^2}{2 \cdot E \cdot I(x)} \, dx \quad y_{\max} = \frac{d}{dF} U \]

\[ y_{\max} := \int_{0 \text{ mm}}^L \frac{F \cdot (x - L)^2}{E \cdot I(x)} \, dx \]

![Graph](image)

If necessary, set upper \( x \) limit on graph to value for \( L \).

For questions on this calculation sheet, contact Gary Miller @2936.
**Latch Opening Efforts**

\[ L_{\text{effort}} := 25\text{mm} \]

\[ y = \text{deflection of spring at rest} \]

\[ y_{\text{open}} = \text{deflection of spring at disengagement} \]

\[ \text{Effort}_{\text{min}} := F \frac{L}{L_{\text{effort}}} \]
30 G Frontal Crash Calculation

Input Variables:

\[ \text{mass}_{\text{latch}} := 0.015 \text{kg} \quad \text{L}2 := 8 \text{mm} \]

Moment of latch in forward direction must be less than the moment of the spring force:

\[ M_{\text{latch}} := \text{mass}_{\text{latch}} \times 30 \text{g} \times \text{L}2 \]

\[ M_{\text{latch}} = 0.035 \text{kg} \cdot \text{m}^2 \cdot \text{sec}^{-2} \]

\[ M_{\text{spring}} := F \cdot \text{L} \]

\[ M_{\text{spring}} = 0.084 \text{kg} \cdot \text{m}^2 \cdot \text{sec}^{-2} \]

Safety factor := \[ \frac{M_{\text{spring}}}{M_{\text{latch}}} \]

If Safety Factor is greater than 1 then the system passes 30G forward crash acceleration.

30G Rearward Crash Calculation

This latching system by design increases latching engagement in a rearward crash therefore it passes 30G rearward crash requirements by inspection.
10 G Vertical Crash Calculation

A. Failure Mode - Latch Shear - Latch tab will shear with a vertical load. Assumes worst case that all the load is concentrated on the latch.

Input variables

\(\text{mass}_{\text{lid}} := 2 \text{kg}\) \hspace{1cm} \(A_1 := 64.6 \text{mm}^2\) \hspace{1cm} \(A_2 := 129.3 \text{mm}^2\) \hspace{1cm} \(\text{Latch}_{\text{shear}} := 4400 \text{psi}\) \hspace{1cm} \(A_3 := 94.1 \text{mm}^2\)

\(\text{Latch}_{\text{crusie}} := 8800 \text{psi}\)

\(F := 10g \cdot (\text{mass}_{\text{lid}} + \text{mass}_{\text{latch}})\)

\(F = 197.604 \text{kg m sec}^{-2}\)

\(\tau_{\text{max}} := \left(\frac{F}{3 \cdot 2A_3}\right)\)

\(\tau_{\text{max}} = 3.15 \times 10^5 \text{kg m}^{-1} \text{sec}^{-2}\)

\(\text{Safety factor} := \frac{\text{Latch}_{\text{shear}}}{\tau_{\text{max}}}\)

If the safety factor is greater than 1 the latch will not fail in shear.
B. Failure Mode - Latch Tension - Worst case assume all load is distributed through the latch catch.

\[ \sigma_{\text{max}} := \left( \frac{F}{A_1} \right) \]

\[ \sigma_{\text{max}} = 3.059 \times 10^6 \text{ kg m}^{-1} \text{ sec}^{-2} \]

\[ \text{Safetyfactor} := \frac{\text{Latchtensile}}{\sigma_{\text{max}}} \]

If the safety factor is greater than 1 the latch will not fail in tension.

C. Failure Mode - Substrate Catch Shear - Substrate catch will shear with a vertical load. Assumes worst case all the load is concentrated thru the latch.

\[ \tau_{\text{max}} := \left( \frac{3F}{2A_2} \right) \]

\[ \tau_{\text{max}} = 2.292 \times 10^6 \text{ kg m}^{-1} \text{ sec}^{-2} \]

\[ \text{Safetyfactor} := \frac{\text{Catchshear}}{\tau_{\text{max}}} \]

If the safety factor is greater than 1 the latch catch will not fail in shear.

10 G Downward Vertical Acceleration

The armrest lid will not open in downward vertical acceleration by inspection.

10 G Upward Acceleration

The center of gravity of the latch is rearward of the pivot, therefore upward acceleration will increase latching engagement. The armrest lid will not open by inspection.
APPENDIX C

DATA PLOTS
FMVSS 201 Linear Impact - 2004 Grand Prix - L.S. Airbag -45 Degrees
Headform Front Ax Velocity

Max: 11.5 [mph] at 0.049 [s]
Min: -3.1 [mph] at 0.082 [s]
FMVSS 201 Linear Impact - 2004 Grand Prix - R.S. Airbag -45 Degrees

Headform Front Ax Velocity

Max: 11.6 [mph] at 0.049 [s]
Min: -3.0 [mph] at 0.081 [s]
FMVSS 201 Linear Impact - 2004 Grand Prix - Dash Center -10.4 Degrees
Headform Front Ax Velocity
Max: 11.8 [mph] at 0.050 [s]
Min: -5.0 [mph] at 0.084 [s]