Memorandum

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

Vehicle Research and Test Center P.O. Box B37
East Liberty, Ohio 43319
(937) 666-4511

Subject: FINAL REPORT: EA12-003 "Ford Freestar Third Seat Anchor Corrosion"

Date: MAR 21 2013

From: Roger A. Saul
Director
Vehicle Research and Test Center

Reply to Attn. Of: NVS-310

To: Frank Borris
Director
Office of Defects Investigation

NVS-210

Enclosed is the final report titled "Ford Freestar Third Seat Anchor Corrosion." This report completes the requirements for this program.

1 Attachment:

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NVS-313:BESSER:iwf:03/18/13:937-666-4511
Copies to:
NVS-313 Chron
Project File: EA12-003
Willke, D.
Esser, B.

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Memorandum Report
DCD-2190 EA12-003
Ford Freestar Third Seat Anchor Corrosion

Background

The Office of Defects Investigations (ODI) has received Vehicle Owner Questionnaire (VOQ) complaints from owners of 2004 and 2005 Ford Freestar vehicles alleging complete loss of attachment of one side of the third seat anchorage point due to corrosion.

Subject vehicles are equipped with a third-row seat that can be stowed to provide a flat floor area at the rear of the van. This design requires that the third seat be easily detachable from the anchor point to the vehicle in order to be stowed. When not stowed, the base of the seat latches onto an anchor loop on the occupant side of the rear wheel wells using a latch that is similar in appearance to a door latch. There is an anchor loop on both rear wheel wells. The anchor loop, in turn, is mounted to a plate that is spot welded onto the wall of the wheel well. This plate is visible from the outside of the vehicle and is located over the front portion of both rear tires.

Because the seat back attaches to the seat base[1], its position is dictated by the position of the seat base. If the seat base rotates upward at the front because of a latch failure, the seatback rotates rearward by the same amount. During a rear impact crash, rearward rotation of the seat may increase the likelihood of the occupants to be ejected out the rear window to the extent that is allowed by the seatbelts.

Several owners noted that the failed condition was brought to their attention by their children who were occupying the third seat. The children reported being able to bounce up and down on the seat, much like sitting on a spring. Other owners discovered the anchor loop, and the plate to which it is attached, laying on top of a rear tire. Other instances were detected during routine maintenance or safety inspection of the vehicle.

Figure 1 shows a subject vehicle. Figure 2 shows an anchor loop with the interior trim panel in place. Figure 3 shows an anchor loop with the trim panel removed. Figure 4 shows the orientation of the seat base when it is latched to the anchor loop. Figure 5 shows the latch

[1] The seat and seatback can be stowed in a well in the floor to create a flat floor for carrying cargo. When the seat is in the erected position, a set of double hinges with limited range of motion allow the seatback to be rigidly attached to the seat base so that it moves with the seat base. These hinges then allow the seatback to fold into the stored position.

Figure 1 – Subject Vehicle

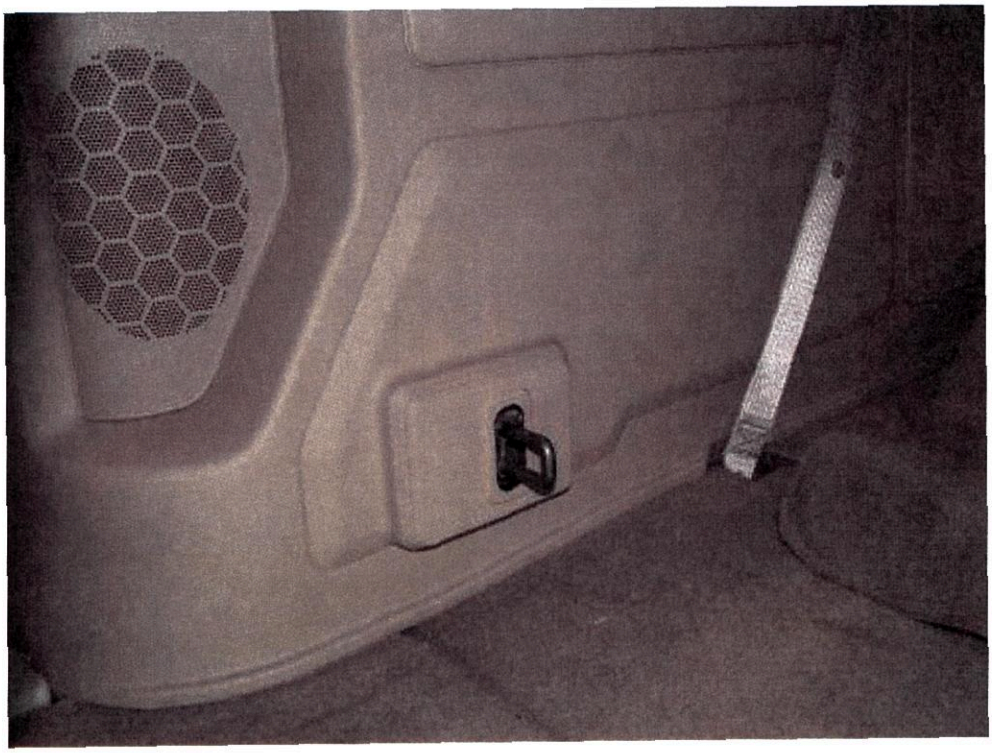

Figure 2 – Anchor Loop with Trim Panel in Place

Figure 3 – Anchor Loop with Trim Panel Removed

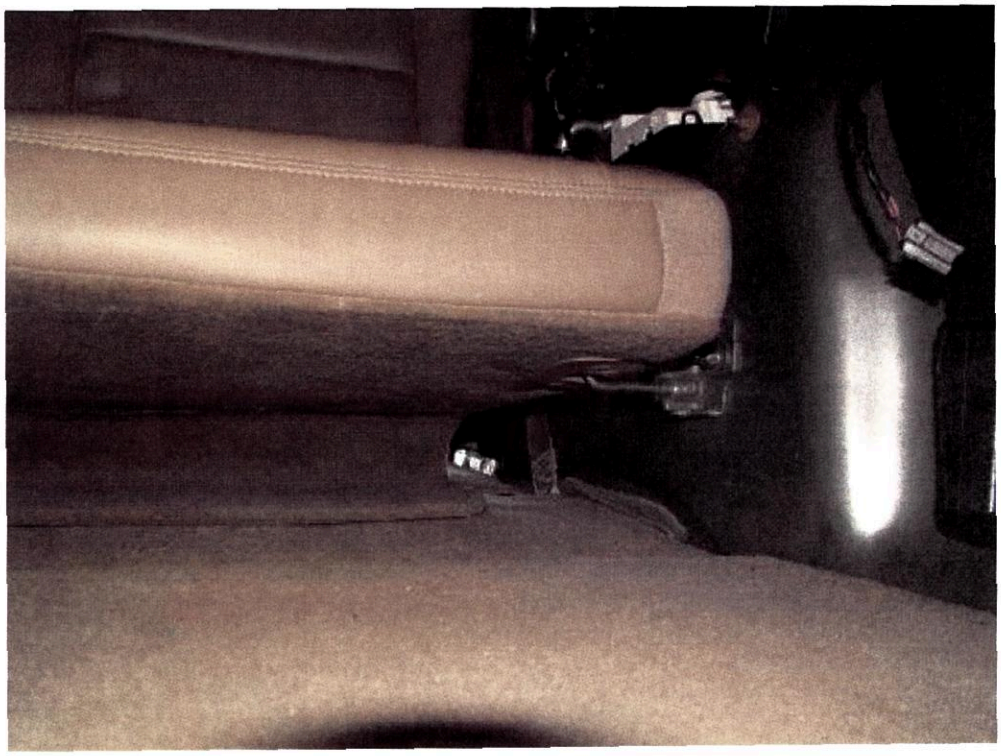

Figure 4 – Seat Base Attached to Anchor Loop

Figure 5 – Latch Mechanism in Seat Base

Figure 6 – Mounting Plate in Rear Wheel Well

Random Subject Vehicle Inspections

The Vehicle Research and Test Center (VRTC) was asked to inspect 14 randomly selected subject vehicles. The first two were owned by VRTC; the rest were inspected in salvage yards. Some of the salvage yards permitted the removal of the interior trim panel in order to complete a full inspection but some did not.

The survey showed that even if corrosion was present, it was usually not readily detectable because it might be hidden behind the trim panel of the occupant compartment or it might be masked by rust proofing applied to the fender well by the manufacturer during the manufacturing process. Of the 14 vehicles inspected, 9 exhibited some level of corrosion at or near one or both of the seat anchorage locations. Documentary photos of each vehicle inspected are shown in Appendix 1.

VOQ Vehicle Inspections

Several vehicles were inspected for which a VOQ had been submitted alleging a complete loss of the left seat anchor. In each case, the claim was verified. Figures 7 -9 show the typical condition of these vehicles.

Figure 7 – Severe Corrosion on VOQ Vehicle

Figure 8 – Fully Corroded and Lost Seat Anchor

Figure 9 – Partially Corroded Seat Anchor

Crash Testing

Four moving-deformable-barrier rear-impact crash tests were performed in order to determine what, if any, effect the seat anchor failure has on rear impact occupant protection. Two vehicles were tested on which the left hand seat anchorage for the third row of seats had corroded to the point of complete loss of the seat anchor (corroded vehicle). Two vehicles that did not exhibit any corrosion of the same seat anchor (intact vehicle) were tested. One intact and one corroded vehicle were tested with the head restraints raised to the level of the center of gravity of the occupant dummies' heads. The other pair was tested with the head restraints lowered to the top of the seatback (i.e., head restraints fully down).

The same test protocol was used for all four tests. The FMVSS 301 moving barrier cart with a deformable face attached impacted the rear of the stationary test vehicle at 40 mph. The vehicle was positioned so that the barrier impacted with a 40% offset to the left (driver side). A 5th percentile female Hybrid III dummy was seated in each of the third seat outboard seating positions, and a 10-year-old Hybrid III dummy was seated in the center seating position of the same seat. All three dummies were restrained using the standard equipment 3-point seatbelts that the manufacturer supplied on the vehicle. Two on-board and 4 off-board digital high-speed cameras captured the crash events.

In addition to measuring cart impact speed and vehicle acceleration levels, each dummy was instrumented to measure head, chest, and pelvis accelerations, neck loading, chest deflection, and femur loading. Pre and post-test measurements were used to determine vehicle crush profiles.

Documentary pre and post-test photographs are shown in Appendix II.

Crash Test Injury Results

The injury assessment values (IAV) from all four crash tests are shown in Table 1 on the following page. IAVs in excess of the allowable limits[1,2] are highlighted in yellow. The N/D entry indicates that this value was not calculated due to instrumentation failure during this test.

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[1] Injury assessment reference values (IARVs) for the Hybrid III 5th percentile female are specified in Federal Motor Vehicle Safety Standard No. 208.

[2] IARVs for the Hybrid III 10-year-old are from "U.S.DOT/NHTSA - Hybrid III 10 Year Old Dummy (HIII-10C) Injury Criteria," Docket Number NHTSA-2005-21245-0023.

Table 1 – Comparison of Injury Results

Test No. and Description	Test 1 (Intact seat, head restraints down)			Test 2 (Corroded seat, head restraints up)			Test 3 (Corroded seat, head restraints down)			Test 4 (Intact seat, head restraints up)			Injury Criteria	
Dummy Position and Type	Left 5th Female	Center 10 YO	Right 5th Female	Left 5th Female	Center 10 YO	Right 5th Female	Left 5th Female	Center 10 YO	Right 5th Female	Left 5th Female	Center 10 YO	Right 5th Female	5th Female	10 YO
HIC [15]	26	29	38	77	73	223	36	150	374	N/D	63	74	700	700
HIC [36]	40	62	73	148	128	242	72	150	374		69	138	---	1000
HIC MAX	64	74	104	245	153	242	128	150	374		69	145	---	---
Chest Acceleration (g)	16	10	15	14	14	10	11	10	14	12	14	18	60	60
Chest Deflection [outward] (mm)	10.3	2.4	0.8	2.1	1.9	1.0	3.4	1.3	0.0	2.2	2.3	1.0	52	40*
Chest Deflection [inward] (mm)	6.6	1.5	1.6	3.0	2.2	1.6	2.6	1.3	1.7	4.1	1.7	1.3	52	40
Neck Axial Tension (N)	669	998	790	1131	1320	1440	781	1045	1191	864	760	1631	4287	3740
Neck Axial Compression (N)	185	139	90	188	132	94	103	77	44	301	200	107	3880	3390
Neck Flexion Moment (N-m)	20	15	20	14	7	9	12	8	11	13	10	19	155	128
Neck Extension Moment (N-m)	25	38	36	48	32	63	23	49	54	31	43	39	67	56
Nij [NTE]	0.5	1.1	0.7	0.9	1.1	1.2	0.5	1.3	0.9	0.6	1.0	1.0	1.0	1.0*
Nij [NTF]	0.19	0.19	0.16	0.17	0.24	0.16	0.09	0.12	0.17	0.17	0.22	0.23	1.0	1.0
Nij [NCE]	0.28	0.00	0.01	0.07	0.00	0.00	0.03	0.00	0.00	0.31	0.09	0.10	1.0	1.0
Nij [NCF]	0.09	0.07	0.07	0.09	0.05	0.06	0.05	0.03	0.04	0.09	0.12	0.04	1.0	1.0
Neck Shear Force [head aft] (N)	99	225	136	164	350	639	132	453	541	157	393	426	2620	1490*
Neck Shear Force [head fore] (N)	176	92	145	212	75	99	144	73	150	146	58	112	2620	1820*
Right Femur Tension (N)	191	485	248	706	450	391	711	507	764	297	512	345	6805	---
Right Femur Compression (N)	314	142	235	254	264	219	249	156	177	509	105	270	6805	---
Left Femur Tension (N)	147	856	92	262	354	378	362	853	1,043	282	958	232	6805	---
Left Femur Compression (N)	309	357	304	277	477	196	260	120	144	383	195	233	6805	---

Notes: Right 5th female HIC values in Test 1 are approximated.

Injury values exceeding injury criteria are highlighted in yellow.

Values with * are for 6 year old. Values for 10 year old have not been established.

Crash Test Head Excursion Results

In each test, the head of one or more of the dummies rotated rearward to a point outside of the plane of the rear window and then rebounded back into the vehicle. The window glazing had been broken by the force of the impact before the dummies' heads reached the plane of the glazing. The maximum head excursion value for each test was determined using photogrammetry and are shown in Table 2. The photos used for this analysis are shown in Appendix III.

Table 2 – Maximum Head Excursion Beyond Plane of Rear Window

	Intact Seat, HR Up	Intact Seat, HR Down	Corroded Seat, HR Up	Corroded Seat, HR Down
Approx. Max. Head Excursion	6 in.	6 in.	12 in.	15 in.

Summary

- Although the injury assessment reference value for maximum Nij has not been established for the 10-year old dummy[3], the center occupant dummy exceeded, in three of the four tests, the value established for the 6 year-old dummy. In one of the four tests, maximum Nij was exceeded for one 5th female dummy in a corroded seat.
- Although none of the dummies exceeded the allowable HIC value, the HIC values were generally higher in tests with corroded seat anchors.
- Occupant excursion outside of the plane of the rear window was the same on an intact seat regardless of the position of the head restraint.
- Occupant excursion outside of the plane of the rear window with a corroded seat anchor was double that of the intact seat anchor with the head restraint up and 2.5 times that of the intact seat anchor with the head restraint down.

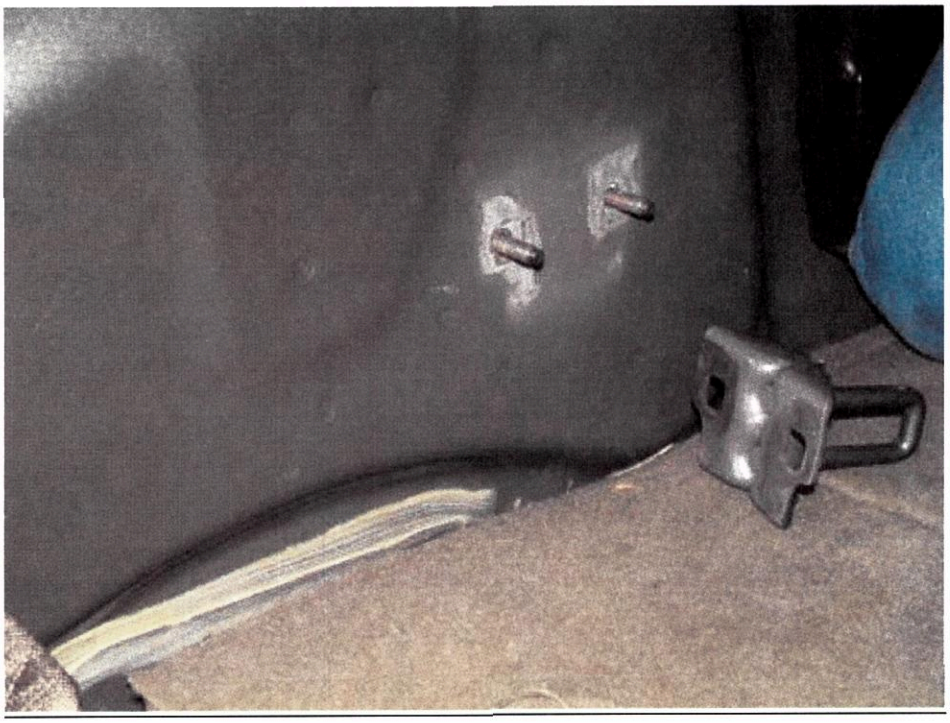
[3] The critical values used to calculate Nij for the 10-year old dummy have not been established because this dummy is not used in FMVSS 208 testing.

Appendix 1

Results of Vehicle Inspections

Vehicle #1 VIN: 2FMDA58255BAXXXXX

This vehicle was owned by VRTC and exhibited no corrosion.



Vehicle #2 VIN: 2FMZA516X4BAXXXXX

This vehicle was owned by VRTC and was inspected twice. The condition of this vehicle in the initial inspection is shown in Figures 1 and 2. The condition of this vehicle in the second inspection, which occurred approximately nine months later, is shown in Figures 3 and 4. Note the increased deterioration between the two inspections.

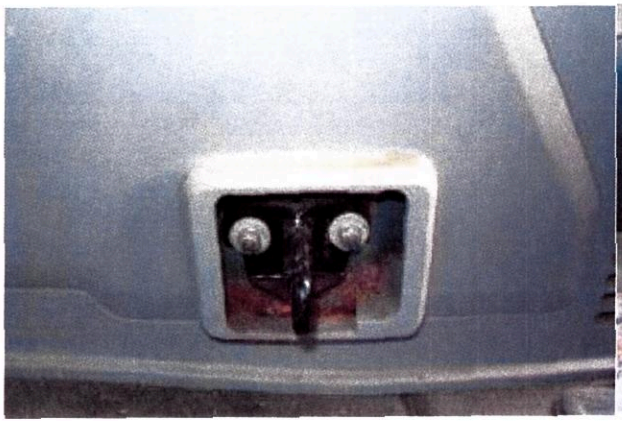


Figure 1
Anchor Loop with Trim Panel

Figure 2
Anchor Loop without Trim Panel

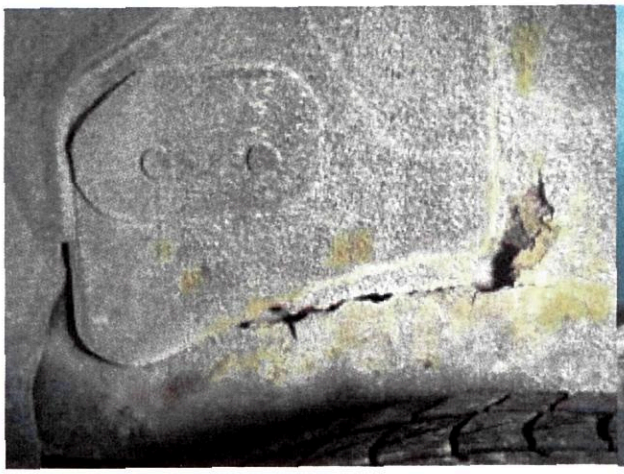
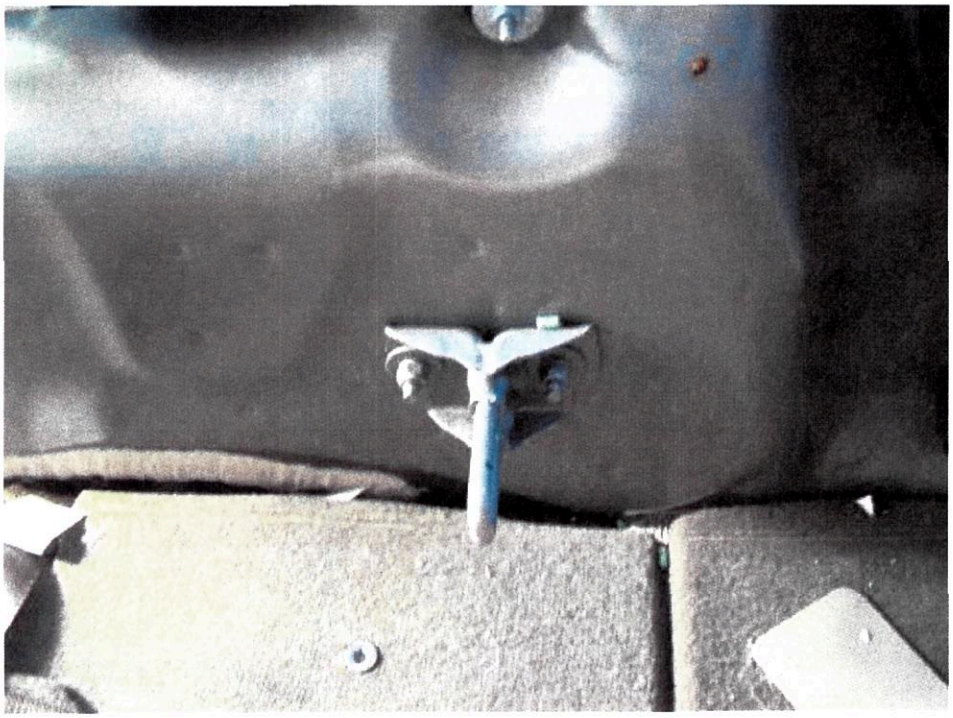


Figure 3
Loop Mounting Plate in Wheel Well

Figure 4
Increased Corrosion of Anchor Loop

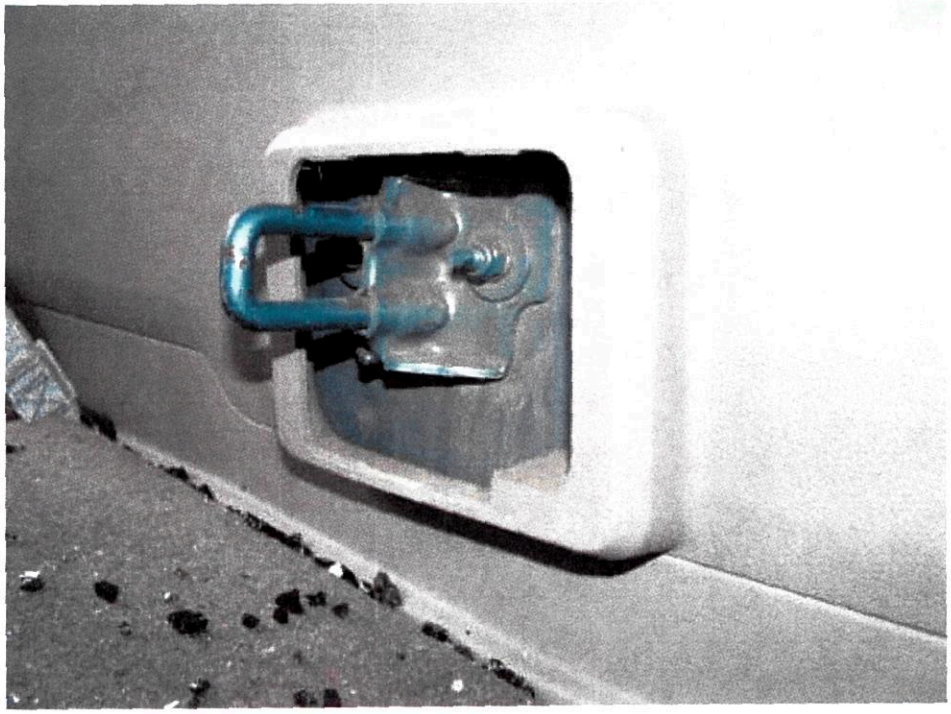
Vehicle #3 VIN: 2MRDA22246BJXXXXX

This vehicle exhibited no corrosion.



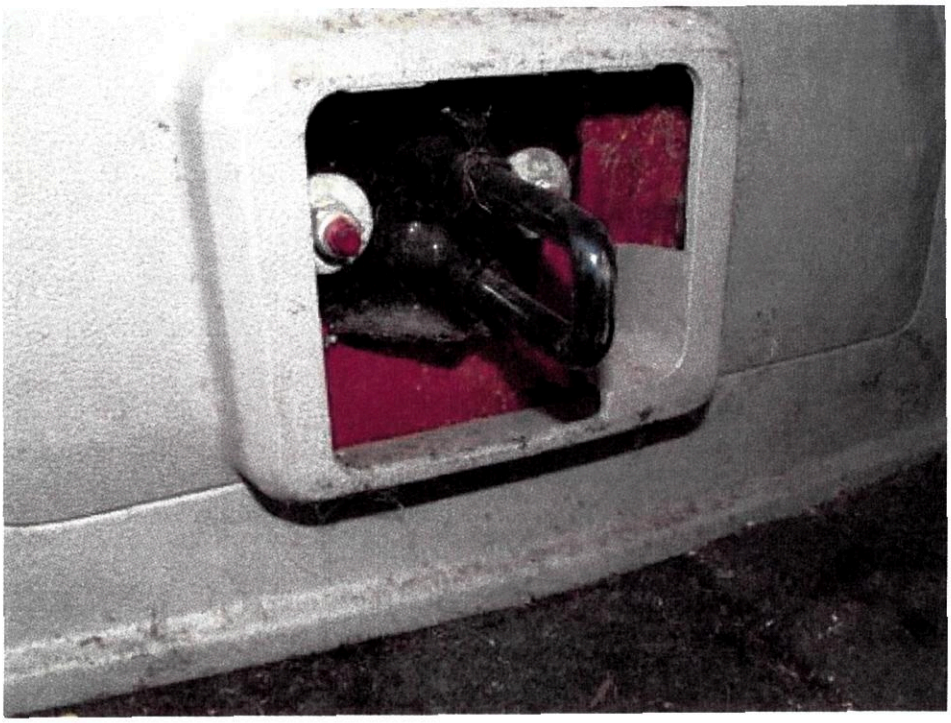
Vehicle #4 VIN: 2FMZA51687BAXXXXX

This vehicle was found in a salvage yard and removing the trim panel was not permitted. It appeared to have little or no corrosion.



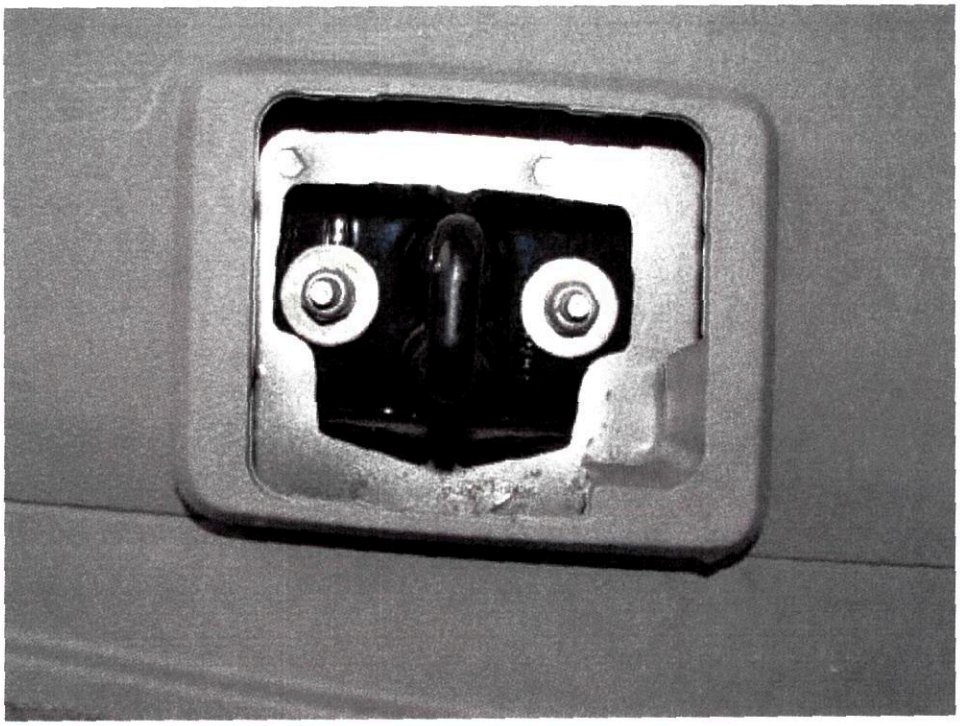
Vehicle #5 VIN: 2FMZA52254BAXXXXX

This vehicle was found in a salvage yard and removing the trim panel was not permitted. Corrosion was readily visible through the hole in the trim panel.



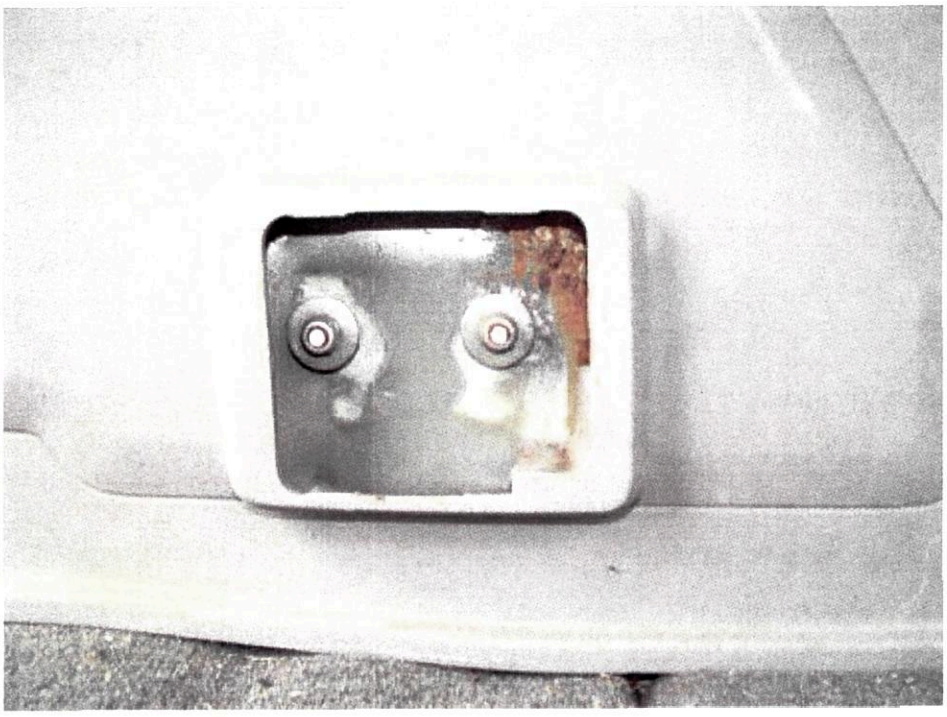
Vehicle #6 VIN: 2MRDA22205BJXXXXX

This vehicle was found in a salvage yard and removing the trim panel was not permitted. The trim panel could be pulled away enough to reveal minor corrosion around the anchor.



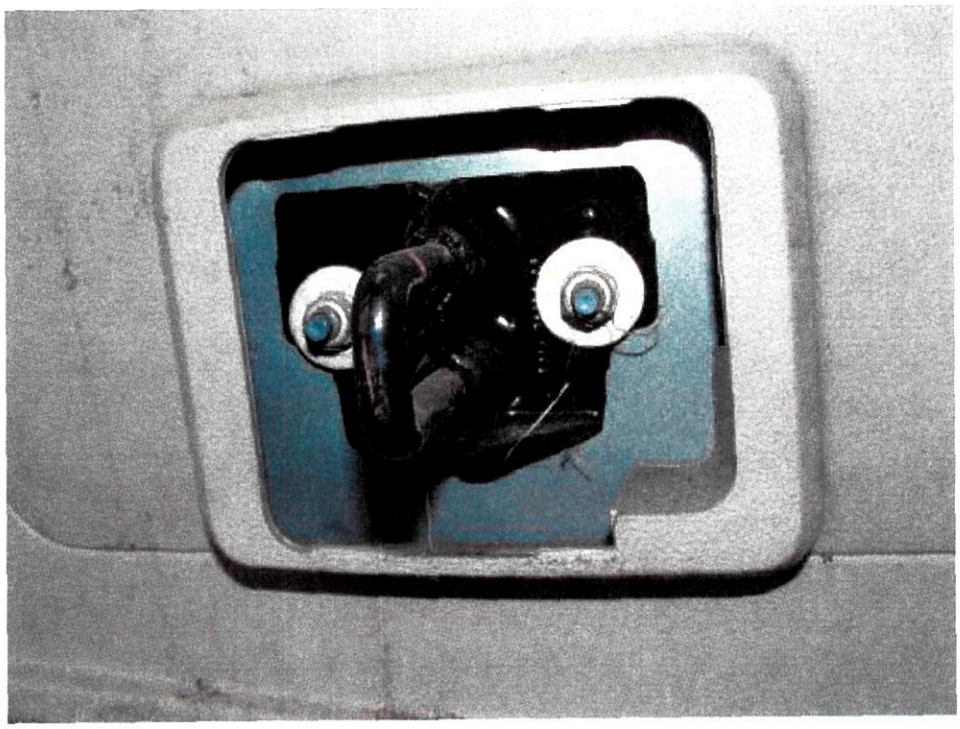
Vehicle #7 VIN: 2FMZA51686BAXXXXX

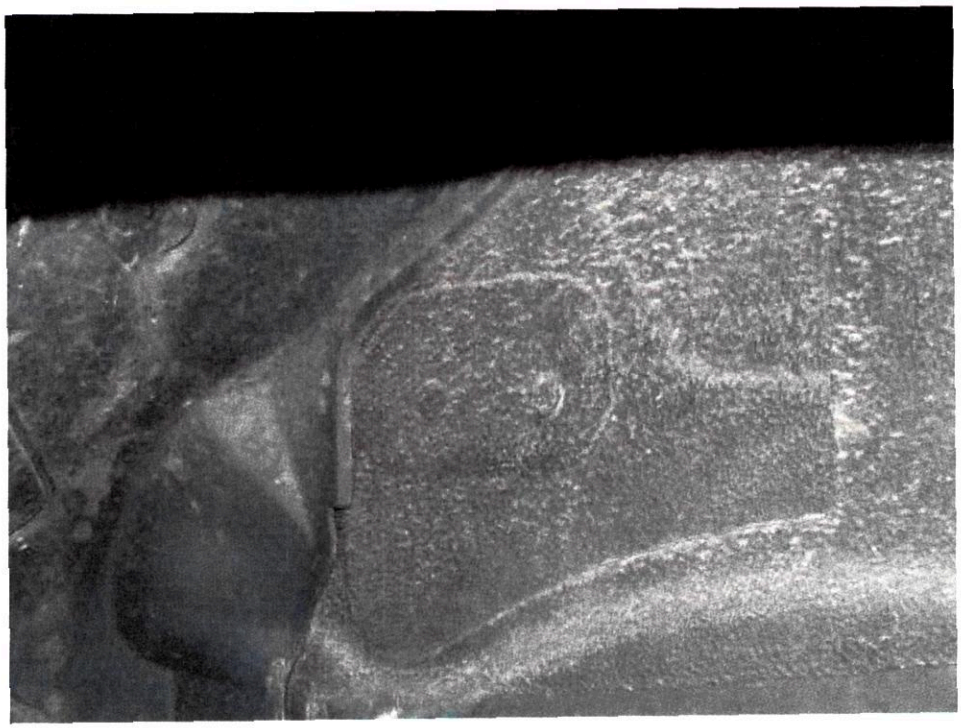
This vehicle exhibited some visible corrosion with the trim panel in place and more when the trim panel was removed.



Vehicle #8 VIN: 2FMZA51604BAXXXXX

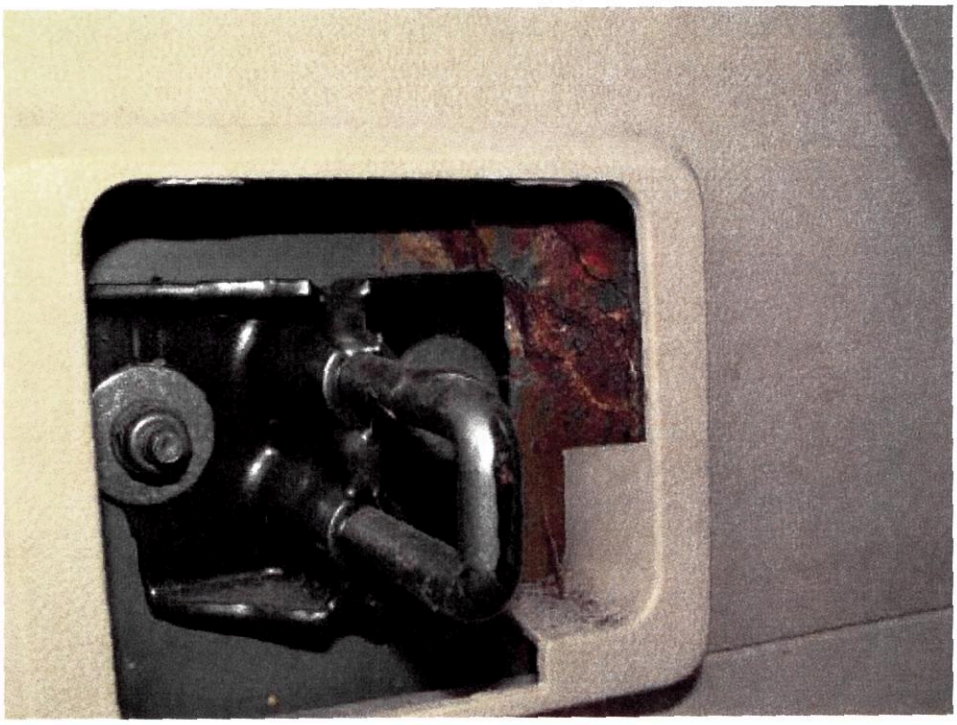
This vehicle was found in a salvage yard and removing the trim panel was not permitted. This vehicle did not exhibit corrosion with the trim panel in place.





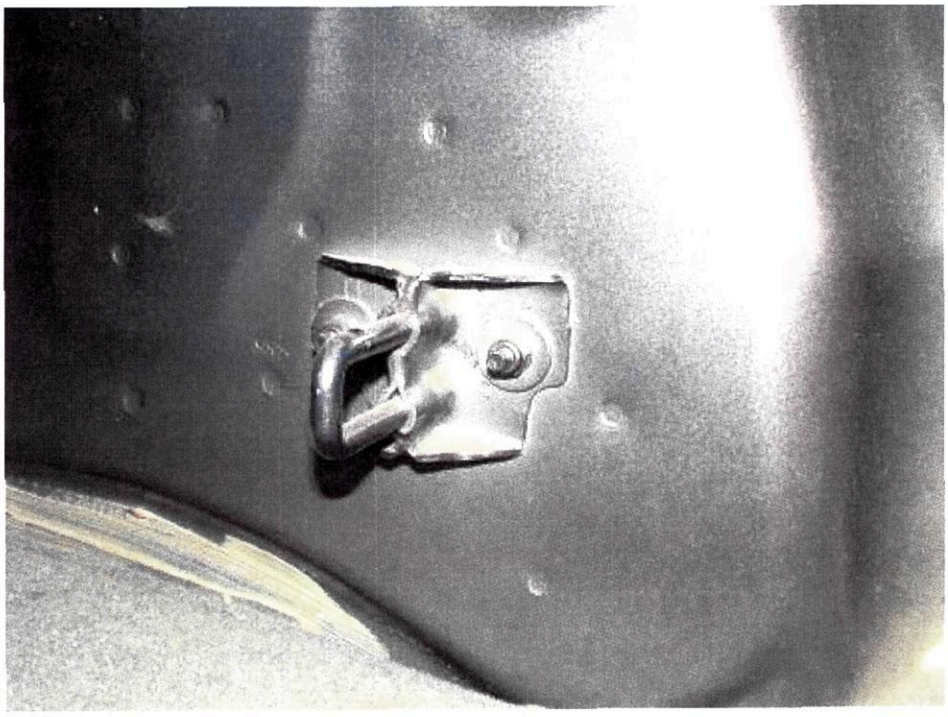
Vehicle #9 VIN: 2FMDA51654BAXXXXX

This vehicle was in a salvage yard and removing the trim panel was not permitted. It exhibited some visible corrosion with the trim panel in place.



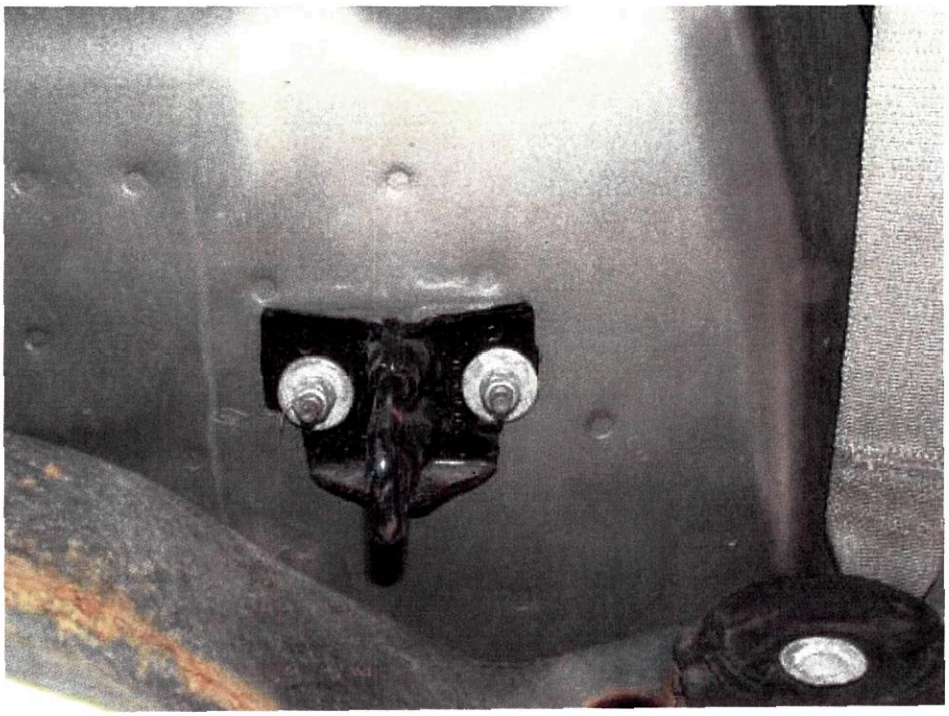
Vehicle #10 VIN: 2FMDA51635BAXXXXX

This vehicle exhibited no corrosion.



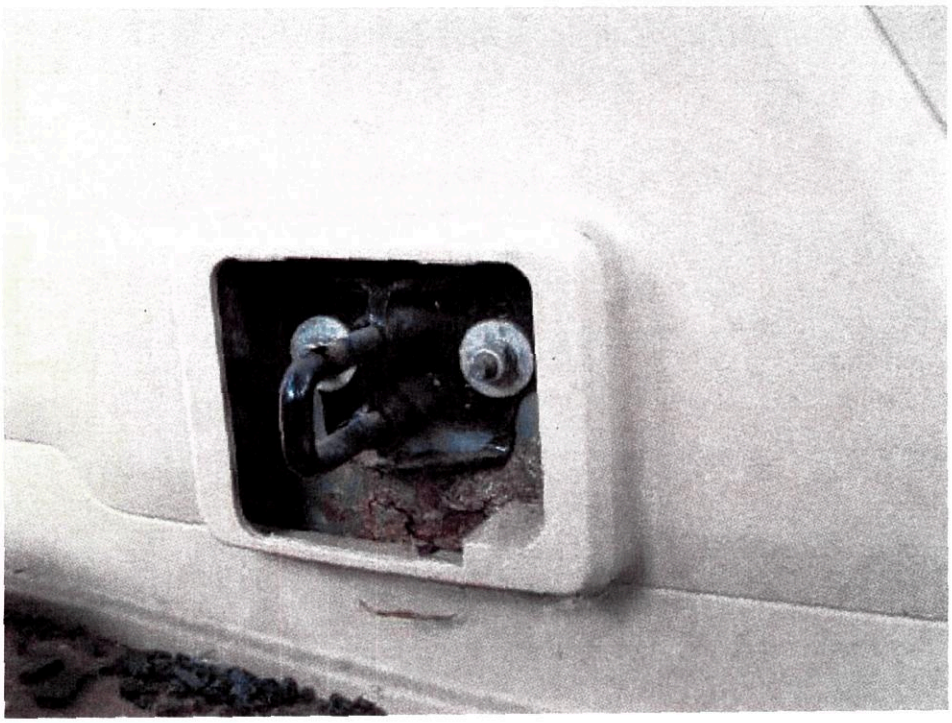
Vehicle #11 VIN: 2MRZA20234BJXXXXX

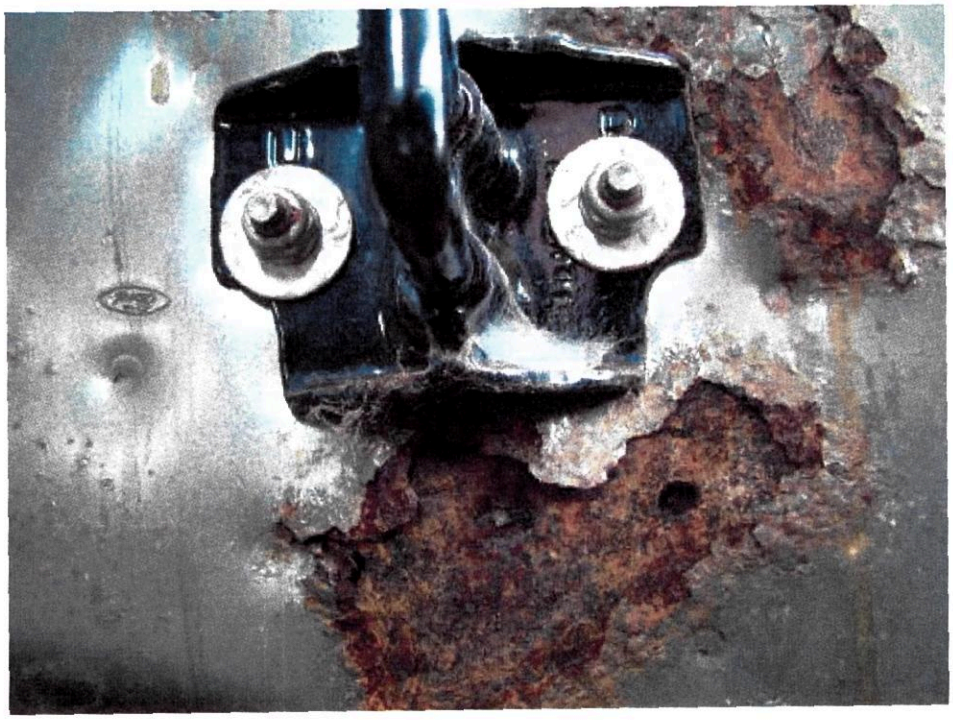
This vehicle exhibited no corrosion.



Vehicle 12 VIN: 2FMZA51674BAXXXXX

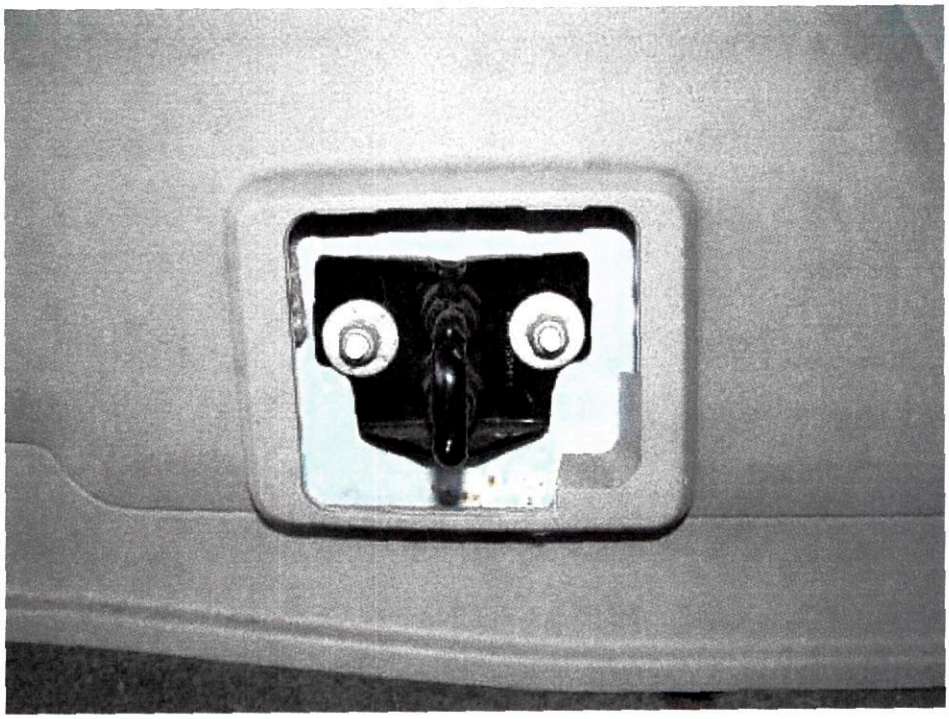
This vehicle exhibited corrosion with the trim panel in place and more so with the trim panel removed.

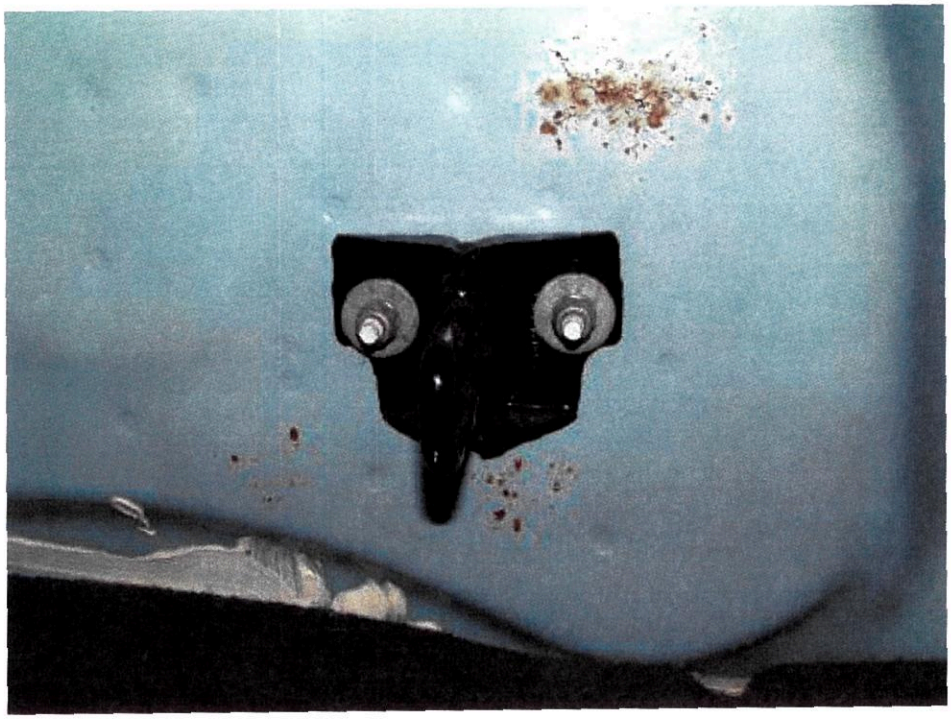




Vehicle #13 VIN: 2FMZA51655BAXXXXX

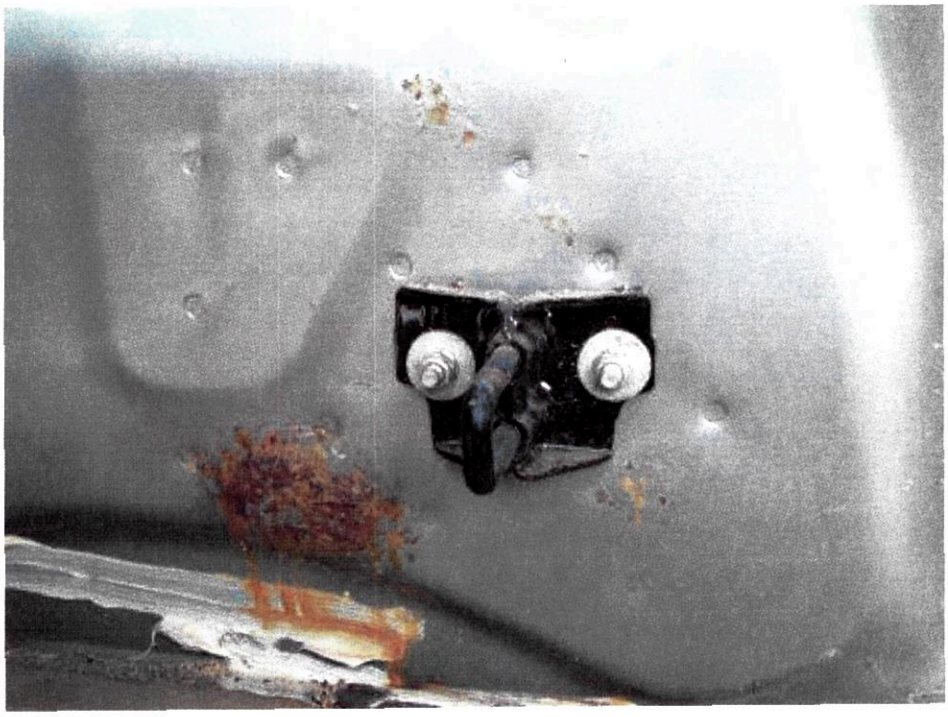
This vehicle exhibited no corrosion with the trim panel in place and only very minor corrosion with the trim panel removed.





Vehicle #14 VIN: 2FMZA57694BAXXXXX

This vehicle exhibited some corrosion on the interior of the occupant compartment and also exhibited a lack of integrity of the undercoating inside the left rear wheel well.

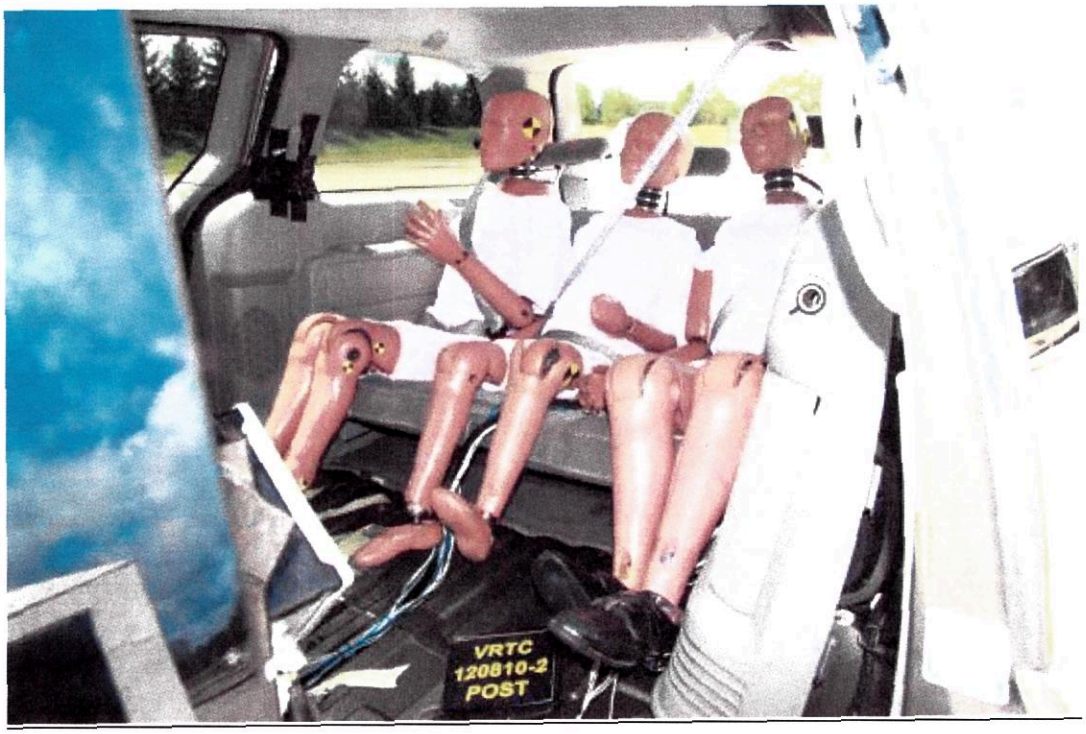


Appendix II

Pre- and Post-Test Photographic Documentation

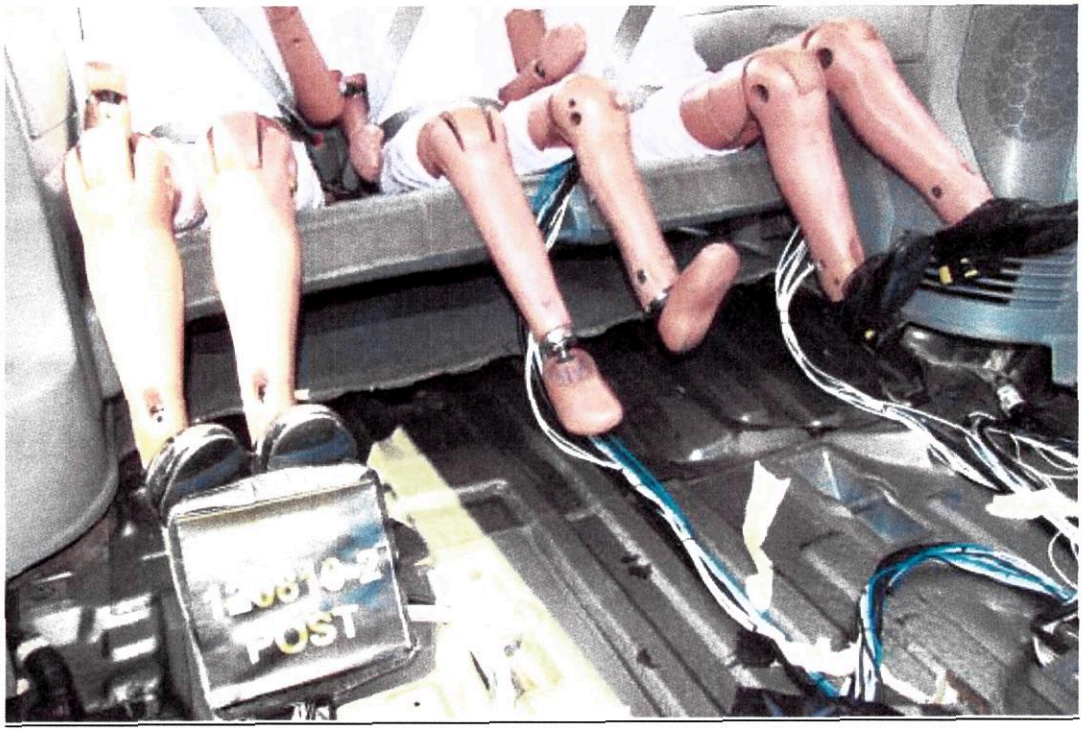
Test 1 - Intact Seat, Head Restraint Up
TRC Test No. 120810-2

Pre-Test Dummy Positioning



Post-Test Dummy Positioning

Test 1 - Intact Seat, Head Restraint Up
TRC Test No. 120810-2



Post-Test Dummy Positioning

Pre-Test

Test 1 - Intact Seat, Head Restraint Up
TRC Test No. 120810-2

Post-Test

Test 2 - Intact Seat – Head Restraint Down
TRC Test No. 120709-1

Pre-Test Condition

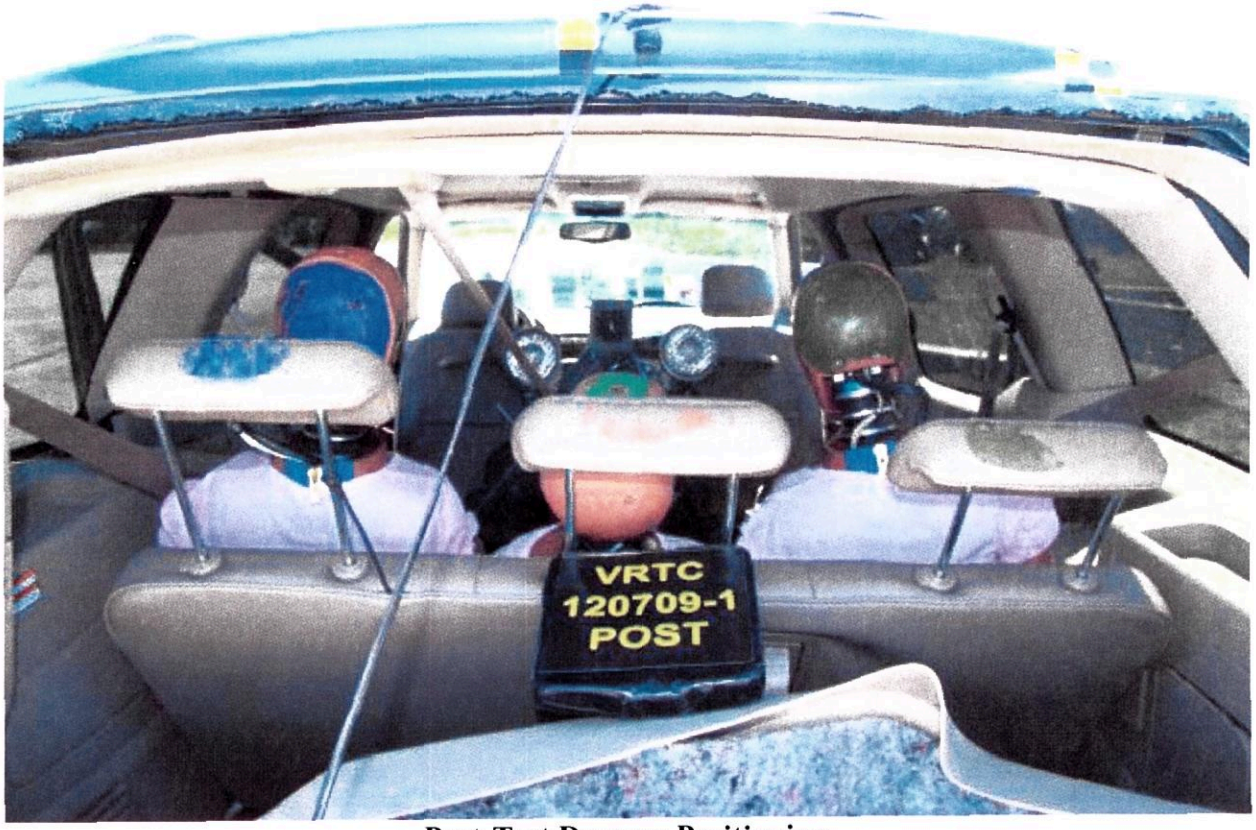
Post-Test Condition

Test 2 - Intact Seat – Head Restraint Down
TRC Test No. 120709-1

Pre-Test Dummy Positioning

Post-Test Dummy Positioning

Test 2 - Intact Seat – Head Restraint Down
TRC Test No. 120709-1



Post-Test Dummy Positioning

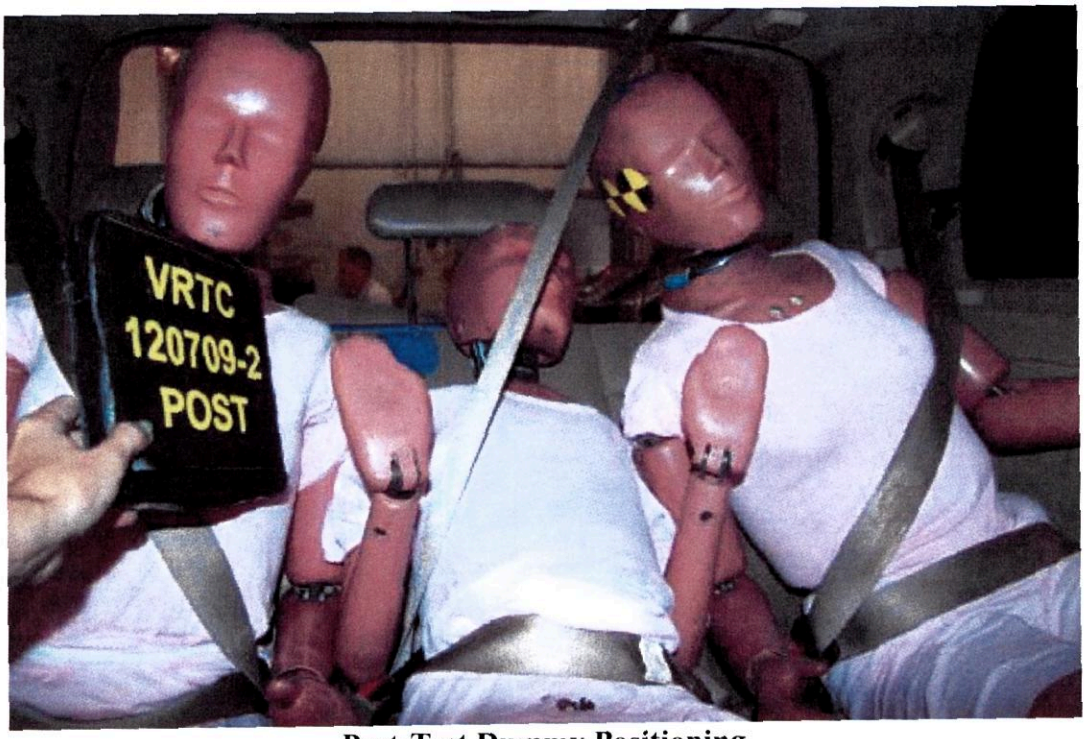
Test 3 - Corroded Seat – Head Restraints Up
TRC Test No. 120709-2

Pre-Test Condition

Post-Test Condition

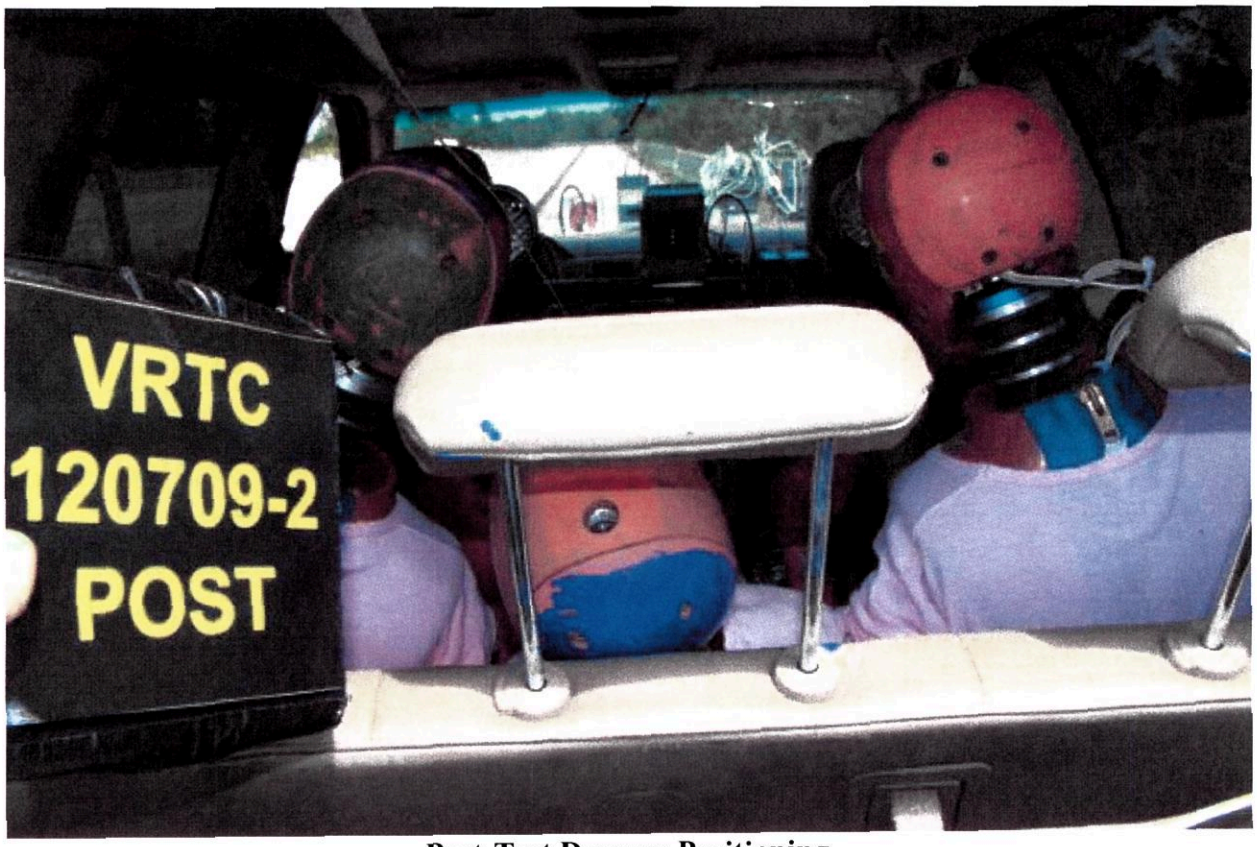
Test 3 - Corroded Seat – Head Restraints Up
TRC Test No. 120709-2

Pre-Test Dummy Positioning



Post-Test Dummy Positioning

Test 3 - Corroded Seat – Head Restraints Up
TRC Test No. 120709-2



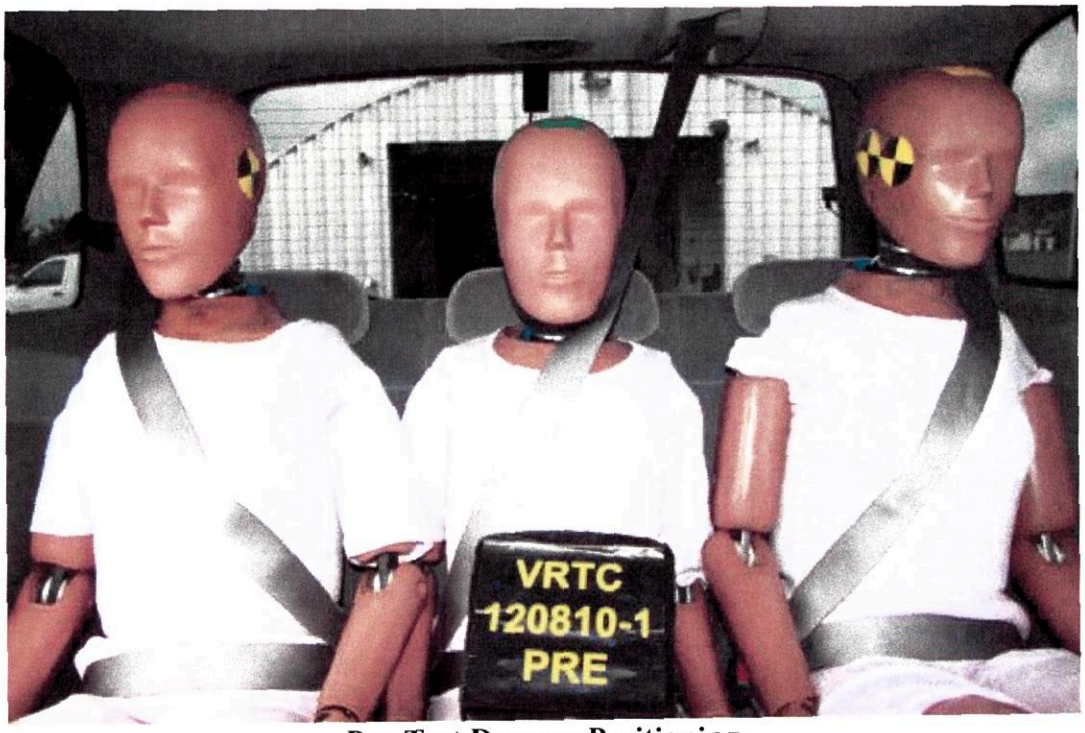
Post-Test Dummy Positioning

Test 4 - Corroded Seat – Head Restraints Down
TRC Test No. 120810-1

Pre-Test Condition

Post-Test Condition

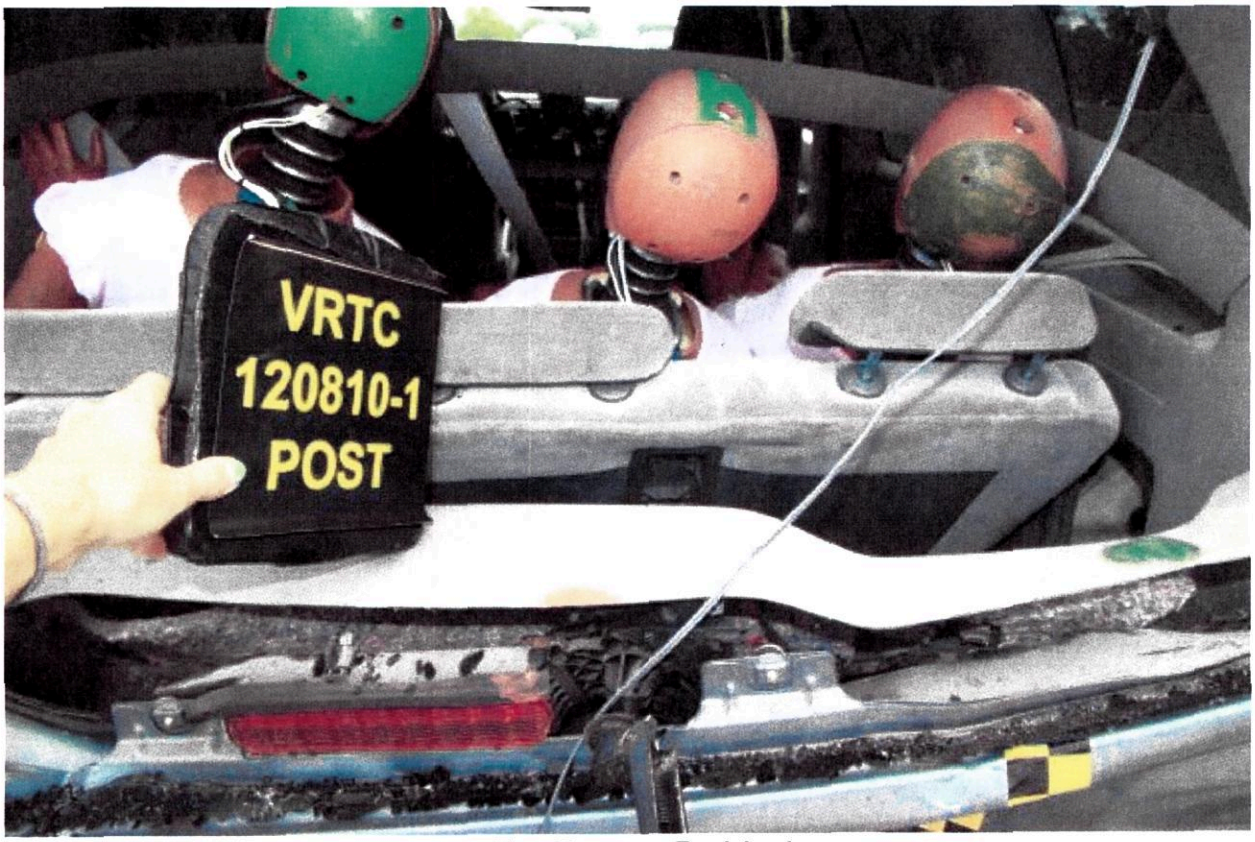
Test 4 - Corroded Seat – Head Restraints Down
TRC Test No. 120810-1



Pre-Test Dummy Positioning

Post-Test Dummy Positioning

Test 4 - Corroded Seat – Head Restraints Down
TRC Test No. 120810-1



Post-Test Dummy Positioning

Appendix III

Analysis of Maximum Head Excursion beyond Plane of Rear Window

RW = Rear Window
RWU = Rear Window Upper
RWL = Rear Window Lower
ToH = Top of Head

Test 120709-1: **Intact seat with head restraints down**
Time of maximum head excursion = 0.167s / 167ms.
RW to ToH at maximum head excursion = 154.94mm / 6.1in.

RW = Rear Window
RWU = Rear Window Upper
RWL = Rear Window Lower
ToH = Top of Head

Test 120810-1: **Corroded seat with head restraints down**
Time of maximum head excursion = 0.191s / 191ms.
RW to ToH at maximum head excursion = 401.782mm / 15.8in.

RW = Rear Window
RWU = Rear Window Upper
RWL = Rear Window Lower
ToH = Top of Head

Test 120810-2: **Intact seat with head restraints up**
Time of maximum head excursion = 0.192s / 192ms.
RW to ToH at maximum head excursion = 180.975mm / 7.1in.

RW = Rear Window
RWU = Rear Window Upper
RWL = Rear Window Lower
ToH = Top of Head

Test 120709-2: **Corroded seat with head restraints up**
Time of maximum head excursion = 0.172s / 172ms.
RW to ToH at maximum head excursion = 339.436mm / 13.4in.