



-U.S. Department
of Transportation
National Highway
Traffic Safety
Administration

ODI RESUME

INVESTIGATION: EA97-023
SUBJECT: Seat Frame Failure
PROMPTED BY: PE97-027
PRINCIPAL ENGINEER: F. Borris

DATE OPENED: 17-JUN-97
DATE CLOSED: 6/1/99

MANUFACTURER: General Motors
MODEL(S): C/K Trucks including C1500, C2500, C3500, K 1500, K 2500, K3500, and Suburban equipped with high back bucket (A95) and 6-way power (AG9) seats
MODEL YEAR(S): 1994-1996
VEHICLE POPULATION: 744,534

PROBLEM DESCRIPTION: The complainants allege that the driver's seat mounting fails allowing the seat to displace

FAILURE REPORT SUMMARY

	ODI		MANUFACTURER	TOTAL
	EA Open	EA Close		
COMPLAINTS:	46	156	219	375
CRASHES:	1	1	5	6
INJURIES:	1	1	4	5
FATALS:	0	0	0	0

DESCRIPTION OF OTHER:

ACTION: The Engineering Analysis has been closed.

ENGINEER: ASD

DIV CHF: Thomas Logan

OFC DIR: [Signature]

DATE

DATE

DATE

SUMMARY: The Office of Defects Investigation has received 375 reports alleging failure of the driver's seat frame which is prone to breakage at the left front attaching point. When this occurs, the seat may tilt away from the riser during accelerating or braking.

(see closing report)

726/3/99

**ENGINEERING ANALYSIS CLOSING REPORT
GENERAL MOTORS C/K SEAT FRAME FAILURES
EA97-023**

BACKGROUND: ODI initiated a preliminary evaluation, PE97-027, on June 17, 1997 after identifying 35 reports alleging failure of seat moorings on 1994-95 General Motors C/K Trucks. The common theme of these reports is excessive movement in the driver's seat often described as a "rocking motion." ODI sent an information request letter to General Motors (GM) which was received on June 24, 1997. GM's response was due by July 31, 1997 but was not received until November 25, 1997 by which time ODI had upgraded its investigation to an Engineering Analysis, EA97-023 on October 31, 1997.

ALLEGED DEFECT: The original equipment installed by the manufacturer (OEM), 6-way power, driver's seat frame breaks without warning at the left-front corner. When this occurs, the seat may tilt away from the riser in a rocking motion. Severe seat deflection could result in the loss of vehicle control.

DESCRIPTION OF SEAT ASSEMBLY: The seat frame is constructed of stamped steel members that are welded to form a rectangular frame (see Figure 1). This frame is covered by a layer of foam and a fabric envelope forming the seat bottom. It is secured to the seat riser at four points by self-tapping bolts (M8 x 1.25). The frame is designed to be utilized in both manual and 6-way power seat applications. At each corner of the seat frame, a pair of weldnuts are spot welded to receive the self-tapping bolts. One of each pair is located outboard and the other is a few inches closer to the center of the seat (inboard). Subject vehicle seats are mounted using the outboard locations on the right side of the frame and conversely on the left side. The front inboard weldnuts, however, are welded to a single layer of steel approximately 0.039" thick whereas all the other weldnut locations are supported by at least 2 layers of steel. The net result is that the seat frame is subjected to asymmetric bending stresses which exceed the yield strength of the OEM seat frame at the left front corner. Stress risers produced by spot welding and surface discontinuities (screw holes, etc.) exasperate the failure.

POPULATION: The subject population consists of model year 744,534 (MY) 1994-1996 General Motors C/K Truck and Suburban vehicles equipped with high-back bucket (A95) or split bench seats (AE7) combined with the 6-way power option (AG9).

<u>Model Year</u>	<u>Population</u>
1994	180,036
1995	267,598
1996	<u>296,900</u>
Total	744,534

COMPLAINTS / INCIDENTS:

TYPE	ODI	GM	TOTAL
OWNER	156	219	375
CRASHES	1	5	6
INJURIES	1	4	5
FATALITIES	0	0	0

WARRANTY: (as of December 22, 1998) According to GM records, 47,687 seat frames have been replaced through it's warranty program. This represents 6.4% of the subject population.

SERVICE BULLETINS: No service bulletins were issued by GM to its dealers that relate to the alleged defect.

DESIGN OR MATERIAL MODIFICATIONS: GM authorized its seat frame supplier to change the material used to construct the seat frame from SAE 850 steel to SAE 950 steel. This change was implemented on February 15, 1996. Prior to this, the supplier made some minor changes to the seat frame which involved eliminating potential stress risers and extending the flange on the seat frame front cross member.

PART SALES: GM records indicate 126,762 C/K truck seat frames were sold to dealers for replacement by GM or its suppliers as of March 1999. This number represents the following part numbers: 12387378 (95-99 MY), 12388923 (94 MY only), 12472585 (95-99 MY), 12549925 (95-98 MY), and 15662329 (94 MY only). As indicated above, some seat frames are applicable to model years outside the scope of this investigation and, therefore, the total sales figure may not be indicative of only the subject population.

FAILURE MODE: The primary failure of the seat frame results from the propagation of stress fractures (cracks) around the left, front weldnut. Eventually, the seat frame can separate from the riser at the precise moment of a number of common events: entering or exiting the vehicle, reaching for a wallet or an object behind the seat, driving over irregular road surfaces such as ramps or potholes, braking or accelerating, or positioning oneself to reverse direction when maneuvering a trailer. In the majority of cases, the seat may displace significantly but not to the extent that the driver may be expected to lose control. However, in some cases involving harsh road inputs and/or larger than average drivers, the seat may recline severely following an initial failure. Depending on the driver's position, arm length, steering wheel position, and other factors, severe cases have been alleged to result in loss of vehicle control.

WARNING: Depending on a number events including human factors, the failure of the seat frame

may occur in one or more phases that have varying degrees of warning:

- Phase 1 - This is the initial separation of the seat frame from the riser. Prior to this event, the driver may or may not experience a gradual increase in the normal deflection of seat during use along with metallic noises as the material around the weldnut fatigues.
- Phase 2 - The seat frame rocks back and forth as the vehicle is accelerated and braked. The driver either chooses to ignore or does not notice the rocking and continues to operate the vehicle for an extended period. Warning is most evident during this phase.
- Phase 3 - This is the catastrophic failure of the seat frame whereas the right front corner separates or the frame distorts to the extent that severe seat displacement occurs.

CRASHES: ODI has identified 6 instances in which the failure of the seat frame is alleged to have caused a loss of vehicle control which resulted in a crash.

VIN/Report No.	MY	MAKE/MODEL	ALLEGATION	REMARKS
1GNFK16K3SJ323272 ODI No. 982509	95	Chevrolet / Suburban	broke while backing from driveway causing collision with snowbank	driver claims injury to neck and back
1GCHC39N8SE124467 Ref. No.960331153	95	Chevrolet / C19	seat fell back while launching a boat; vehicle completely submerged	prior knowledge of seat condition; minor injuries
2GCEC19K5S1218417	95	Chevrolet / C19	seat fell back while accelerating; collided with fire hydrant	prior knowledge of seat condition; minor injuries
1GNFK16K5SJ309227	95	Chevrolet / Suburban	broke while backing from driveway; could not reach brake; hit parked vehicle	no injuries, minor damage parked vehicle
1GTFK29K1SE515079 Ref. No. 9503833502	95	GMC / K29	broke crossing railroad tracks; lost control and drove into ditch	prior knowledge of seat condition; minor injuries
1GTEK19K2RE555459	95	GMC / K19	broke while backing out of driveway; released brake and hit mailbox	no injuries

TESTING: Testing of the seat frame assembly has been conducted by the Vehicle Research and Test Center (VRTC) on ODI's behalf (VRTC-79-0485). These tests were conducted to determine the force deflection characteristics of the seat frame in both the normal and failed conditions. To simulate a failed seat, seat frame specimens were tested with the left front attaching bolt removed. Like previous seat integrity testing performed at VRTC, a static load was applied to the seat back at a point 16 inches above the H-point (see Figure 2). The deflection

was measured as a function of the applied load. A total of 5 seat frames were tested (see Figure 3). Data generated from these tests were compared to previous seat recalls (87V-079, 89V-011 and 89V-170) to determine the potential safety risk.

TEST RESULTS: The chart below shows a comparison between the force deflection data of the worst case subject vehicle test specimen and data collected from test specimens of the previously mentioned seat recalls. The worse case test specimen came from a 1994 MY C/K truck and is designated as test specimen "94-01."

	EA97-023/94-01	89V-011	89V-170	87V-079
Load (lbs.)	Seat Deflection in Inches			
0	0	0	0	0
20	1.2	1.0	2.0	2.5
40	2.0	1.9	2.8	5.1
60	2.9	3.3	4.5	6.0
80	3.7	4.6	7.8	7.5
100	4.4	6.2	8.9	9.3
120	5.3	9.8	10.4	10.8

MANUFACTURER'S POSITION: GM provided the following response in its letter dated November 25, 1997:

"...Some 1995 and 1996 C/K trucks equipped with high back bucket seats (A95) and 6-way power driver's seats (AG9) may exhibit breakage of the driver's seat cushion at the left front mounting to the power seat track assembly. If this breakage were to occur, the driver would experience a pronounced looseness. If the driver ignores this looseness and continues to operate the vehicle, over an extended period it would be possible for the seat frame to eventually break at the right front mounting to the power seat track assembly. When General Motors reviewed this matter, we were aware of one allegation of breakage at both front mountings points. This report was not confirmed. Given the pronounced warning to the driver and that this warning would have to be ignored for quite some time before the right side mounting would break, General Motors concludes that this condition does not pose an unreasonable risk to safety."

ANALYSIS: The OEM seat frame design is inadequate to meet its intended purpose. Over 47,000 have been replaced under warranty (6.4%) and many complainants reported having to bear the costs of seat frame replacement. This fact and the sales data indicate that the actual number of failed seats is probably much higher than indicated by complaints. However, despite these numerous incidents of seat failure, there have been relatively few confirmed cases where the failure of a seat frame without adequate warning resulted in loss of vehicle control. Of the 6 cases

of seat frame failure alleged to have caused a crash, 3 include some indication that the owner was aware, prior to the incident, that the seat integrity was substandard.

The tests results indicate that at a load of 100lbs., the worst case test specimen deflects 45.9% less (on average) than previously recalled seats. This supports ODI's position that the initial separation of the seat frame from the riser is not expected to cause significant displacements resulting in loss of vehicle control. The test results are depicted graphically in Figure 4.

The overall complaint rate is approximately 50/100K and the crash rate is 1.1/100K for the 1995 MY for those cases without any indication of prior knowledge of a substandard seat frame. This crash rate is further reduced (0.40/100K) if the entire subject population is taken into account.

ODI continues to receive reports of seat frame failure in the subject vehicles, however, the rate is declining rapidly. Only 5 reports have been received in calendar year 1999 as compared to 33 at the same time in 1998. A complaint history is depicted in Figure 5.

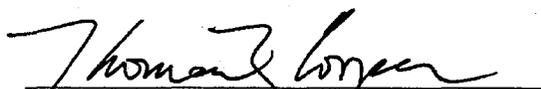
SUMMARY:

- ▶ the driver's seat fails at the front left corner
- ▶ the initial failure produces detectable looseness but does not generally result in loss of control (as reported by complainants)
- ▶ ignoring warning may lead to failure of right front corner where material thickness is double the left front corner
- ▶ of 6 reports alleging failure of seat frame caused loss of control, 3 complainants acknowledged looseness of the seat.
- ▶ testing shows deflection of a failed seat is less than deflection of previous recalled seats

REASON FOR CLOSING: A safety-related defect trend has not been identified at this time and further use of agency resources does not appear to be warranted. The closing of this investigation does not constitute a finding by NHTSA that no safety-related defect exists. The agency reserves the right to take further action if warranted by the circumstances.


Safety Defects Engineer

6/1/99
Date


Chief, Vehicle Integrity Division

6/1/99
Date


Director, Office of Defects Investigation

6/1/99
Date