

ENGINEERING ANALYSIS CLOSING REPORT

SUBJECT: Intermediate Steering Shaft Binding

EA No.: EA08-017

OPENED DATE: 28-Aug-2008

CLOSED DATE: 01-Jul-2009

SUBJECT VEHICLES: Model Year (MY) 2002 through 2004 Kia Sedona minivans sold or registered in salt-belt states.¹



Figure 1. Model Year 2004 Kia Sedona

BASIS: On April 28, 2008, the Office of Defects Investigation (ODI) opened Preliminary Evaluation PE08-033 to investigate alleged complaints of steering binding in MY 2002 through 2004 Kia Sedona minivans. At the conclusion of PE08-033 the complaint rates per 100,000 vehicles were 187 in salt-belt states and 29 in non-salt belt states. The warranty rate for replacement of the steering intermediate shaft (SIS) was 5.5 percent for vehicles sold in the salt belt and 0.5 percent for all others. Based on this information, the investigation was upgraded to an Engineering Analysis (EA08-017) on August 28, 2008.

COMPONENT DESCRIPTION: The steering intermediate shaft (SIS) allows for connection of the primary steering column/shaft and the power steering rack input shaft. Because of the change in angle required, the SIS is equipped with a universal joint (Figures 2). This universal joint allows for off-axis rotation and allows steering wheel hand forces to smoothly apply torque to the steering rack input shaft.

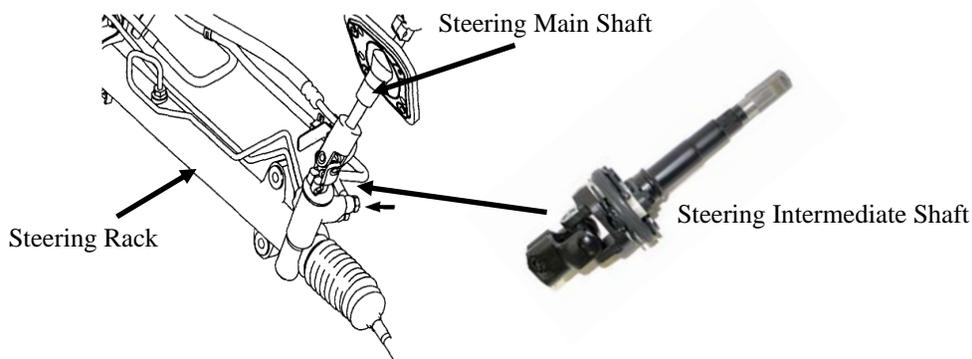


Figure 2. Component detail – Steering Intermediate Shaft.

¹ For purposes of this investigation the “Salt Belt” includes Connecticut, Delaware, the District of Columbia, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia and Wisconsin.

ALLEGED DEFECT: The steering intermediate shaft universal joint bearings may corrode over time (Figure 3), which can result in increased steering effort – particularly during initial steering maneuvers after the vehicle has been parked over night or longer.



Figure 3. Corroded SIS universal bearing.

FAILURE EFFECTS: Drivers may experience increased steering effort, particularly at low speeds after a cold start. Over a period of time the condition may also be associated with some noise such as clicking or rattling, which indicates the need for service. In extreme cases, steering response can be slow to return to neutral or can exhibit increased steering effort when coming out of a sharp turn.

FAILURE MECHANISM / CONTRIBUTING FACTORS: The primary contributing factor to the alleged defect is the loss of lubrication due to failure of the SIS universal bearing cap seals. Failure of the seals allows water to intrude into the bearings which then corrode and over time will lead to increased steering effort. Exposure to de-icing materials (road salt) will cause the bearings to degrade faster.

VEHICLE POPULATION:

Region	MODEL YEAR			Total
	2002	2003	2004	
Non-Salt Belt	28,954	29,201	32,026	90,181
Salt Belt	20,777	22,314	21,115	64,206
Total	49,731	51,515	53,141	154,387

Table 1. MY 2002 through 2004 Kia Sedona sales by region and model year.

FAILURE REPORT SUMMARY: ODI has identified 145 complaints to ODI and Kia and 3,757 warranty claims for SIS repairs for MY 2002 through 2004 Kia Sedona vehicles in salt-belt states.

Problem Experience	EA Opened			EA Closed		
	ODI	Kia	Total	ODI	Kia	Total
Owner Reports / Field Reports	6	111	117	14	131	145
Claims/Lawsuits	-	0	0	-	0	0
Injury Incidents	0	1	1	0	1	1
Fatal Incidents	0	0	0	0	0	0
Warranty Claims	-	3,418	3,418	-	3,757	3,757

Table 2. Complaints and Warranty Claims in salt belt states.

WARRANTY: ODI’s analysis of warranty claim data provided by Kia show that the alleged defect has occurred predominantly in salt-belt states, which account for less than half (41.5 percent) of the MY 2002 through 2004 Kia Sedona sales but 86.2 percent of warranty claims. The claim rate in salt belt states (5.9 percent) is almost an order of magnitude greater than in non-salt belt states (0.7 percent). Analysis of the data shows that on average a steering shaft is replaced at 42 months or 45,000 miles of service.

ODI’s analysis of the 1,231 claims that included owner comments found that the most frequent complaint was for hard or stiff steering (Figure 4). Approximately 18% of these claims were related to some other power steering problem, like “steering rack replacement” or “leaking fluid”. Note also that the sum of categories are greater than 100 percent, since many claims are counted in more than one category (e.g., claims for binding, stiff or hard steering also claim noise or “Other” comments)².

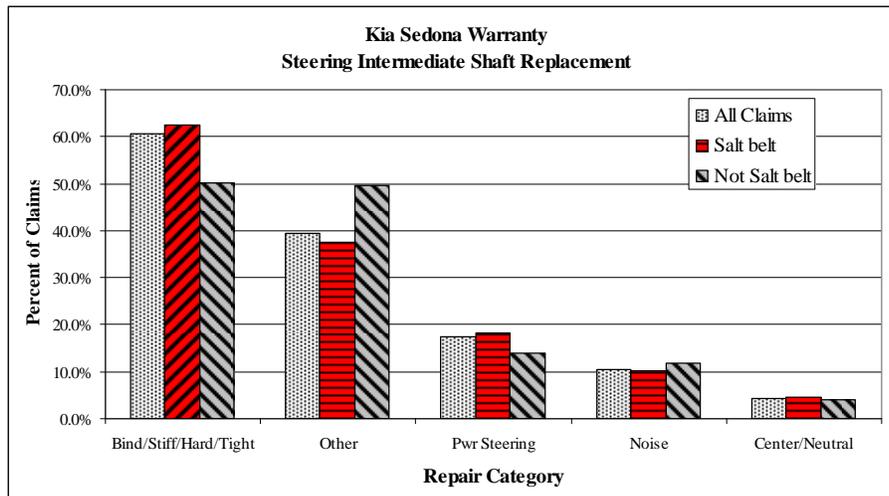


Figure 4. Sedona warranty by complaint category.

COMPONENT DESIGN CHANGES: In its response to ODI’s information request, Kia indicated that concerns with binding of the steering intermediate shaft were first identified and investigated in August 2002, in vehicles sold in Indonesia. Kia’s investigation resulted in the addition of stiffening ribs to the bearing cap seals. In June 2003, Kia again investigated owner complaints of steering noise and higher than normal steering resistance and in October and November of 2003 design changes to the shaft universal joint bearings were made to improve lubricant retention and to eliminate water intrusion that could lead to early bearing failure.

TESTING: NHTSA’s Vehicle Research Test Center (VRTC) conducted testing to assess the effects of the alleged defect on steering effort when nearly stopped (parking lot maneuvers) and during dynamic turning/cornering³. The testing consisted of a series of static steering tests to determine the baseline hand wheel forces required for a NEW vs. BAD steering shaft and several on road driving tests including the “worst case” engine off, no power steering assist operating. The dynamic tests were conducted using a MY 2004 Sedona instrumented and continuously monitored for hand wheel forces, speed and lateral acceleration. The tests were conducted by driving a simulated mix of daily conditions and a slalom course used to measure hand wheel force as a function of lateral acceleration (turning speed). For the first test, the simulated mix road driving with the normal steering shaft hand wheel forces for all conditions varied from 1.0 to 3.0 lbf, and with the bad steering shaft forces

² Most warranty claim notes contain more than one category of claim like “Noise” and “Power steering went out”.

³ Refer to the VRTC final report in the document file for EA08-017.

varied from 1.0 to 5.0 lbf. In a second test, after remaining at rest for several days, the vehicle was driven through the same slalom course as the previous test. With the engine off, considered the “worst case” condition, transmission in neutral and coasting down from a straight-line speed of 40 mph the vehicle hand wheel forces were measured. For this case, engine off, no steering assist the maximum gain (percent increase in effort) occurred at 0.1 lateral g and steering the force increase was 5.0 lbf to 6.0 lbf (20% change). The results for all conditions are shown in Table 3.

VRTC Dynamic Steering test			
Lateral acceleration (g's)	Hand wheel force (lbf)		Gain (%)
	New Shaft	Bad Shaft	
0.1	5	6	20
0.2	16	16	0
0.3	24	25	4
0.4	30	32	7

Table 3. Dynamic steering gain forces.

MANUFACTURER’S TESTING AND EVALUATION: During PE08-033 Kia conducted various tests to assess the effects of the alleged defect on steering efforts⁴. These tests included static parking tests, dynamic steering effort evaluation in a slalom course and stalled vehicle testing to assess efforts with both the subject condition present and a loss of power steering assist (i.e., dual failure mode). The static parking effort tests were conducted to measure the steering effort required at very low speeds for four warranty returned intermediate shafts exhibiting the subject condition. Steering wheel hand forces were approximately doubled in the worst field return part (10 lbf) in comparison to a new part (4.5 lbf). For all field return parts tested, torque resistance ranged from 4.7 lbf to 10.3 lbf, with an average resistance of 7.0 lbf. Only 1 of the 4 returned parts had a steering force higher than the Kia target for a new part (8.8 lbf). Vehicle dynamic steering effort testing showed that the driver was able to steer through a slalom course without difficulty at all speeds. The maximum steering effort measured in the stalled vehicle testing was 33 lbf. Kia concluded that under no foreseeable driving conditions would the binding of the SIS result in the failure of a driver to steer the vehicle safely.

TECHNICAL SERVICE BULLTIN: Kia issued technical service bulletin TSB-CHA-019, “Sedona (GQ) Increased Steering Effort,” in October 2008, to provide dealers with instructions for diagnosing and repairing the alleged defect condition in the subject vehicles. The bulletin states that in areas where road salt is used, if a customer complains of increased steering effort or noise while steering the steering intermediate shaft should be checked and or replaced to address the concern.

REASON FOR CLOSING: ODI’s analysis of warranty data shows that the alleged defect has occurred at a relatively high frequency in salt-belt states (5.9 percent). However, the tests conducted by ODI and Kia have shown that the alleged defect has a minimal effect on steering efforts. In addition, ODI interviews of owners who experienced the alleged defect showed that in most cases the problem was preceded by months or years of noise or a gradual increase in steering efforts and was more of a nuisance concern.

⁴ See PE08-033 Public File “MFR IR SUPPLEMENTAL RESPONSE LETTER *9/10/08*p” for Kia’s test results.

There has been one allegation of a minor crash related to the alleged defect, involving a MY 2003 Kia Sedona with 59,900 miles. The vehicle had been checked twice in the previous nine months by a dealer for complaints of "stiff" steering and that the vehicle felt like it was intermittently losing power assist. The crash occurred as the driver was attempting to make a left turn while traveling at approximately 20 miles per hour and struck a vehicle parked on the right side of the street that the vehicle was turning into. The crash resulted in minor injuries to the driver. After the crash it was determined that the intermediate shaft was exhibiting some binding of the SIS bearings. While the absence of additional crashes or injuries does not mean that there is not a safety-related defect, there have been no reported additional crashes caused by the alleged defect in the past three years. The release of the technical service bulletin should assist service personal in diagnosing this potential problem long before it becomes potentially dangerous.

Accordingly, this investigation is closed. The closing of this investigation does not constitute a finding by NHTSA that a safety-related defect does not exist. The agency will continue to monitor complaints and other information relating to the alleged defect in the subject vehicles and take further action in the future if warranted.

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