



U.S. Department
of Transportation

National Highway
Traffic Safety
Administration

ODI RESUME

INVESTIGATION: EA99-013

DATE CLOSED: 10-AUG-01

SUBJECT: Post-Collision Fuel System Integrity

DATE OPENED: 11-Jun-99

PROMPTED BY: PE99-010

PRINCIPAL ENGINEER: Jun 99 - Mar 01, J. Quandt; Mar 01-Aug 01, T. Cooper

MANUFACTURER: DaimlerChrysler Corporation

MODEL(S): NS-Minivans (Dodge Caravan/Grand Caravan; Plymouth Voyager/Grand Voyager; Chrysler Town and Country)

MODEL YEAR(S): 1996-2000

VEHICLE POPULATION: 2,774,470

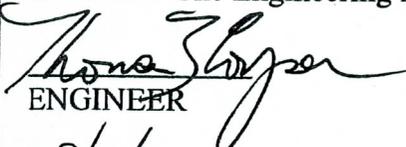
PROBLEM DESCRIPTION: Collision-induced damage to the filler neck assembly leading to fuel leakage or fire.

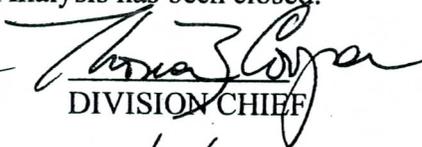
FAILURE REPORT SUMMARY

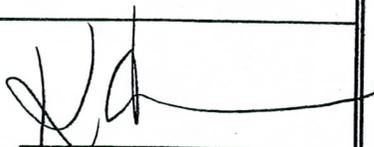
	ODI	MANUFACTURER	TOTAL
COMPLAINTS:	2	3	5
CRASHES:	2	3	5
BURN INJ CRASHES:	0	0	0
# INJURIES:	0	0	0
BURN FATAL CRASHES:	1	1	2
# FATALS:	2	3	5
OTHER:	3	0	3

DESCRIPTION OF OTHER: FMVSS 214/SINCAP left-side impact tests resulting in filler neck assembly leakage.

ACTION: The Engineering Analysis has been closed.


ENGINEER


DIVISION CHIEF


OFFICE DIRECTOR

8/10/01
DATE

8/10/01
DATE

8/10/01
DATE

SUMMARY: This investigation is closed. Further investigation would not likely produce evidence sufficient to demonstrate the existence of a safety-related defect. 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 new or changed circumstances.

(continued next page)


8/10/01

Background: On February 3, 1999, ODI opened a Preliminary Evaluation (PE99-010) following a filler neck separation incident in a Federal Motor Vehicle Safety Standard (FMVSS) No. 214, "Side impact protection," compliance test of a model year (MY) 1999 Dodge Caravan (short wheelbase). The test, conducted by MGA Proving Ground in Burlington, Wisconsin for NHTSA's Office of Vehicle Safety Compliance (OVSC), was performed on January 5, 1999. The filler neck separation allowed approximately 11 gallons of test fuel (Stoddard solvent) to leak from the vehicle's fuel tank. The vehicle's fuel tank has a 20 gallon capacity and was filled with 18.43 gallons of Stoddard solvent for the test in accordance with the procedures of FMVSS No. 214.

Prior to this, on December 18, 1998, NHTSA had tested a MY 1999 Dodge Grand Caravan (long wheelbase) under the Side Impact New Car Assessment Program (SINCAP), which resulted in trace leakage from a small split in a plastic segment of the filler vent tube.

On June 11, 1999, ODI upgraded the preliminary evaluation to an Engineering Analysis (EA99-013). On January 6, 2000, a second filler neck separation incident occurred in a SINCAP test of a MY 2000 Dodge Caravan.

The NS-body DaimlerChrysler minivan was introduced in MY 1996 and production continued through MY 2000. Prior to 1996, DaimlerChrysler produced its minivans on the AS-body platform. The earlier AS minivans do not share the same filler neck assembly design as the subject NS minivans. The fuel filler tube on the AS minivan is a one-piece steel tube connected to a metal fuel tank by a rubber grommet. The filler tube on the NS minivan is a steel tube connected to a plastic fuel tank by a 5-inch rubber hose. A more detailed description of the NS fuel system design is provided below.

System Description: The subject filler neck assembly is routed from the filler door through the forward portion of the left-rear wheelhouse. A plastic liner covers the assembly in the wheelhouse. The assembly extends forward from the bottom of the wheelhouse, through a space between the inner sill wall and the left rail structural member, to the fuel fill and vent fittings of the fuel storage tank (See Figure 1). The tank is mounted inboard of the left rail structural member forward of the rear axle. The filler neck assembly consists of the fuel filler tube and the fuel tank vent tube. A 5-inch long rubber hose (painted green in Figure 1) connects the steel filler tube (yellow) to a 1.6 inch, inner diameter high-density polyethylene (HDPE) nipple or spud (orange/red) on the side of the tank. The hose extends over the spud about 1 $\frac{3}{4}$ inches and over the steel tube about 1 $\frac{3}{4}$



Figure 1 Filler hose connection to fuel tank

inches. The rubber hose is secured to the filler tube and tank spud by standard worm drive type hose clamps (see Figure 2).

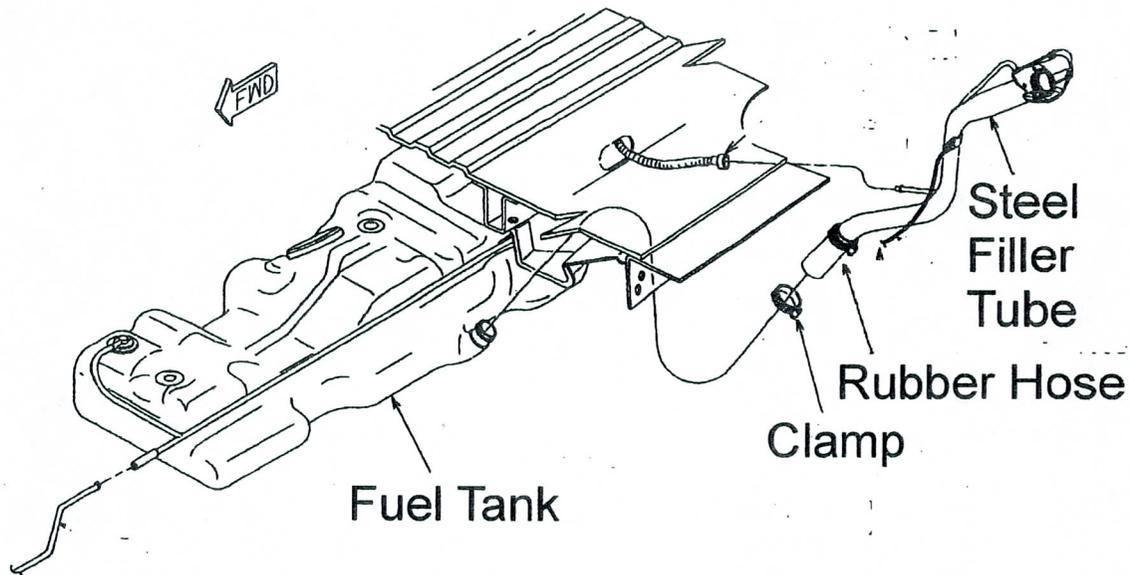


Figure 2 Fuel tank and filler pipe

Several aspects of DaimlerChrysler's design of the filler neck assembly for the subject minivans contribute to an overall lack of robustness in the design to withstand either a high tensile load or significant displacement input during a moderate to severe crash. This is confirmed by NHTSA's evaluation of data collected from other manufacturers of minivans (NHTSA sent peer information request letters to five other manufacturers to obtain information about their filler neck assembly designs). For example, the rubber hose connected to the fuel tank inlet is significantly shorter than the hose on other peer minivans (giving rise to higher tensile load for a given amount of displacement), and the bead on the tank spud (which provides resistance to pull-off force) is ramped with a shallower angle than peer minivans. The location of the filler neck assembly and the surrounding vehicle structure does not isolate the filler neck from crash forces as well as other minivans. For this reason, the filler neck assemblies of some other minivans will experience less loading and displacement on the filler neck during a crash. Also, DaimlerChrysler did not reinforce the tank spud on the subject minivans with a metal liner, as some other manufacturers did on their minivans, which would have reduced compression deformation of the tank spud during high tensile loading. Finally, DaimlerChrysler does not have performance specifications for the minimum pull-off force of the rubber hose from the filler pipe or fuel tank spud as do some other minivan manufacturers, and the company did not test the capability of the hose to withstand such a force during development of the subject minivans.

Crash Reports:

DaimlerChrysler has provided the following information to NHTSA concerning complaints of fuel spillage or fire arising out of left side collisions into the subject minivan in the vicinity of the fuel tank.

1. Name:

Date of Incident: 5/8/99

Location: Milford, Ohio

Vehicle: 1999 Plymouth Grand Voyager

VIN: 2P4GP24G6XR196325

Fire: Yes

Casualties: 2 - Non-burn trauma

Summary: DaimlerChrysler reports the Voyager was traveling at low speed through an intersection and was impacted by a full sized pickup truck traveling at 55 mph. The point of impact was "perpendicular to the left side from the trailing edge of the driver's door extending back to about the filler cap area." Both occupants of the Voyager, driver and front seat passenger, received injuries. Chrysler's Vehicle Fire Investigation Report indicates the driver noticed "fire outside the van on the left rear and after getting out saw burning fuel leaking from tank." The fire continued about 20 minutes until the fire department arrived to extinguish the flames. DaimlerChrysler believes the fuel from the fuel tank did not start the fire. The plastic fuel tank is melted/burned at the area of the filler pipe connection and the rubber filler hose was consumed. It is not known whether the filler hose disconnected initially at impact or whether the rubber connecting hose was consumed during the spread of the fire, fueled by the release of flammable liquid from another source on the vehicle.

2. Name:

Date of Incident: 5/27/99

Location: Dortches, NC

Vehicle: 1999 Grand Caravan VIN: 2B4GP44R8XR221644

Fire: No

Casualties: 1 - Non-burn trauma

Summary: DaimlerChrysler reports that the subject vehicle "was struck as it pulled out of a gas station by a full size 4-door sedan traveling at a reported 40 mph." The impact was to the left rear door of the minivan and the "fuel filler steel tube separated from fuel filler rubber hose, and hose was still secure on plastic tank nipple." Gas leaked from the minivan; however, no fire occurred. The vehicle was occupied by the driver and right front passenger. DaimlerChrysler's report indicates the passenger suffered facial cuts and no injury is mentioned for the driver.

3. Name:

Date of Incident: 8/22/98

Location: Crockett County, Texas

Vehicle: 1998 Dodge Grand Caravan

VIN: 2B4GP4439WR659485

Fire: Yes

Casualties: 3 - Fatal burn injuries

Summary: DaimlerChrysler is a defendant in a lawsuit alleging that the gas tank is "in a location that would cause a fire if it hit another vehicle or object during a crash." The incident involves a single vehicle crash in which the subject van was traveling on an

interstate highway, its speed estimated to be between 70 and 80 mph. The police report indicates the van departed the roadway into the left median, impacted the end of a guardrail, rolled 1/4 turn on its left side and spun across the highway striking another guardrail, became upright again, skidded backwards catching fire prior to coming to a rest on the right side of the highway. Two occupants were fatally burned.

ODI reviewed its complaint data base and the NASS (National Automotive Sampling System) for crashes involving the subject vehicles that appeared to be related to the alleged defect. From this review, ODI has identified the following crash reports.

1. Name:

Date of Incident: 8/19/99 Location: Roseburg, Oregon

Vehicle: 1996 Chrysler Town and Country VIN: 1C4GP55L7TB504242

Fire: Yes Casualties: 2 - Fatal burn injuries

Summary: The subject van was impacted on the left side by a full-size van at a speed of about 50 mph. The impact crushed the left side driver's and passenger's doors and broke the left wheel hub from the axle. A intense fire consumed the vehicle. The two occupants, a driver and a front passenger were killed. NHTSA's Special Crash Investigation report indicates the subject vehicle caught on fire as it came to rest from the impact. An off duty policeman broke through the passenger side window, observed the driver was not moving and while attempting to remove the passenger, heard the passenger utter a couple of words, but was not able to remove the passenger and was driven back by the flames. The fire deformed or consumed the plastic fuel tank and rubber hose connecting the spud on the tank to the metal filler pipe. Examination of the metal fuel filler pipe revealed a deformation pattern very similar to the pattern exhibited in the 214 and SINCAP tests.

2. Name:

Date of Incident: 5/7/99

Location: Horsham, Pa

Vehicle: 1996 Plymouth Voyager

VIN: (first 10 characters) 2P4GP4531T

Fire: No

Casualties: 1 - Non-burn trauma

Summary: The subject vehicle was impacted in the left side by a 1994 Dodge 3/4 ton pickup truck. The NASS reconstruction case report (#1999-005-052) indicates that the impact crushed the left side of the van from the rear portion of the driver's door to above the left rear wheel housing. The filler hose separated from the fuel tank inlet. The posted speed limit for the pickup truck was 45 mph, but police report does not provide a speed estimate of the truck at impact. The NASS investigator reported crush measurements and computed a delta V for the Voyager that indicates the impact was more severe than the 214/SINCAP tests.

Fatality Analysis Reporting System (FARS): The FARS is a near census of all fatal crashes occurring on public highways in the United States.

ODI examined the 1995 through 1999 FARS data files to provide a comparison of the real-world performance of the subject minivans to other MY 1996 and newer minivans. The other minivans included:

- 1996-97 Ford Aerostar
- 1996-00 Ford Windstar
- 1996-00 GM Astro/Safari
- 1996 GM APV Van
- 1997-00 GM U-Van
- 1999-00 Honda Odyssey
- 1996-00 Mercury Villager/Nissan Quest
- 1996-00 Mazda MPV
- 1996-97 Toyota Previa
- 1998-00 Toyota Sienna
- 1996-00 VW Eurovan

ODI obtained counts of fatal crashes and fires by primary damage area: filler neck side, front, rear, opposite side, unknown, and total. For the period of time covering calendar years 1995 through 1999, the subject minivans are reported in 11 fires out of a total of 705 fatal crashes yielding a fire/crash ratio of 11/705 or 1.6%. Non-subject peer minivans are reported in 20 fires out of 791 crashes yielding a fire/crash ratio of 2.5%. (The individual fire/crash ratio of non-subject minivans – excluding those having only one crash fire – ranges from 1.0 to 5.7%)

For fires and crashes where the primary damage area is the filler neck side of the vehicle, the subject minivans are reported in 2 fires out of 65 fatal crashes for a ratio of 3%. Non-subject minivans are reported in 1 fire out of 66 crashes for a ratio of 1.5%. The two subject minivan fatal fire crashes are described above, in the Roseburg, Oregon crash and the Crockett County, Texas crash.

Five-State File Analysis: ODI examined the state crash data files for five states: Florida, Maryland, Ohio, Pennsylvania and Utah for the calendar years 1995 through 1998. NHTSA gets electronic data from 17 states. Only 8 contain decoded Vehicle Identification Numbers for all crashes. Data from three states, Missouri, New Mexico and North Carolina were not useful for analysis based on insufficient fire data and erroneous coding of fire data. Using the five-state data, the frequency of fires to crashes was essentially the same for the subject minivans and the group of all other minivans. This result was found for all crashes as well as for impacts only to the filler neck side of the minivans.

Automobile Club of Southern California (Auto Club): ODI contracted with the Auto Club to identify fuel leaks or fires in left side impacts to the subject minivans. The Auto Club has a large

database consisting of crash repair records for members who insure a subject minivan with the Auto Club. It reviewed every claim from September 1995 to May 15, 2000. The Auto Club identified 973 collision claims (for impact damage to any part of the vehicle) of \$1,000 or greater on the subject minivans. These included 65 crashes with an impact to the left side of a subject minivan from behind the driver's door to in front of the rear bumper. The crash claims to the left side contained no reports of fire or indication of a fuel leak.

Compliance with Safety Standards: Federal Motor Vehicle Safety Standard (FMVSS) No. 301, "Fuel system integrity" specifies requirements for the integrity and security of a vehicle's fuel system in front, rear and lateral barrier impact crash tests. The fuel loss may not exceed one ounce per minute both during and following these barrier crash tests. The lateral impact test is performed by impacting a test vehicle on either side of the vehicle using a flat faced barrier weighing 4,000 pounds, traveling at 20 mph in a direction perpendicular to the side of the test vehicle. The center of the barrier face contacts the side of the test vehicle on a line perpendicular to the test vehicle that passes through the driver's seating reference point. DaimlerChrysler certified that the subject minivans meet FMVSS No. 301 side impact requirements based on tests performed during 1995 and later.

As described in the background section above, the opening of this investigation was triggered by results from NHTSA testing of a subject minivan to measure compliance with FMVSS No. 214, "Side impact protection." The vehicle satisfied the requirements of that standard, in that the injury readings on the anthropomorphic dummies were below the maximums allowed by the standard. Although the procedures of FMVSS No. 214 require a test vehicle's fuel tank be filled with Stoddard solvent, the criteria for measuring compliance does not specify any limitation for unacceptable amounts of fuel leakage. Consequently, leakage of Stoddard solvent during a FMVSS No. 214 test does not constitute a noncompliance with that standard.

On April 12, 1995, NHTSA published an Advanced Notice of Proposed Rulemaking (ANPRM)(60 FR 18566) announcing plans to upgrade Standard No. 301. Regarding side impact testing for fuel system integrity, DaimlerChrysler, Ford, GM and others supported replacing the current Standard No. 301 side impact test with the current Standard No. 214 test for purposes of fuel system integrity. They argued that the moving deformable barrier (MDB) used in Standard No. 214 is more realistic than the one currently used in Standard No. 301 and that no new test development was necessary because the current Standard No. 214 is more stringent and more representative of real-world crash conditions than Standard No. 301.

On November 6, 2000, NHTSA issued a Notice of Proposed Rulemaking (NPRM) (65 FR 67693) to upgrade Standard No. 301 to replace the current side impact test procedures with the Standard No. 214 side impact test procedures. On February 9, 2001 DaimlerChrysler submitted the following comment in response to the NPRM:

...we are not fully inclined to support a belief that the current FMVSS 214 barrier is sufficient in representing actual crashes. We have provided data to the agency (developed

for another purpose) which shows that fuel fed post collision fires are extremely rare, although side impact collisions are not. This data suggest that any potential benefit from the change would be de minimus. While we do not believe that there is either a demonstrated need nor a demonstrated safety benefit to replacing the FMVSS 301 lateral test with the FMVSS 214 side impact test, DaimlerChrysler Corporation and Mercedes-Benz USA, LLC do not object to a prospective change.

Additional DaimlerChrysler Testing: Prior to the opening of this investigation, DaimlerChrysler performed FMVSS No. 214 and FMVSS No. 301 side impact testing on several minivans at various levels of vehicle development (pre-production through production, testing dates from 5/94 through 1/98). On April 9, 1999, it stated, "DaimlerChrysler knows of no side crash tests resulting in leakage from the filler neck assembly other than those recently conducted by NHTSA."

In January and February 2000, DaimlerChrysler conducted three crash tests of NS minivans using a MDB and under conditions similar to SINCAP testing. All three vehicles tested were short wheelbase (113 inch) models, two without and one with the sliding door on the left side (impact side). In all 3 of these tests, the filler pipe detached from the fuel tank spud, allowing a significant amount of fluid to escape from the fuel tank.

Additional NHTSA Testing: During the investigation, Chrysler claimed that the FMVSS No. 214 barrier test was unrepresentative of real world crashes due to the stiffness of the MDB. It claimed that in real world crashes, vehicle impacts to the side of the subject vehicles produce impact deformation that is unlike the deformation produced by the MDB. Specifically, DaimlerChrysler stated, "... the load forces at a given displacement associated with the FMVSS 214 barrier differ significantly from those on a typical (or any) vehicle. The sill deformation that created the hose separation by the barrier in laboratory testing is not readily duplicated by actual vehicles." NHTSA performed additional testing to determine whether the fuel leak during the FMVSS No. 214 testing could be repeated in a test which substituted a motor vehicle for the MDB as the impacting object.

NHTSA's Vehicle Research and Test Center performed a crash test in which a MY 1996 Dodge Dakota pickup truck impacted the side of a new MY 2000 Chrysler Voyager. The Voyager was a standard wheelbase (113") 3-door minivan. The test performed was a 90 degree left-side impact using the procedures in FMVSS No. 214 as a guideline, but it did not precisely follow the FMVSS No. 214 procedures. Both vehicles' fuel tanks were filled with Stoddard fluid prior to the test. The bullet vehicle was aligned so that the impact point on the Voyager was near the fuel filler neck. The impact speed was 30 mph for the Dakota, and the Voyager was stationary. No fluid loss was noted during the side impact test or the static rollover test performed after the crash test.

Findings: The testing of the subject vehicles according to FMVSS No. 214 and SINCAP procedures has shown that in certain crash modes, the impact may damage the filler neck

assembly and breach the integrity of the subject vehicle's fuel storage system. The design of the subject vehicle's filler neck assembly and its packaging in the structure of the vehicle leads to significant strain being placed on the short rubber hose connecting the fuel tank to the filler pipe when a side impact deforms this part of the vehicle. Comparable minivans present alternate design strategies that isolate the filler neck assembly from severe tensile loads and excessive strain in FMVSS No. 214 type impacts and also provide greater resistance to being pulled off.

The testing that produced fuel leaks was performed using a MDB and the lateral velocity of the barrier ranged from 30 to 35 mph. Examining individual cases of the subject minivans producing fuel leaks or fires from left-side impacts indicates that the leak or fire in the real-world appears to be associated with higher crash energy and/or speed.

Given that the subject vehicles have been on the road for up to 5 years in significant numbers, there has definitely been a large number of crashes into the left side of the subject vehicles. However, despite the shortcomings of the design of the subject vehicle's fuel filler neck assembly, ODI's search of complaint data, FARS data, NASS data, State data and certain insurance data indicates that these crashes have not produced a significant number of crash-related fires. The FARS data contains two incidents of fatal fires due to left side impacts to the subject vehicle. The overall fatal fire involvement for all crash modes of the subject minivans is essentially the same as or less than that of other minivans.

Conclusion: Under the circumstances, it is unlikely that further investigation would produce evidence sufficient to demonstrate the existence of a safety-related defect in the subject minivans. Therefore, this investigation is closed based on the evidence available at this time. The agency reserves the right to take further action if warranted by new or changed circumstances.

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