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Via Hand Delivery

Jeffrey L. Quandt, Chief
Vehicle Control Division
Office of Defects Investigation
National Highway Traffic Safety Administration
1200 New Jersey Avenue, SE
West Building
Washington, DC 20590

Re: PE07-042 – Air Suspension System Failures in Model Year 2000-2004 Mercedes-Benz S-Class Vehicles

Dear Mr. Quandt:

This letter is submitted on behalf of DaimlerChrysler AG and Mercedes-Benz USA, LLC (collectively "Mercedes-Benz") to the National Highway Traffic Safety Administration ("NHTSA" or "Agency") in response to the Office of Defects Investigation's August 22, 2007 request for information relating to the Agency's preliminary evaluation of the air suspension system in model year 2000-2004 Mercedes S-Class vehicles. Responses to NHTSA Requests No. 1 through 7 were submitted on October 10, 2007; this letter responds to the remaining requests, Requests No. 8 through 11.

Prior to responding to the Agency's specific requests, this letter provides an overview of the issues related to Mercedes-Benz's Airmatic air suspension system.

Overview

The subject S-Class vehicles contain a compressed air-based suspension system known as "Airmatic."[1] The system uses air suspension struts on each of the four wheels in lieu of

[1] As explained in our October 10, 2007 submission, the SL-Class vehicles included in the Agency's definition of "subject vehicles" do not use the Airmatic system and are not included in this response. MY

traditional springs and shock absorbers. Each strut contains an integral oil filled shock absorber which is linked by a steel rod to a pneumatic chamber at the top of the strut. The pneumatic chamber essentially takes the place of the steel spring used in a standard suspension system. The use of compressed air rather than a spring to support the weight of the vehicle has a number of performance advantages over traditional steel spring suspension systems, including: better vibration and damping characteristics, the ability to actively adjust the pressure at each wheel to adjust the ride height of the vehicle for different loading configurations, reduce body roll and pitch, and adjust the vehicle's ride characteristics for different driving situations.

Failure Modes: Over the course of production of the subject Airmatic system, Mercedes-Benz has identified three different failure modes in the air strut that could cause it to lose air pressure. Each of these failure modes is discussed in detail in response to Request Nos. 9 and 10. In general, in each of the failure modes, air leaks develop over time in various rubber elements of the strut assembly. A review of reported instances indicates that the air leaks are small and develop gradually over time. These small air leaks result in gradual loss of air pressure in the integral air chamber located at the top of the strut. In these cases, when the vehicle is in operation, the residual compressed air in the system, and the additional air pressure that can be added by the system's air compressor, typically increase air pressure in the system faster than the air is lost through cracks or gaps in the rubber elements of the air strut. Accordingly, the consequence of these types of failures is that when the vehicle is parked for extended periods of time, some or all of the air pressure can be lost, but while the vehicle is being driven, the system is functional. The vast majority of all warranty claims and complaints relate to the gradual loss of air pressure while parked which the driver notices upon returning to the vehicle.

Although the Airmatic pump system has the ability to compensate for small leaks, all Airmatic vehicles are equipped with electronic ride height monitors which will flash progressive driver warnings on the instrument cluster if the designed ride height is not obtained and maintained by the pump system. Specifically, if the vehicle drops to 10 mm below the normal ride height, and the normal ride height cannot be reached after 8 minutes of compressor operation, then an initial driver warning will be flashed in red which reads "AIRMATIC – DRIVE CAREFULLY." If the vehicle level drops to 65 mm below the normal ride height, then a high priority warning message will flash immediately in red which reads: "AIRMATIC" "STOP, CAR TOO LOW!"

If over time an air leak is not repaired, the leak may increase in size to the point where the loss of air pressure exceeds the air compressor's ability to maintain normal ride height during vehicle operation. These types of air losses will result in activation of the progressive automatic

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2000-2004 SL-Class vehicles were equipped with an entirely different suspension system known as "Active Body Control" or "ABC" which does not use pneumatic air suspension struts.

driver warnings discussed above. These types of leaks can also cause the vehicle's air compressor to enter an automatic shutdown mode. Specifically, the air pump is designed to automatically shut down when the vehicle's ride height cannot be maintained within 10 mm of normal ride height after eight minutes of continuous pump operation.

In a case where the compressor cannot sustain air pressure in the air strut during vehicle operation and the driver continues to operate the vehicle after the warning messages noted above for extended periods, vehicle ride height can be reduced by as much as 105 mm below the normal ride height. In this case, the vehicle will rest on the shock absorber's rubber stops which are designed for this purpose. Each shock absorber contains a rubber stop or bumper, which is designed to take the load of the vehicle when the vehicle "bottoms out" under normal driving circumstances, like when hitting a large pot hole or when the air suspension system malfunctions. When all the air pressure is lost from the pneumatic portion of the strut, the full load of that wheel rests on the steel rod in the shock absorber and the rubber stops at the end of the steel rod.

Impact on Drivability:

Under all of the foregoing situations there is a no impact on vehicle drivability. To confirm the drivability of the subject S-Class vehicles, Mercedes-Benz has video taped several driving tests of the subject vehicles with partial and complete loss of air pressure. As shown in the videos, there is only very limited contact between the tires and the body or fender well on S-Class vehicles at slow speeds and high steering angles. This is true for all of the driving conditions tested, which included slow-speed turns, complete turns to wheel-lock, high-speed turns, high-speed evasive driving maneuvers and emergency braking. Under all driving conditions tested there was also no increase in steering wheel torque needed to maneuver the vehicle. The referenced video files are attached as Attachment 1.

For these reasons, there is no material adverse impact on motor vehicle safety associated with even the complete loss of air pressure in the Airmatic struts.

Responses to Requests No. 8-11

The responses to NHTSA's requests numbered 8-11 are provided below following a restatement of the Agency's original requests.

Request No. 8: *Describe all assessments, analyses, tests, test results, studies, surveys, simulations, investigations, inquiries and/or evaluations (collectively, "actions") that relate to, or may relate to, the alleged defect in the subject vehicles that have been conducted, are being conducted, are planned, or*

are being conducted, are planned, or are being planned by, or for, Mercedes-Benz. For each such action provide the following information:

a) Action title or identifier;
b) The actual or planned start date;
c) The actual or expected end date;
d) Brief summary of the subject and objective of the action;
e) Engineering group(s)/supplier(s) responsible for designing and for conducting the action; and
f) A brief summary of the findings and/or conclusions resulting from the action.

For each action identified, provide copies of all documents related to the action, regardless of whether the documents are in interim, draft, or final form. Organize the documents chronologically by action.

Response to Request No. 8:

The subject system was produced between 1999 and 2006, and over that time there were a number of actions conducted with respect to the loss of air from the Airmatic struts. Below is a short description of those actions in chronological order:

- December, 2003 Japanese MLIT Inquiry: In January of 2003, DaimlerChrysler Japan received an informal request for information about Airmatic failures in a limited number of subject vehicles. DaimlerChrysler Japan provided information on the complaints at issue and the lack of safety impact and the matter was closed.

- May, 2005 Japanese MLIT Inquiry: In May, 2005 DaimlerChrylser Japan received another inquiry about five specific Airmatic customer complaints. DaimlerChrysler Japan provided additional information about each of these customer complaints to MLIT and the lack of impact on drivability and the investigation was closed.

- November, 2004 Supplier Quality Testing: In November, 2004, routine supplier quality testing was conducted by the Tier 2 supplier for the air spring, Vibracoustic, on two sample front struts that were produced in October 1999 and which were removed from a customer vehicle which had accumulated 200,000 km over five years. This investigation found that the air spring and all rubber elements of the examined parts exceeded the manufacturer's original specifications for air tightness (including surpassing the original burst pressure specification of $\geq$ 35 bar). A report on this investigation is attached.

- April, 2003 ThyssenKrupp Bilstein Design Change Assessment: As discussed in response to Request No. 9, a redesign of the rubber elements of the top mount was completed in the Spring of 2003, by the supplier ThyssenKrupp Bilstein. The redesigned top mount reduced the potential for air leakage from the top mount which could occur in the original design due to settling of the rubber elements due to long-term aging and exposure to high temperatures.

  Documents related to these actions are attached as Attachments 2-5.

Request No. 9: *Describe all modifications or changes made by, or on behalf of, Mercedes-Benz in the design, material composition, manufacture, quality control, supply, or installation of the subject component, from the start of production to date, which relate to, or may relate to, the alleged defect in the subject vehicles. For each such modification or change, provide the following information:*

a) The date or approximate date on which the modification or change was incorporated into vehicle production;
b) A detailed description of the modification or change;
c) The reason(s) for the modification or change;
d) The part number(s) (service and engineering) of the original component;
e) The part number(s) (service and engineering) of the modified component;
f) Whether the original unmodified component was withdrawn from production and/or sale, and if so, when;
g) When the modified component was made available as a service components; and
h) Whether the modified component can be interchanged with earlier production components.

Also, provide the above information for any modification or change that Mercedes-Benz is aware of which may be incorporated into vehicle production within the next 120 days.

Response to Request No. 9:

There have been two design changes to the subject component that were made to improve the durability of the unit and reduce the potential for air leakage, which could relate to the alleged defect:

- *Residual Pressure Valve:* On December 16, 1998 the residual pressure holding valve was replaced with an improved design in component production. The original design was found to be prone to slow leakage when the high pressure air hose was disconnected during service visits. During service visits, after disconnection of the high pressure hose, early production vehicles were found to slowly sink when the hose was disconnected for long periods (overnight), due to slow leaks in the valve. It was determined that the rubber sealing elements in the original valve were not sufficiently elastic (compression set was not consistent in valve production). The original valve was replaced with a different valve design that is commonly used in other high air-pressure vehicle applications, such as on heavy duty trucks. This failure mode can only occur when the high-pressure hose is disconnected from the strut during servicing of the vehicle. Sectional drawings of the old and new valve designs are included at Attachment 6 with the sealing locations of the valve highlighted. The new part was introduced into vehicle production in March 1999.

- *Top Mount Design:* The integral steel rod in the air strut mounts into the top of the strut with a set of rubber mounts to reduce the transmission of vibration. The mount must remain air tight. Over time, the rubber elements in the original top mount design could settle and compress after exposure to pressure and high temperatures. Compromised top mount rubber elements could result in very slow air leaks from the system. When the vehicle is parked and the air compressor is not operational this could result in the vehicle losing air pressure and eventually settling on the rubber elements of the shock absorber over time. During vehicle operation, the compressor will be able to compensate for air loss through the top mount. However, a new improved top mount was designed which included an additional rubber O-ring in the head of the top mount that would make the mount air tight regardless of any settling of the other rubber elements in the mount. Sectional drawings of the old and new top mount designs are included at Attachment 7 , with the new rubber O-ring highlighted. The new top mount design was placed into part production on March 21, 2003. The new part was incorporated into vehicle production in March 2003 and introduced into spare parts supply that same month.

Request No. 10: *Provide a list of all serviceable components of the subject system and state the number of each that Mercedes-Benz has sold that may be used in the subject vehicles by component name, part number (both service and engineering/production), model and model year of the vehicle in which it*

is used and month/year of sale (including the cut-off date for sales, if applicable).

For each component part number, provide the supplier's name, address, and appropriate point of contact (name, title, and telephone number). Also identify by make, model and model year, any other vehicles of which Mercedes-Benz is aware that contain the identical component, whether installed in production or in service, and state the applicable dates of production or service usage.

Response to Request No. 10:

The serviceable components of the subject system are as follows:

Part Number	Description
A2203202538	Strut Repair Kit
A2113200304	Compressor
A2203200304	Compressor
A2203200004	Compressor
A2203200104	Compressor
A2203200258	Valve Block
A2203202438	Front Strut
A220320511326	Front Strut
A2203205113	Front Strut
A2203207713	Front Strut
A2203201338	Front Strut
A2203201438	Front Strut
A2203202138	Front Strut
A2203202238	Front Strut
A2203205013	Rear Strut
A2203207913	Rear Strut
A0003270369	Pressure Valve Connector
A2205450532	Control Unit, Pneumatic Suspension
A2205450732	Control Unit, Pneumatic Suspension
A2205450832	Control Unit, Pneumatic Suspension

A2205453832	Control Unit, Pneumatic Suspension
A2205454132	Control Unit, Pneumatic Suspension
A0025421319	Relay
A002542131926	Relay

The number of parts sold that may be used in the subject vehicles is provided by part number and month/year of sale in Attachment 8. Mercedes-Benz does not keep part sales information by model and model year.[2]

The supplier name, address and contact information for each part is as follows:

	Contact Name Phone Number	**Address**
Air suspension strut and Repair Kit **(Tier 1 supplier)**	Dr. Bernd Asmuss Tel.: +49 2334 91-4134	Thyssen Krupp Bilstein Suspension GmbH August Bilstein Str. 4 D 58256 Ennepetal
(Tier 2 supplier of air spring)	Jürgen Berg Tel.: +49 40 7667-1419	Vibracoustic GmbH & CoKG Hörstener Straße 45 D 21079 Hamburg
Air suspension compressor	Andreas Ruß Tel.: 49 511 922-1346	Wabco GmbH Am Lindener Hafen 21 D 30453 Hannover
Valve block	Roman Pausch Tel.: +49 9287 884-260	Rapa Rausch & Pausch GmbH Albert-Pausch-Ring 1 D 95100 Selb

[2] Note that these part sales totals include all parts sold for use in any Airmatic vehicles. In addition to the subject MY 2000-2004 S-Class vehicles, MY 2005-2006 S-Class vehicles were also equipped with an Airmatic type suspension system which could use these same replacement parts. The compressor units in the model 211 and 219 vehicles identified above also would use these parts.

The compressor used in the subject vehicles is also installed in Mercedes-Benz model 211, which is the model year 2003 and later E-Class, and model 219, which is the model year 2006 and later CLS-Class.

Request No. 11: *Furnish Mercedes-Benz's assessment of the alleged defect in the subject vehicle, including:*

a) The causal or contributory factor(s);
b) The failure mechanism(s);
c) The failure mode(s);
d) The risk to motor vehicle safety that it poses;
e) What warnings, if any, the operator and the other persons both inside and outside the vehicle would have that the alleged defect was occurring or subject component was malfunctioning; and
f) The reports included with this inquiry.

Response to Request No. 11:

Failure Mechanisms and Modes: As discussed generally in the introduction, three separate failure modes have been observed in the Airmatic struts, none of which results in a potential impact on vehicle drivability and control. The first two failure modes are: air leaks from the residual pressure valve during service; and air leaks from the top mount rubber, which were discussed in detail above in response to Request No. 9. In addition, it is also possible for air leaks to develop at the sealing location of the sliding rubber mount. The sliding rubber mount is depicted in the cutaway drawing at Attachment 9. Over time and exposure to high heat, normal migration of damper oil from the shock absorber can collect on the rubber seal and damage it through a long term chemical reaction. Oil contamination of the rubber seal can cause it to slowly lose air in some cases. With this fault mode, when the vehicle is parked for extended periods, a loss of air pressure can occur because the compressor is not operating. While driving, the compressor typically will be able to fully compensate for this kind of loss.

Reports Included with This Inquiry: There were nineteen reports included with this inquiry. In addition, NHTSA forwarded two additional reports for inclusion in this response. Of the 21 reports, three relate to vehicles that do not have the Airmatic system. See VOQ 10142714; VOQ 10196490; 10152584. Of the remaining 18 reports, at least five involve parked or recently parked vehicles. (Several reports do not provide precise information as to whether or not the car was in a parked position at the time of the alleged failure.) As noted above, Mercedes-Benz believes that the most common pattern of Airmatic system incidents involves a slow lowering of the suspension system from the residual pressure holding valves, the top mount,

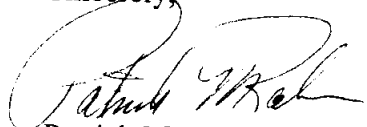
or the sliding rubber mount. This pattern would be consistent with those reports alleging Airmatic system failures either while parked or following long-term parking. See, e.g., VOQ 10055275; VOQ 10166081; VOQ 10177636; VOQ 10189289; VOQ 10189289. Three of the 18 reports indicated that the vehicle came into contact with the wheels during the alleged Airmatic system failure. See VOQ 10108181; VOQ 10155687; VOQ10186744. This type of failure mode is very rare; the Company's review of its customer complaints (which were provided in Mercedes-Benz's October 10, 2007 response to NHTSA) indicates that only three out of the 670 complaints alleged any type of contact between the vehicle and the wheels. Moreover, Mercedes-Benz notes that its road tests of steering wheel angle and lateral acceleration, referenced above, suggest that tire-fender contact only occurs at lower speeds, when the tire touches the fender at a steering wheel angle of approximately 90 degrees. There is no impact on steering wheel torque or the ability to turn the wheel through its full range of motion. Mercedes-Benz also notes that only three of the 18 reports to NHTSA alleged vehicle handling concerns. See VOQ 10186744; VOQ 10192385; VOQ 10202102.

Operator Warnings: As indicated above, all Airmatic equipped vehicles are also equipped with electronic ride height monitoring technology. The subject vehicles monitor ride height by the millimeter. A sustained reduction in ride height of 10 mm results in an initial warning of "AIRMATIC DRIVE CAREFULLY." A reduction of 65 mm results in a high priority warning of "AIRMATIC" "STOP, CAR TOO LOW!" Even at 65 mm below normal, there is no potential for tire contact with the fenders in any vehicle configuration. With a total loss of air pressure the vehicle will be at 105 mm below normal. This loss of vehicle height would be immediately apparent to any vehicle owner before even entering the vehicle.

Risk to Motor Vehicle Safety: Regardless of which failure mode is at issue, even the complete loss of air pressure will not impair vehicle drivability or control. A complete lowering of the vehicle will cause a very hard ride without suspension. Because there is no impact on steering, and the potential contact between the tire and fender is very limited, there is no impact on motor vehicle safety associated with failures of the Airmatic suspension system.

Please feel free to contact me if you have any questions concerning this submission.

Sincerely,



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