DAIMLERCHRYSLER

May 11, 2004

DaimlerChrysler Corporation
Stephan J. Speth
Director
Vehicle Compliance & Safety Affairs

Ms. Kathleen DeMeter, Director
Enforcement
Office of Defects Investigation
National Highway Traffic Safety Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

Dear Ms. DeMeter:

Reference: NVS – 213pjk; EA03-023

This follows up on the previous submission of information by DaimlerChrysler Corporation ("DCC") on March 12th, 2004 and numerous conversations with various members of NHTSA's Office of Defects Investigation thereafter. Enclosed you will find DCC's final response to NHTSA's Engineering Analysis 03-023 dated January 22nd, 2004 regarding the upper ball joint assembly in 1998-2003 model year Dodge Durango vehicles and in 1997-2004 Dodge Dakota pickup trucks ("subject vehicles").[1]

In response to NHTSA's PE and EA, DCC performed a thorough investigation into alleged upper ball joint separations in the subject vehicles. After analysis and review of the data retrieved from the investigation, DCC has concluded that there is not a safety-related defect present in the upper ball joints of the subject vehicles. The data retrieved from the investigation revealed several factors (supported in this and prior submissions) that led DCC to this conclusion:

- First, the ball joint assemblies on the subject vehicles are "compression" type joints. Unlike "tension" ball joints, a compression ball joint assembly has the weight of the vehicle constantly pressing the ball joint assembly together. This design characteristic makes separation very improbable during the normal operation of the vehicle. In fact, separation has only been observed at lower speeds during extreme suspension travel (e.g., making a sharp turn and proceeding up an inclined driveway). Testing has shown that these types of driving maneuvers develop the highest measured tensile peak loads at the ball joint, and only for very short durations. In all other steady state driving events, the load at the ball joint is virtually zero, ensuring that separation is not possible.

[1] In reaching the analysis and conclusions, and by providing the information contained herein, DCC is not waiving its claim to attorney work product and attorney-client privileged communications.

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Q16. For each model and drive type, provide computer model images of the front suspension components at full jounce and full rebound. Include in each drawing the loads (x-, y-, and z-direction forces and the resultant forces magnitudes and directions) of the upper and lower ball joints. Also, include the angles of articulation of each control arm and ball joint (measured from the ball joint stem to control arm axis) from static curb weight condition to the full jounce and full rebound positions.

A16. Copies of all documents have been summarized as requested and submitted in Supplemental Enclosure 16 - Confidential (CD-Rom) to Ms. Jacqueline Glassman, Office of the Chief Counsel, under separate cover with a request for confidential treatment of information.

Supplemental Enclosure 16 contains results from a computer model simulation of the peak forces acting in the x, y, and z axes for the Dakota 4X4, Durango 4X4, and Dakota/Durango 4X2, each at the three articulation positions described in Question 16. Load magnitude and direction was generated using the ADAMS vehicle dynamics software analysis program and validated with vehicle test data. The load data generated from analysis and in-vehicle testing incorporates rebound bumpers, which will result in maximum articulation angles less than the metal to metal condition presented with the March 12th, 2004 initial EA03-023 response.

Q17. For each model and drive type of subject vehicle, describe, and provide copies of all documents relating to, all vehicle testing (including computer simulations) to assess the forces acting on the subject ball joints. Provide DaimlerChrysler's assessment of the forces acting on the subject ball joints and the associated control arm bushings in the x-, y-, and z-directions during: (a) static conditions; (b) steady state driving; (c) cornering (both sides); (d) braking (normal and hard); and (e) transient driving conditions (e.g., force vs. time plots of forces associated with driving over a vertical perturbation in the road at a designated speed – for instance, force vs. time plots for each load direction showing transitions from steady state to full jounce to full rebound to steady state while driving at 30 mph).

A17. DaimlerChrysler Corporation (DCC) conducted a comprehensive test program to measure the requested information, and the documents have been summarized and are being submitted in Supplemental Enclosure 17 - Confidential (CD-Rom) to Ms. Jacqueline Glassman, Office of the Chief Counsel, under separate cover with a request for confidential treatment of information.

Included are two reports summarizing test data collected from a Dakota 4X2 vehicle and a Durango 4X4 vehicle. The testing generated the actual forces

acting on the upper ball joint assembly and the surrounding components. Data was collected at DCC's Chelsea Proving Grounds (CPG) as well as a public road course including typical driving maneuvers. At the CPG there were two series of data collection, including a specific list of DCC defined special events which represent typical customer use and are described in detail within Supplemental Enclosure 17. The CPG durability test cycles represent 95th percentile customer use and contain events which are abusive enough that most customer vehicles would never experience them during normal usage.

During data acquisition with the Durango 4X4, selected channels of the vehicle left side instrumentation experienced data corruption issues. Right side data as well as left side data that was not corrupted on the same vehicle is included. Based on a review of the CPG and public road courses, Durango 4X4 data similarities to that obtained from the Dakota 4X2 acquisition, and the presence of the right side Durango 4X4 load data, DCC is confident that all ball joint peak load conditions were accurately captured. Due to redundancies in the data, DCC has no plans to re-run the left side Durango 4X4 data acquisition.

There is no correlation, and therefore no conclusion, that can be made regarding bushing loads versus peak ball joint loads seen during the testing cycles.

DCC's assessment relative to the loads measured will be provided in the answer to Question 30.

Q18. Provide DaimlerChrysler's assessment of which of the above (In Request No. 17), or other, operating conditions contribute most to: (a) wear of the subject components; and (b) separation of worn joints.

A18. In DCC's comprehensive vehicle test program, there were no scenarios or operating conditions that created or developed unusual loading or articulation which would contribute to premature wear in an uncompromised joint. The only potential contributing factor to premature wear in an upper ball joint assembly could be a compromised sealing surface combined with long term exposure to a corrosive environment and failure of the vehicle operator to respond to the multiple warnings provided.

DCC's vehicle test data confirms that the upper ball joint assembly is a stabilizer link by design, and carries only small loads the majority of the time, thereby reducing the opportunity for potential grinding wear of the joint. The maximum vertical tensile load measured on an NCM upper ball joint assembly was less than 1250 pounds for a very short amount of time (much less than 0.50 seconds) in a CPG event that induced severe body/frame twist not representative of typical customer usage.

Comparing the instantaneous load measured during vehicle testing to DCC's impact wear test procedure provides a relative metric for assessing wear of the joint. The impact wear test procedure is part of DCC's standard component validation testing information that was provided in the March 12th, 2004 initial EA response and provides a test cycle that measures the increase in wear via vertical end play following 250,000 cycles at 1700 pounds with an allowable end play increase of no more than 0.5mm (0.020"). Considering the load/cycle profile of the impact wear test procedure, and the instantaneous characteristics of the maximum vertical loads measured during vehicle testing, it becomes clear that any potential degradation of the ball joint assembly would be a lengthy process dependent upon a number of factors.

DCC's assessment relative to the conditions necessary for separation to be possible will be provided in the answer to Question 30.

Q19. Describe, and provide copies of all documents relating to, all testing conducted by, or for, DaimlerChrysler to assess the separation or pull-out forces for new and used ball joint assemblies used in the subject vehicles. Provide copies of all test plans and procedures used and video demonstrating how each test was performed. Include in your response to this request a detailed comparison of the axial and side-load forces required to separate ball joints supplied by TRW and NCM in both new and field return parts. For the latter, state the VIN, mileage, symptoms reported by the owner, end-play (if measured), ball diameter, and any other measurements or observations that characterize the degree of wear for each part. Provide pull-out/separation force vs. ball joint wear curves for the TRW and NCM parts and DaimlerChrysler's assessment of the relative performance of the parts from the two suppliers and the relationship of each to the forces that the parts may see in service in each of the subject models and drive types.

A19. Copies of all documents have been summarized as requested and submitted in Supplemental Enclosure 19 - Confidential (CD-Rom) to Ms. Jacqueline Glassman, Office of the Chief Counsel, under separate cover with a request for confidential treatment of information.

A sampling of 256 warranty field return parts categorized by levels of wear indicates:

- 228 (89%) of the returned parts exhibited measured end play below DCC's recommended maximum allowable end play of 0.060",
- 28 (11%) of the returned parts exhibited measured end play that exceeded 0.060".

Samples from these 256 field return parts were used to compile the data responsive to this question.

The reports included in Supplemental Enclosure 19 provide a detailed description of the test procedure and a comparison of the axial and side-load forces required to separate new and filed returned TRW and NCM ball joints. There are three reports provided which provide separation force versus ball joint wear curves for new TRW and NCM components, field returned TRW components, and field returned NCM components. Also included is a detailed overview of the field returned parts that were tested, with information on the VIN, mileage, symptoms reported by the owner, end-play measurements, and other data relevant to the returned component. In each case the ball and socket surface condition was evaluated, however, ball diameter was not measured following pull tests as the resulting distortion would not accurately indicate the condition of the ball prior to the test.

A detailed description of the methodology used to measure end play is provided with the test reports in Supplemental Enclosure 19.

Components were subjected to a tensile load in the axial direction, as well as a tensile load at 25.4 degrees of articulation, which represents the angle of articulation where the peak vertical loads were seen during vehicle testing. This angle of articulation also represents the maximum angle of articulation by design, which protects for metal to metal contact between the control arm and the vehicle frame. Physical inspection of parts that have been returned to DCC from the field for analysis showed that the 25.4 degrees of articulation was not exceeded.

There was no conclusion that could be drawn regarding any differences between the vehicle models or drive types.

While the provided data does show differences in peak pull out forces for the TRW and NCM parts, these differences are inconsequential relative to the magnitude of the peak load measurements found during vehicle testing.

DCC's assessment relative to the conditions necessary for separation to be possible will be provided in the answer to Question 30.

Q20. Using the information furnished in response to Request Nos. 17 and 19, provide DaimlerChrysler's assessment of the wear conditions and load conditions (and the associated driving maneuvers) that are necessary to cause a ball joint separation to occur. State what evidence, if any, is available to correlate this assessment to actual incidents of ball joint separation that have been investigated by DaimlerChrysler.

A20. DCC's assessment relative to the conditions necessary for separation to be possible will be provided in the answer to Question 30.

Q22. Describe, and provide copies of all documents relating to, the DaimlerChrysler field survey that was referenced during the December 9, 2003 meeting with NHTSA.

A22. From a sample of over 200 Durango and Dakota vehicles identified in Southeastern Michigan representing all subject model years, 78 were selected for a comprehensive review of the condition of the front suspension upper ball joints. The 78 vehicles selected represented a cross section of model years, mileages, and customer usage duty cycles. Updated copies of all documents related to the survey approach as well as the observed and measured findings have been summarized as requested and submitted in Supplemental Enclosure 22 - Confidential (CD-Rom) to Ms. Jacqueline Glassman, Office of the Chief Counsel, under separate cover with a request for confidential treatment of information.

It remains apparent from a large sample of survey data that even on vehicles identified with compromised sealing in either the boot or the crimped ball joint surface that any degradation of the ball to socket interface occurs over an extended period of time. This appears to be true of both TRW and NCM designed upper ball joint assemblies. On 2000 model year survey vehicles equipped with NCM upper ball joints ranging in mileage from 29,000 to 120,000 (average 66,900 miles), only one (1) of 14 vehicles surveyed had a measured end play (at 0.073") beyond the recommended 0.060" replacement specification. Since a small number (one) of warranty return parts measured to have end play approaching 0.400" have been identified without experiencing separation from the socket, it can be deduced that degradation in end play due to a compromised seal, evacuation of grease, bearing wear and ultimately grinding corrosion takes a significant amount of time and mileage. As supported with the complaint data, this period of time and/or mileage is more than sufficient for customers to recognize the issue through audible noise, tire wear, or normal inspection during vehicle maintenance.

Q23. Describe in detail, and provide copies of all documents relating to, all other testing and analyses that have been conducted by, or for, DaimlerChrysler on field return samples of subject components. Provide an electronic listing of all such parts collected by DaimlerChrysler. Include the following information in the list: (a) VIN; (b) repair date; (c) symptoms reported by the consumer; (d) end-play (if measured); (e) dealer technician notes/observations; (f) DaimlerChrysler's characterization of the severity of the wear in the part (use the categories low, moderate, or severe and state the conditions used by DaimlerChrysler to define each category); (g) ball

diameter; (h) ball hardness; (i) socket hardness; and (j) a column for each of the analyses that have been completed or are planned by DaimlerChrysler, with the results for completed tests shown for each part. Provide photographs of each part, including high-resolution pictures of the balls that have been removed from returned parts with metric scales shown in the images.

A23. Requested information has been summarized and submitted in Supplemental Enclosure 23 - Confidential (CD-Rom) to Ms. Jacqueline Glassman, Office of the Chief Counsel, under separate cover with a request for confidential treatment of information. Supplemental information collected from field returned samples is provided in this enclosure where available. Some information requested above in (a) through (j) is not commonly collected or measured, and is not provided.

A sampling of 256 warranty field return parts categorized by levels of wear indicates:

- 228 (89%) of the returned parts exhibited measured end play below DCC's recommended maximum allowable end play of 0.060",
- 28 (11%) of the returned parts exhibited measured end play that exceeded 0.060".

To provide more objective data relating to the warning that a driver would incur during normal operation of a subject vehicle with an extremely worn upper ball joint assembly, DCC performed a series of 30 second drive evaluations comparing the audible levels in the cabin of a Durango 4X4 vehicle with ball joints exhibiting less than 0.005" of end play, and the same vehicle with one upper ball joint assembly exhibiting approximately 0.200" of measured end play. Details regarding the paved surface and test cycle are provided in Supplemental Enclosure 23. These results show that, at the driver's ear position, the worn ball joint is more than twice as loud as the non-worn ball joint during various events in the cycle.

Q24. Describe, and provide copies of all documents relating to, all metallurgical testing and analyses of new and field return ball joint assemblies supplied by TRW and by NCM that have been done by DaimlerChrysler or of which DaimlerChrysler is otherwise aware. Include all mechanical and chemical analyses of ball, socket, and wear debris, such as microscopy, metallography, macroscopic and microscopic hardness testing, microstructure analysis, and chemical analyses of wear surfaces or wear debris. Describe by manufacturing process, hardness, and thickness all case hardening and/or or surface coatings in the balls and

sockets/capsules of new parts supplied by TRW and NCM and provide copies of relevant specifications and documents.

A24. Copies of all documents have been summarized as requested and submitted in Supplemental Enclosure 24 - Confidential (CD-Rom) to Ms. Jacqueline Glassman, Office of the Chief Counsel, under separate cover with a request for confidential treatment of information.

DCC has performed further metallurgical testing analyses of both new and field return ball joint assemblies supplied by TRW and NCM, and the results provided offer no conclusions or findings of any significance that may be relevant to this investigation. Nonetheless, the reports are provided.

Q26. Provide DaimlerChrysler's assessments of the approximate mileage ranges and symptoms associated with the following stages of upper ball joint wear progression: (a) initiation of water intrusion; (b) evacuation of joint lubrication; (c) deterioration/disintegration of the plastic bearing; (d) onset of corrosive/grinding wear the ball and socket; (e) 25 percent reduction of joint pull-out forces; (f) 50 percent reduction in joint pull-out forces; and (g) severe loss of joint retention capability (e.g., ball can be separated from socket with less than 200 pounds force of axial or side load). For parts "e" through "g," state the approximate ball diameters associated with the respective joint load capacities. For part "d" through "g," state DaimlerChrysler's assessment of the wear rates through each stage, including whether the wear rates are approximately constant or if they may accelerate at some point in the process. State the bases for each such assessment.

A26. DCC's assessment relative to the mileage ranges and symptoms associated with various stages of wear defined above will be provided in the answer to Question 30.

Q30. Furnish DaimlerChrysler's current assessment of the alleged defect in the subject vehicles, including:

a. The causal or contributory factor(s) of corrosive/grinding wear related failures of subject components;
b. The failure mechanism(s) of corrosive/grinding wear related failures of subject components;
c. The wear condition of upper ball joints that have been involved in known incidents of upper ball joint separation that have been investigated to date – this should be limited to parts that have been inspected, tested, or otherwise analyzed by, or for, DaimlerChrysler;
d. The driving maneuvers associated with known incidents of upper ball joint separation that have been investigated to date – include

DaimlerChrysler's assessment of the estimated forces from each such maneuvers on the subject components;
e. The reason(s) for differences in rates of separation between subject components supplied by TRW and NCM;
f. The reason(s) for the disproportionately high rate of separation incidents currently alleged in the MY 2000 subject vehicles;
g. The reason(s) for differences in the rates of subject component separation, if any, when compared by model and drive type;
h. The risk to motor vehicle safety that it poses;
i. 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
j. The reports included with this inquiry.

A30. After analysis and review of the data from this investigation, DCC has concluded that there is not a safety-related defect present in the upper ball joints of the subject vehicles.

(a) Regarding the causal and contributory factors to corrosion and grinding, analysis of returned parts indicates that the wear is related to a compromising of the ball joint seal leading to intrusion of water, evacuation of the grease, bearing wear and, after a significant amount of time, corrosion leading to grinding wear of the joint. Further explanation is provided in (h) through (j) below.

(b) The long term effects of corrosion cause degradation of the joint integrity due to the reduction of metal at the interface between the ball and socket. Separation of an upper ball joint assembly is only foreseeable if the conditions described in subpart (a) above are permitted to exist for an extended period of time and the associated warnings are ignored. This must be combined with extreme suspension travel, which necessarily occurs at low vehicle speeds. As supported by the data supplied, this scenario would provide adequate warning, and result in a low risk of accident or injury.

Data provided from the pull testing program indicate that the tensile performance of a new NCM upper ball joint assembly provides a safety factor which is at least nine (9) times the peak measured tensile load an upper ball joint assembly might ever see, even during extreme usage. The duration of this loading is also relevant, as the dynamic load seen during vehicle maneuvers is extremely short in duration and typically occurs for much less than 0.50 seconds. Even in an extremely worn NCM ball joint assembly, one with measured end play of just under 0.400" and which represents less than 0.5% of the parts returned to DCC from the field for analysis, the safety factor for the vertical tensile capability of the joint is greater than four (4) times that of the peak load measured in the vehicle. The tensile performance of the components which exceed DCC's recommended

allowable end play specification of 0.060", which represents less than 9% of the parts returned to DCC, exhibit a tensile strength which is at a minimum over six (6) times the safety factor of the peak vertical loads generated during vehicle testing. Based on DCC's objective testing of audible noise on a Durango 4X4 with a worn upper ball joint, these assemblies returned from the field represent a range of wear that indicates the likely presence of audible and tactile warning, as well as tire wear, over an extended period of time alerting the operator of the issue.

(c) Nearly all documented separations reviewed to date reveal a severely corroded ball stud and housing, which based on an analysis of the circumstantial data surrounding these incidences, takes a minimum of 30 months to manifest. This supports the assertion that there is significant notice prior to a separation and if the operator had followed the recommended maintenance procedures contained in the owner's manual, this condition would have been detected well in advance of separation of the joint.

Analysis of the 25 documented separations meeting the definition of the alleged defect indicates:

- 21 of the 25 vehicles were originally sold or leased in corrosion belt states,
- The average mileage to alleged separation was 55,000 miles while the average time from vehicle delivery to alleged separation was 40 months,
- Even in the case of the lowest mileage/time to alleged separation, there were multiple opportunities for inspection during routine maintenance procedures that would have allowed for detection of the condition.
- Based on DCC's part field returns analysis and the extensive test data provided in this response, any ball joint assembly exhibiting severe degradation within a time period of less than 30 months must have experienced an abnormal and unpredictable event, such as a severely torn boot. Even so, all of the warning elements would still be present.

DCC's data clearly indicates that the majority of customers are having their ball joints inspected and repaired if necessary before a separation may ever occur. In fact, DCC's field return data indicates that most upper ball joint assemblies are being replaced unnecessarily. The extremely low rate of confirmed separations, at 1.29 conditions per 100,000 vehicles, appears to be due to the fact that a small percentage of people are ignoring the audible and tactile warnings and associated tire wear present with an extremely worn ball joint assembly. Although DCC's warranty parts return center was unable to acquire any field return parts that exceeded 0.400" of end play, a conservative extrapolation of the

provided test data will clearly indicate that even the most extreme driving maneuvers would have to be combined with a ball joint worn beyond 0.750" (over 12 times the recommended maximum end play) for the possibility of a separation to occur. Even at 0.400" of end play, the NCM ball joint assembly maintains approximately 51% of its original tensile strength. During the extended period of time it would take to achieve this extreme level of degradation, there would be ample audible and tactile warning and associated tire wear indicating to the operator of the vehicle that inspection may be required.

(d) In the rare situation where a separation might occur in an extremely worn upper ball joint assembly, DCC's test data correlates very well with the information that has been provided with the documented complaints of separation:

- Such events occur only at low speeds combined with high angles of suspension articulation.
- These events occur only in the case of extremely worn joints; worn beyond the level of any parts that have been returned to DCC for analysis, and only after a significant period of tire wear and audible and tactile input to the operator of the vehicle.
- There were no injuries.

DCC did not measure any upper ball joint loads during comprehensive vehicle testing that exceeded 1250 pounds of tensile vertical load. The relationship between this maximum load seen during extreme events and the maximum tensile capability of a significantly worn ball joint exhibiting just under 0.400" of end play (which represents a wear level of over six (6) times DCC's recommended level) indicates that the peak vertical load seen throughout the most abusive vehicle tests is only approximately 25% of the tensile strength of this grossly worn ball joint assembly. This assembly represents the most significantly worn part returned to DCC. It remains clear that any upper ball joint assembly approaching this level of wear is capable of withstanding vertical loads that are at least four (4) times that which it may ever see, even in the most severe customer usage. Additionally, at that level of wear, audible and tactile warnings and associated tire wear, are present to the driver during even the most routine of driving events.

In the case of turning into or out of a driveway through an incline, which is arguably more representative of typical customer events in general, testing shows the peak vertical load in the upper ball joint assembly to be less than 1000 pounds, which suggests that the necessary level of wear supporting the possibility of separation would have to be extreme. It is nearly impossible to imagine that this would not be detected by the operator through one of the many ways already described in great detail.

During steady state driving, crossover plots provided in the attached enclosures show a sustained peak dynamic vertical load which is approximately 4% of the load required to separate the most worn upper ball joint assembly received by DCC (at just under 0.400" of measured end play). This further supports that it is not possible for even the most worn ball joint assembly to experience separation during steady-state driving.

(e) There is not a statistically significant difference in the rate of alleged separation between the subject components supplied by TRW and NCM, because the rate of separation for both is so low. However, based on the testing and analysis contained within this response and information previously provided to NHTSA, it is apparent the differences in the ball-to-housing opening geometry may contribute to a slight difference in the rates of alleged field separation.

Based on extensive in-vehicle data acquisition and subsequent tensile testing on TRW and NCM parts returned to DCC for analysis, there was no case where the peak measured upper ball joint tensile load in the vehicle remotely approached loading required for separation. The results from this pull testing indicate that the scenarios evaluated during the vehicle test program did not reach 25% of the tensile load required to pull the most extremely worn NCM upper ball joint assembly (just under 0.400" measured end play) to tensile separation.

In addition, DCC's vehicle survey data indicates that even on vehicles identified with compromised sealing in either the boot or the crimped ball joint surface that any degradation of the ball to socket interface occurs over an extended period of time. This appears to be true of both TRW and NCM designed upper ball joint assemblies. On 2000 model year survey vehicles equipped with NCM upper ball joints ranging in mileage from 29,000 to 120,000 (average 66,900 miles), only one (1) of 14 vehicles surveyed had a measured end play (at 0.073") beyond the recommended 0.060" replacement specification. Since a small number (only one) of warranty return parts measured to have end play as high as 0.400" have been identified without experiencing separation from the socket, it can be deduced that degradation in end play due to a compromised seal, evacuation of grease, bearing wear and ultimately grinding corrosion takes a significant amount of time and mileage. As supported with the complaint data, this period of time and/or mileage is more than sufficient for customers to recognize the issue through audible noise, tire wear, or normal inspection during vehicle maintenance.

(f) Although the rate of alleged upper ball joint separations is slightly higher in model year 2000 than the other model years, there is insufficient data to indicate that a complaint rate of 4.20 conditions per 100,000 vehicles is disproportionately high. In fact, NHTSA recently closed a ball joint investigation (RQ03-002) into a competing manufacturer's vehicles with a complaint rate of over 13 conditions

per 100,000 vehicles. Facts surrounding that case also establish that it was a "tension" ball joint geometry, which will provide less audible and tactile warning for a shorter period of time in the event of corrosive degradation than the "compressive" type ball joints that are the subject of this investigation.

(g) Component separation data shows no trend based on drive type or vehicle model. Testing shows the measured loads and articulation angles to be comparable regardless of vehicle model or drive type.

(h-j) DCC has concluded that there is not a safety-related defect present in the upper ball joints of the subject vehicles and therefore no risk to motor vehicle safety for the following reasons:

- First, the ball joint assemblies on the subject vehicles are "compression" type joints. Unlike "tension" ball joints, a compression ball joint assembly has the weight of the vehicle constantly pressing the ball joint assembly together. This design characteristic makes separation very improbable during the normal operation of the vehicle. In fact, separation has only been observed at lower speeds during extreme suspension travel (e.g., making a sharp turn and proceeding up an inclined driveway). Testing has shown that these types of driving maneuvers develop the highest measured tensile peak loads at the ball joint, and only for very short durations. In all other steady state driving events, the load at the ball joint is virtually zero, ensuring that separation is not possible.

- Next, there were few complaints that alleged actual upper ball joint separation and those complaints did not reveal a trend or pattern. Even distinguishing the NCM upper ball joint equipped vehicle population from the whole, the complaint rate was only 2.0 conditions per 100,000 vehicles.

- Third, there is substantial and sufficient warning to vehicle owners that the upper ball joints may need replacement well before an upper ball joint separation occurs. The investigation revealed that nearly all of the operators responded to these warning signs. It was only the few operators that (1) ignored the lengthy and obvious warnings such as audible noise and tire wear, (2) did not want to pay for ball joints service and/or (3) elected not to follow the suggested maintenance and inspection service procedures contained in the owner's manual that experienced a risk of separation of the upper ball joint assembly.

- Fourth, it is apparent from a large sample of survey data that even on vehicles identified with compromised sealing in either the boot or the

crimped surface that any degradation of the ball to socket interface occurs over an extended period of time. This appears to be true of both TRW and NCM designed upper ball joint assemblies. On 2000 model year vehicles equipped with NCM upper ball joints ranging in mileage from 29,000 to 120,000 (average 66,900 miles), only one (1) of 14 surveyed vehicles had a measured end play (at 0.073") beyond the recommended 0.060" replacement specification. Since warranty return parts measured to have end play as high as just under 0.400" have been identified without experiencing ball separation from the socket, it can be deduced that degradation in end play due to a compromised seal, evacuation of grease, bearing wear and ultimately grinding corrosion takes a significant amount of time and mileage. As supported with the complaint data, this period of time and/or mileage is more than sufficient for customers to recognize the issue.

- Fifth, data shows that peak upper ball joint tensile loads as measured in vehicle during severe duty cycle events are still less than 25% of the measured tensile separation strength of a severely worn ball joint with just under 0.400" end play. This end play exceeds the recommended replacement specification of 0.060" by a factor of greater than six (6).

- Sixth, there were dramatic spikes in ball joint complaints among vehicle owners immediately following national media stories related to the investigation that do not accurately reflect actual ball joint issues in the subject vehicles. As evidence, many of the complaints following the media coverage were driven by a liberal application of the term "ball joint" as a causal description for many vehicle related complaints, including issues not even relating to the front suspension.

- Lastly, there were no injuries caused by a ball joint separation in the subject population of vehicles that has, in some instances, been on the road for over seven years. In fact, the overwhelming majority (98.3%) of customer complaints received regarding these subject ball joints did not communicate any safety concern whatsoever. The issues raised by customers primarily related to the cost of ball joint service.

Further review of the small number of complaints received by DCC that alleged actual upper ball joint separation did not reveal a trend or pattern. Several of the reports indicate that there had been subsequent warning that the driver had ignored for a significant amount of time before the alleged separation occurred. Additionally, the text from several of the reports provides information which is not consistent with DCC's test results and vehicle and component survey results, in that the time and mileage to alleged separation is not consistent with DCC's findings regarding long term wear. From DCC's analysis of the confirmed reports

of alleged separations provided in the initial EA response, the earliest time from vehicle delivery to the reported separation was 30 months in a corrosive environment, while the minimum mileage to alleged separation was just over 28,000 miles in a corrosive environment. It is DCC's position, which is supported by the vehicle survey and the field part return data (both provided to NHTSA as a part of the EA submission) that only a very small number of components could ever achieve this grossly negligent level of wear. In a period of 30 months or 28,000 vehicle miles, one would expect that most reasonably responsible owners would have had the vehicle serviced at least three (3) times, which would have provided ample opportunity to have the vehicle inspected and the condition detected.

In summary, for the reasons stated above and based on the data contained in this and prior submissions, it is DCC's assessment that there is not a safety-related defect in the ball joints of the subject vehicles or an unreasonable risk to motor vehicle safety.

- Next, there were few complaints that alleged actual upper ball joint separation and those complaints did not reveal a trend or pattern. Even distinguishing the NCM upper ball joint equipped vehicle population from the whole, the complaint rate was only 2.0 conditions per 100,000 vehicles.

- Third, there is substantial and sufficient warning to vehicle owners that the upper ball joints may need replacement well before an upper ball joint separation occurs. The investigation revealed that nearly all of the operators responded to these warning signs. It was only the few operators that (1) ignored the lengthy and obvious warnings such as audible noise and tire wear, (2) did not want to pay for ball joints service and/or (3) elected not to follow the suggested maintenance and inspection service procedures contained in the owner's manual that experienced a risk of separation of the upper ball joint assembly.

- Fourth, it is apparent from a large sample of survey data that even on vehicles identified with compromised sealing in either the boot or the crimped surface that any degradation of the ball to socket interface occurs over an extended period of time. This appears to be true of both TRW and NCM designed upper ball joint assemblies. On 2000 model year vehicles equipped with NCM upper ball joints ranging in mileage from 29,000 to 120,000 (average 66,900 miles), only one (1) of 14 surveyed vehicles had a measured end play (at 0.073") beyond the recommended 0.060" replacement specification. Since warranty return parts measured to have end play as high as just under 0.400" have been identified without experiencing ball separation from the socket, it can be deduced that degradation in end play due to a compromised seal, evacuation of grease, bearing wear and ultimately grinding corrosion takes a significant amount of time and mileage. As supported with the complaint data, this period of time and/or mileage is more than sufficient for customers to recognize the issue.

- Fifth, data shows that peak upper ball joint tensile loads as measured in vehicle during severe duty cycle events are still less than 25% of the measured tensile separation strength of a severely worn ball joint with just under 0.400" end play. This end play exceeds the recommended replacement specification of 0.060" by a factor of greater than six (6).

- Sixth, there were dramatic spikes in ball joint complaints among vehicle owners immediately following national media stories related to the investigation that do not accurately reflect actual ball joint issues in the subject vehicles. As evidence, many of the complaints following the media coverage were driven by a liberal application of the term "ball joint" as a causal description for many vehicle related complaints, including issues not even relating to the front suspension.

- Lastly, there were no injuries caused by a ball joint separation in the subject population of vehicles that has, in some instances, been on the road for over seven years. In fact, the overwhelming majority (98.3%) of customer complaints

received regarding these subject ball joints did not communicate any safety concern whatsoever. The issues raised by customers primarily related to the cost of ball joint service, or following opening of the investigation were primarily media driven.

In summary, for the reasons stated above and based on the data contained in this and prior submissions, it is DCC's assessment that there is not a safety-related defect in the ball joints of the subject vehicles or an unreasonable risk to motor vehicle safety.

Sincerely,

For Stephan J. Speth
Director
Vehicle Compliance and Safety Affairs

Attachment