11/21/05

GENERAL MOTORS NORTH AMERICA
Structure & Safety Integration

November 11, 2005

Richard P. Boyd, Chief
Vehicle Control Division
Office of Defects Investigation
NHTSA
Room #5326
400 Seventh Street, S.W.
Washington, D.C. 20590

GM-671 Supplement 4

NVS-213phk
PE04-060

Dear Mr. Boyd:

This letter is General Motors' (GM) response to your October 14, 2005 e-mail request for additional information regarding the subject investigation.

Your questions and our corresponding replies are as follows:

Information Request - GM Hummer H2 Supplier - Grade Foundry

1. **Provide the material specifications for the ductile iron used in the casting of the H2 steering knuckles including any dated changes, substitutions, or other requirements.**

   The knuckle material is specified in SAE standard J434 (revised version of June 1986) as Grade D4512 (typical 45 ksi yield strength with 12% elongation) with required 156-217 Brinell Hardness Number (4.8-4.1 mm Brinell Indent Diameter). See Attachment 1 CD with a file name "Resp to Q1 SAE J434 JUN86" for a copy of the SAE J434 JUN86 Revised version.

2. **Which party designed the component and was the material specified and used in the Finite Element Analysis?**

   GM has design responsibility for the knuckle used in the subject vehicles. GM's steering knuckle finite element analyses use material properties that are consistent with J434 (June 1986) specified in response to question 1. See Attachment 2 CD GM Confidential with file name "Resp to Q2 CAE Material Property" for model criteria used for the analysis on the current H2 steering knuckle.

3. **What is the range of metallographic composition and the chemical composition for the material used including required amounts, limitations, and acceptable levels of impurities?**

   The hardness and microstructure of the material are identical to the requirements of SAE J434 (revised version of June 1986). The metallurgical and chemical compositions are varied to achieve the material hardness specification.

   The typical metallurgical compositions are:
   86% minimum nodularity (80% minimum requirement)
   10-80% pearlite
   Chemical composition is adjusted by the foundry to meet nodularity and material hardness specification while avoiding primary carbides. The typical chemical compositions are shown below:
   Carbon - 3.5-4.0%;
   Silicon - 1.9-2.8%;

Magnesium - > 0.025%;
Copper - < 0.35%;
Chromium - < 0.09%;
Tin - < 0.012%;
Manganese - < 0.5%;
Phosphorous - < 0.045%;
Sulfur - < 0.02%;
All other elements - < 0.1% max

4. **How is the melting, casting, and shakeout process documented? Please provide QS9000 or TS16949 documentation.**

   See attached control plan for the Reedsburg facility in Attachment 3 CD Grede Confidential with file name "Resp to Q4 and Q5 Control Plan". Similar information for the St. Cloud facility is being assembled and will be provided at a later date.

5. **How is the melting, casting, and shakeout process monitored for compliance? Include examples of audits, supervisory layered audits, and other checklists from the winters of 2002/2003/2004. Provide reaction plans for audit non-conformance.**

   See attached control plan for the Reedsburg facility in Attachment 3 CD Grede Confidential with file name "Resp to Q4 and Q5 Control Plan" for melting, casting, shakeout process monitored for compliance, and reaction plans for audit non-conformance. Three examples of control plan check sheets from the winters of 2002, 2003, and 2004 are provided. Similar information for the St. Cloud facility is being assembled and will be provided at a later date.

6. **How are the knuckles cast? How many knuckle molds are cast in each pour? Are the left and right knuckles cast in the same mold?**

   Knuckles are cast in a green sand mold on a 2070 Disamatic molding machine. Iron is cupola melted, treated using the George Fisher pure magnesium converter process, and poured from a pressure pour furnace. Each pour makes four castings. There are two lefts and two rights in the same mold. Attached are photos for pattern plates in Attachment 1 CD with file names "Resp to Q6 knuckle tooling picture 1" and "Resp to Q6 knuckle tooling picture 2".

7. **How are the parts packaged for transport?**

   The knuckles are bulk packed in a wire basket.

8. **Is any further heat treat performed on the castings beyond shakeout?**

   The cast knuckles are not heat treated.

9. **What is the age of the facility where the castings are made?**

   Grede Foundries Reedsburg and St. Cloud are approximately 55 years and 36 years old, respectively. The age of the facility refers to the building properties. The cupola melting, iron treatment and flaskless Disamatic casting equipment used in production of the castings are state of the art. Pattern tooling is new for each part.

10. **What are the quality performance metrics of the knuckle mold line for 2002, 2003, 2004, and year to date 2005? This would include scrap rate, First Time Quality, Shipment schedule compliance.**

    See attached quality performance metrics in Attachment 3 CD Grede Confidential with file name "Resp to Q10 Knuckle scrap History".

11. **Is there an in-line test for 100% of the parts to confirm nodularity and ductility?**

    100% of the knuckle castings are tested for nodularity using ultrasonic velocity testing.

12. **What is the maximum level of inventory (tons or estimated quantity) of H2 knuckles that has been carried since the H2 start of production?**

    Since the start of vehicle production for the 2003 model year, Grede typically has approximately 1700 knuckle castings (H2 and GMT800 pickup) in their inventory which equates with approximately one day of vehicle production.

Information Request- GM Hummer H2- Assembly Plant

1. **What is the torque specification for the H2 Knuckles with respect to the lower ball joint? (include any dated changes, substitutions, or other requirements.) What are the acceptable limits today? Provide a history of any changes.**

   GM provided this information to NHTSA in the IR response letter of February 28, 2005 for question numbers 9 (action number 9-7) and 10. This information is provided in Attachment 2 CD GM Confidential with file name "Resp to Q1 Torque Spec".

2. **List the plant equipment that torques the lower ball joint (herein lbj). Is it pneumatic or electric? What are the capabilities? How long has this equipment been in use? List the same information for preceding equipment performing this job.**

   The LBJ torque tool is Atlas Capco Electric (model number ETV S7 150 CTSAD HAD). The tool is electric and has a maximum torque capability up to 150 Nm with angle sensing. The tool is serviced and calibrated every six months and has been used since the 2003 Model Year start of vehicle production.

3. **How is the lbj torque process documented? Please provide QS9000 or TS16949 documentation.**

   Dynamic torque and angle data is recorded and stored in a database and is kept for 6 months. Quality Control Operation Sheet from the Mishawaka plant is also provided in Attachment 2 CD GM Confidential with file name "Resp to Q3 H2 Front LCA QCOS" and "Resp to Q3 H2 Torque Control 2CP0021".

6.(a)(i) **How is the lbj torque process monitored for compliance? Include examples of audits, supervisory layered audits, and other checklists from 2002 to present.**

   GM provided this information to NHTSA in the IR response letter of February 28, 2005 for question number 9 (action number 9-7). The plant takes 3 static readings per shift (one by Quality Verification personnel and two by production line personnel). The data is recorded on a trend chart and kept for 30 days. A sample of a static torque worksheet from April 2004

through January 2005 is provided in Attachment 2 CD GM Confidential with file name "Resp to Q5 H2 LCA to knuckle static torque" and "Resp to Q5 static torque raw data". The data taken by QV personnel is kept electronically for 6 months and was submitted in the original response on 9-7.

6. Is this process done the same way in the H2 plant as in the C/K truck plants? How is it different?

This information is in Attachment 2 CD GM Confidential with file name "Resp to Q6".

A letter from Grede that requests confidential treatment for documents can be found in Attachment 3 CD Grede Confidential.

Sincerely,

Gay P. Kent
Director
Product Investigations

Attachments

GM671 Supplement 4
PE04-080

ATTACHMENT "1"

GM671 Supplement 4
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CONFIDENTIAL MATERIAL HAS BEEN REMOVED FROM THIS ATTACHMENT AND SUPPLIED TO THE OFFICE OF THE CHIEF COUNSEL

ATTACHMENT "2"

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ATTACHMENT "3"

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