

September 23, 2013

Scott Yon, Chief
Vehicle Integrity Division
Office of Defects Investigation
National Highway Traffic Safety Administration
1200 New Jersey Ave, SE, Room W46-409
Washington, DC 20590

N130136
Partial II

NVS-212eer
RQ13-003

Dear Mr. Yon:

This letter is General Motors' (GM) partial response to your Recall Query (RQ13-003) to investigate Generator Control Module (GCM) overheating that could lead to smoke and/or fire. The overheating occurs in certain model year (MY) 2012-2013 Buick Regal and LaCrosse, and MY 2013 Chevrolet Malibu Eco vehicles, equipped with eAssist, manufactured by General Motors LLC (GM).

As you agreed, in emails dated August 29, 2013 and September 16, 2013, this is a partial response containing the responsive information to request numbers 10, 12, and 13. The response to request numbers 1- 6, 7a, 7b, 8 and 11 was provided on September 9, 2013, the remainder of the response will be provided by October 7, 2013.

Your requests and our corresponding replies are as follows:

10. Describe all modifications or changes made by, or on behalf of, GM in the design, material composition, manufacture, quality control, supply, or installation of the GCM in the subject vehicles, including components within the GCM of the subject vehicles, 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- f. Whether the original unmodified component was withdrawn from production and/or sale, and if so, when;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 component; and
- h. Whether the modified component can be interchanged with earlier production components.



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

GM is providing a summary of the information requested in Q10 (a-h) on ATT_1_GM disk in the folder labeled "Q_10". Refer to the file labeled "Q_10_GCM Modifications".

GM is not aware of any modifications or changes to the subject component that may be incorporated into vehicle production within the next 120 days, which relate to, or may relate to, the alleged defect in the subject vehicles.

12. The service procedure utilized for recall remedy 13V-173 and earlier GM service actions as outlined and described in GM Recall Bulletins 13136 and 13142 (including all prior or later versions of the procedure that GM has issued or produced – referred to as the remedy procedure) includes an inspection and testing that stresses the GCM in order to identify potential failures in the subject component. With respect to each remedy procedure contained in Recall Bulletins 13136 and 13142, as it existed at any time:

- a. State the (earliest) date the remedy procedure was developed;
- b. State the date of the remedy procedure's latest revision or change;
- c. Identify each specific failure mechanism of the subject component (e.g., thermal management faults, component or device failures, resistive shorting between components or power and ground planes, circuit board defects such as contamination, resin defects, electro-migration paths, moisture, dendritic growth, flux contamination, plate through hole defect, etc.) that the remedy procedure is intended to, or is capable of, identifying;
- d. Separately for each failure mechanism in item (c), identify the specific component, device, and/or the circuit board (location) where the failure occurs or resides, or may occur or reside;
- e. Separately for each failure mechanism in item (c), describe in detail how the remedy procedure causes the failure mechanism to occur or manifest itself in the subject component, and what specific mechanisms or conditions does the remedy procedure introduce or exploit to cause or to manifest the failure;
- f. Identify and explain any substantive changes or revisions incorporated in each version of the remedy procedure that affected its ability to identify failure mechanisms or failure locations;
- g. For all changes or revisions identified in item (f), state the date of the change and describe in detail how the change affected the remedy procedure's efficacy;

- h. Describe in detail how the remedy procedure is capable of, or effective in, identifying any of the item (c) failure mechanism in the event they exist on the GCM circuit board that filters electrical voltage/power between the high voltage battery and the engine coupled starter/generator machine (e.g., if the capacitor printed circuit board (PCB) contains one of the item (c) failure mechanisms, can the remedy procedure identify it, and if so, how); and,**
- i. Identify any GCM failure mechanisms known to GM that may result in the alleged defect that the procedure is unable to identify, and state the specific component/device/circuit board where the mechanism occurs/ resides.**

GM Recall Bulletin 13142:

All the vehicles subject to GM Recall Bulletin 13142 (13142) were identified as Bucket B in the May 15, 2013 Presentation to NHTSA. The service procedure (remedy procedure) utilized in 13142 does not include inspection and testing that stresses the GCM. It was not intended to identify a failure mechanism or be effective in identifying any failure mechanism. The remedy procedure in 13142, instructs dealers to:

1. Remove GCM.
2. Install a new GCM.
3. Perform a charging system voltage output test by following one of the 2 options listed in the bulletin.

The purpose of the charging system voltage output test is to verify that the new GCM has been installed correctly and functions as expected.

Development of the remedy procedure in 13142 started in late April 2013. It was released in the bulletin on May 23, 2013.

On August 1, 2013, GM Recall Bulletin 13142A (13142A) was released. The remedy procedure revision in 13142A was not related to identifying a failure mechanism. GM explained this revision in detail in a discussion with NHTSA on September 5, 2013.

On August 12, 2013, GM Recall Bulletin 13142B (13142B) was released. The remedy procedure in 13142B was not revised. The part information was revised and that revision was not related to identifying a failure mechanism.

GM Recall Bulletin 13136:

The vehicles subject to GM Recall Bulletin 13136 (13136) were identified in the May 15, 2013 Presentation to NHTSA as Buckets A and C. The remedy procedure in 13136 includes an inspection process designed to accelerate normal customer usage relating to the GCM by increasing temperature and cycling the voltage and current for a length of time that stresses the GCM.

a. State the (earliest) date the remedy procedure was developed;

Development of the remedy procedure in 13136 started on August 10, 2012.

b. State the date of the remedy procedure's latest revision or change;

On August 12, 2013, GM Recall Bulletin 13136C was released. This version of the bulletin contained a revision to the remedy procedure. This revision was not a substantive change to the remedy. GM explained this revision in detail in a discussion with NHTSA on September 5, 2013.

c. Identify each specific failure mechanism of the subject component (e.g., thermal management faults, component or device failures, resistive shorting between components or power and ground planes, circuit board defects such as contamination, resin defects, electro-migration paths, moisture, dendritic growth, flux contamination, plate through hole defect, etc.) that the remedy procedure is intended to, or is capable of, identifying;

The remedy procedure was developed to identify resistive shorts between adjacent layers in the PCBs.

d. Separately for each failure mechanism in item (c), identify the specific component, device, and/or the circuit board (location) where the failure occurs or resides, or may occur or reside;

Resistive shorts can occur between: HV+ to HV-, HV+ to GND, HV- to GND, 12V+ to GND.

e. Separately for each failure mechanism in item (c), describe in detail how the remedy procedure causes the failure mechanism to occur or manifest itself in the subject component, and what specific mechanisms or conditions does the remedy procedure introduce or exploit to cause or to manifest the failure;

The remedy procedure was developed to:

- Accelerate normal usage stress by increasing temperature and cycling the voltage and current for a length of time.
- Heat the PCB components and traces using as much current as possible through the traces while keeping the high voltage potential as high as possible.

The combination of these stress factors over a period of time was used to determine if a void that led to a short circuit was present in any of the PCBs within the GCM. A void in an insulating layer in a PCB may provide a path for electro-migration. The electro-migration may propagate with time, temperature, voltage and current, resulting in a conductive path that leads to a resistive short and local heating.

- f. Identify and explain any substantive changes or revisions incorporated in each version of the remedy procedure that affected its ability to identify failure mechanisms or failure locations;**

There were no substantive changes made to the remedy procedure that affected its ability to identify failure mechanisms or failure locations that were incorporated into 13136 or any revisions to 13136.

- g. For all changes or revisions identified in item (f), state the date of the change and describe in detail how the change affected the remedy procedure's efficacy;**

See the response above. No substantive changes were made to the remedy procedure that affected the procedures efficacy.

- h. Describe in detail how the remedy procedure is capable of, or effective in, identifying any of the item (c) failure mechanism in the event they exist on the GCM circuit board that filters electrical voltage/power between the high voltage battery and the engine coupled starter/generator machine (e.g., if the capacitor printed circuit board (PCB) contains one of the item (c) failure mechanisms, can the remedy procedure identify it, and if so, how); and,**

The requested information is provided in response to 12e above.

- i. Identify any GCM failure mechanisms known to GM that may result in the alleged defect that the procedure is unable to identify, and state the specific component/device/circuit board where the mechanism occurs/resides.**

There may be failure mechanisms related to discrete internal GCM components, other than the GCM PCBs, that could cause odor or smoke. However they are

not expected to result in an overheat condition that could result in fire. The remedy procedure was developed to identify resistive shorts between adjacent layers in PCBs. It was not developed to identify every GCM failure mechanism.

13. Furnish GM'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; and**
- 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;**

a. The causal or contributory factor(s);

The GCM contains three PCBs. These multi-layer boards consist of a number of conductive layers separated by insulating layers. The insulating layers in some of the PCBs may have some voids due to the inclusion of dry resin with the liquid resin during the manufacturing process.

The GCMs subject to 13142 (bucket B) were identified as having PCBs built from board lots that had a relatively high frequency of these voids due to an apparent loss of quality control at the board supplier. PCBs in the GCMs subject to 13136 (bucket A and C) have demonstrated a very low level of faults related to this condition.

b. The failure mechanism(s);

When the GCM is subjected to normal usage stress (e.g. temperature, current, voltage) for a length of time, a void may provide a path for electro-migration. The electro-migration may propagate with time, temperature, voltage and current resulting in a conductive path that leads to a resistive short and local heating.

The potential for this to occur requires the void to be present, but not all voids lead to a resistive short circuit. The void must occur between areas where conductive layers with differing voltage potentials are present.

The service procedure used in the field actions included an inspection procedure that subjected the GCM to conditions that may be experienced under normal customer usage, but at an accelerated rate. The procedure was designed to heat the PCB components and traces using as much current as possible through

the traces while keeping the high voltage potential as high as possible. The combination of these stress factors over a period of time was used to determine if a void that led to a short circuit was present in any of the PCBs within the GCM. If so, the GCM was replaced.

c. The failure mode(s);

The results of the local heating of the PCB will vary depending upon which circuit board (power board or capacitor board), which conductive traces are involved and which components are near the localized heating of the PCB. As described in the owner notification letters, a gradual loss of battery charge and the illumination of the malfunction indicator light may occur. If the customer continues to drive the vehicle in spite of these warnings, the engine will stall and/or not start. In addition, the customer may notice a burning or melting odor or smoke and/or may hear a "popping" noise from within the trunk.

d. The risk to motor vehicle safety that it poses;

Of the 82 cases in the May 15, 2013 Presentation to NHTSA, the predominant effect of the GCM failure in 46 cases where the incident occurred during customer use was odor (15), visible smoke (12), soot or other visible evidence (9)¹. One of the cases cited an engine stall and six stated an engine no-start. There is one case that indicated visual flames. That vehicle was built in the same period that later became the vehicle population included in GM Recall 13142 (bucket B). The recall remedy for all vehicles subject to GM Recall 13142 is to replace the GCM.

The remaining 36 cases occurred during the inspection procedure at the dealership. The predominant effect of those cases was visible smoke (21), odor (16), and soot or other visible evidence (12)¹. There was one dealer owned vehicle that manifested visible flames during the inspection procedure.

GMs review of field reports, warranty claims and analysis of returned GCMs has continued since the May 15, 2013 presentation to NHTSA. This information indicates:

- The only failure mode that has resulted in a fire outside the GCM that required outside intervention to extinguish is an isolation failure of the capacitor (cap) board
- Statistical analysis demonstrates a continually decreasing failure rate for the GCM related to the alleged defect

¹ Some cases report multiple symptoms

- More than 80% of all isolation related returns occurred before 1000 miles
 - More than 98% of all isolation related returns occurred before 10,000 miles
 - GCMs subject to 13136 have a very low rate of PCB isolation related returns
 - There have been no additional cap board failures since the start of field action 13136
 - The procedure in 13136 simulates vehicle operating conditions representative of severe customer usage but is within the design capability of the GCM and has a negligible effect on the life of the component
 - The projected number of incidents of capacitor board isolation failures, for vehicles that pass the inspection process, is 0.05 incidents by 150,000 miles.
- 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;**

A gradual loss of battery charge which will illuminate the red battery light may occur. Additionally, the malfunction indicator light may illuminate. If a customer continues to drive the vehicle, in spite of these warnings, the engine will stall and/or not start. The customer and/or other persons both inside and outside the vehicle may notice a burning or melting odor or smoke and/or may hear a "popping" noise from within the trunk.

In summary, it is GM's conclusion that the inspection procedure described in the GM Recall Bulletin 13136 has proven to be an effective field remedy and has addressed any potential risks to motor vehicle safety for the following reasons:

- The rate of the alleged defect for the vehicles included in 13136 is very low
- The estimated future failure rate for the cap board is extremely low
- There have been no cap board failures in vehicles included in 13136
- If a cap board failure were to occur, it would likely only occur at low mileage and in vehicles subject to 13142 which requires the replacement of the GCM.

* * *

This response is based on searches of General Motors (GM) locations where documents determined to be responsive to your request would ordinarily be found. As a result, the scope of this search did not include, nor could it reasonably include, "all of their past and present officers and employees, whether assigned to their principal offices or any of their field or other locations, including all of their divisions, subsidiaries (whether or not incorporated) and affiliated enterprises and all of their headquarters, regional, zone and other offices and their employees, and all agents, contractors, consultants, attorneys and law firms and other persons engaged directly or indirectly (e.g., employee of a consultant) by or under the control of GM (including all business units and persons previously referred to), who are or, in or after January 2006, were involved in any way with any of the following related to the alleged defect in the subject vehicles:

- a. Design, engineering, analysis, modification or production (e.g. quality control);
- b. Testing, assessment or evaluation;
- c. Consideration, or recognition of potential or actual defects, reporting, record-keeping and information management, (e.g., complaints, field reports, warranty information, part sales), analysis, claims, or lawsuits; or
- d. Communication to, from or intended for zone representatives, fleets, dealers, or other field locations, including but not limited to people who have the capacity to obtain information from dealers."

This response was compiled and prepared by this office upon review of the documents produced by various GM locations, and does not include documents generated or received at those GM locations subsequent to their searches.

Please contact me if you require further information about this response or the nature or scope of our searches.

Sincerely,

A handwritten signature in black ink, appearing to read "M. Carmen Benavides". The signature is fluid and cursive, with a large, stylized "B" at the end.

M. Carmen Benavides, Director
Product Investigations and Safety Regulations

Attachments