



June 27, 2024

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National Highway Traffic Safety Administration
1200 New Jersey Ave., SE
Room W46-409
Washington, DC 20590

VIA EMAIL
G244857

PE24-011

Subject: General Motors LLC's Responses to NHTSA's May 15, 2024, Information Request in Investigation PE24-011

Dear Ms. Yukevich:

This letter contains General Motors LLC's ("GM") responses (the "**Responses**") to the information requests in your May 15, 2024, letter (the "**Requests**") relating to National Highway Traffic Safety Administration ("NHTSA") Preliminary Evaluation PE24-011, which is a NHTSA investigation of "allegations of a loss of brake assist while driving due to the fracture of a spindle internal to the Electronic Brake Control Module (EBCM), also known as eBoost" in certain model year ("**MY**") 2023-2024 Cadillac Lyriq vehicles (as defined in the Requests, the "**Subject Vehicles**"). GM's Responses also contain information related to 2023-24MY Chevrolet Colorado, 2023-24MY GMC Canyon, 2024MY Chevrolet Traverse, 2024MY GMC Acadia, 2024MY Chevrolet Blazer EV, 2024MY Chevrolet Equinox EV, 2024MY Acura ZDX and 2024MY Honda Prologue vehicles (as defined in the Requests, the "**Peer Vehicles**").¹ GM requested and was granted an extension to provide its full document production accompanying GM's Responses by July 26, 2024. Unless otherwise defined herein, GM's Responses rely on the defined terms in the Requests.

PRELIMINARY STATEMENT

GM prepared its Responses by: (i) identifying, in consultation with the appropriate GM business personnel, the primary electronic databases and document repositories in GM's custody and control that store potentially responsive documents and information in the ordinary course of business, as more fully identified in the Responses below; and (ii) conducting a reasonable search, as appropriate, of these databases and document repositories for responsive documents and

¹ The Requests also list the 2024 MY Cadillac Celestiq as a Peer Vehicle. GM has not and will not produce any 2024MY Cadillac Celestiq vehicles and therefore has not provided any information related to the 2024MY Cadillac Celestiq in its Responses. Although the 2024MY Chevrolet Equinox EV and 2024 MY Acura ZDX vehicles are not identified as Peer Vehicles in the Requests, GM has also included relevant information regarding these vehicles in its Responses as these vehicles are equipped with the Subject Component.

information. GM objects to the definitions of “document” and “GM” in the Requests as overbroad, unreasonably burdensome, and not reasonably tailored to records that might be expected to bear relevant and responsive information. GM’s document production does not contain: (i) attorney-client privileged information or information protected as attorney-work product; and (ii) documents generated or archived in these locations after the dates that GM conducted its final searches. GM construes the Information Request as pertaining to vehicles manufactured for sale in the United States and its territories.

GM’s document production is contained in the folder titled G244857_1_GM. Certain portions of these documents are exempt from public disclosure under the Freedom of Information Act (5 U.S.C. § 552(b)(4)) (“**FOIA**”) and 49 CFR part 512, and have been redacted in the copy contained in the folder. GM has submitted the unredacted nonpublic copy of its document production (in the folder titled G244857_2_GM_CONF) to the NHTSA Office of Chief Counsel under 49 C.F.R. part 512.

Some of the documents in GM’s production contain personally identifiable information (“**PII**”) (e.g., vehicle registration information or VIN, employee names, and customer/employee contact information). GM today submits documents with unredacted PII with the understanding that NHTSA (or GM, if NHTSA prefers) will redact any PII before disclosing these documents to the public.

REQUESTS AND RESPONSES

REQUEST 1:

State, by model and model year, the number of subject vehicles GM has manufactured for sale or lease in the United States. Separately, for each subject vehicle manufactured to date by GM, state the following:

- a. Vehicle identification number (VIN);
- b. Make;
- c. Model;
- d. Model Year;
- e. Subject component part number(s) and design version(s) installed as original equipment;
- f. Date of manufacture (MM/DD/YYYY);
- g. Date warranty coverage commenced (MM/DD/YYYY); and
- h. The State in the United States where the vehicle was originally sold or leased, or delivered for sale or lease (postal abbreviation).

Provide the table in Microsoft Access 2010, or a compatible format, entitled “PRODUCTION DATA.”

GM RESPONSE:

Table 1-1 summarizes the number of Subject and Peer Vehicles that GM has manufactured for sale or lease in the United States.

		MODEL YEAR		
MAKE	MODEL	2023	2024	TOTAL
Cadillac	Lyriq	3317	31572	34889
Acura	ZDX EV	0	2796	2796
Chevrolet	Blazer EV	0	23959	23959
Chevrolet	Colorado-2	63931	44578	108509
Chevrolet	Equinox EV	0	9975	9975
Chevrolet	Traverse C1-2	0	24061	24061
GMC	Acadia C1-2	0	9113	9113
GMC	Canyon-2	20045	18796	38841
HONDA	Prologue EV	0	558	558
TOTAL		87293	165408	252701

TABLE 1-1: SUBJECT AND PEER VEHICLES

GM has produced the information requested in subparts (a) through (h) in the G244857_1_GM folder in the subfolder labeled “Q_01”. Refer to the Microsoft Access 2010 file labeled “Q_01_PRODUCTION DATA.”

In response to subpart (e), the spindle internal to the EBCM (as defined in the Requests, the “**Subject Component**”), is a component internal to the module and does not have its own GM part number. The spindle was identified by the supplier as Pedigree A, B, C, D, or E to distinguish parts having different performance tests and/or manufacturing processes. Accordingly, GM has provided the part number for the EBCM, which is traceable to each VIN, and the supplier pedigree for the Subject Component. GM’s Response to Request 12 provides details on the Subject Component pedigrees.

REQUEST 2:

State the number of each of the following, received by GM, or of which GM is otherwise aware, which relate to, or may relate to, the alleged defect in the subject and peer vehicles:

- Consumer complaints, including those from fleet operators;
- Field reports, including dealer field reports;
- Reports involving a crash, injury or fatality;

- d. Reports involving a fire;
- e. Property damage claims; and
- f. Third-party arbitration proceedings, both pending and closed, where GM is or was a party to the arbitration; and
- g. Lawsuits, both pending and closed, in which GM is or was a defendant or codefendant.

For subparts “a” through “f” state the total number of each item (e.g., consumer complaints, field reports, etc.) separately. Multiple incidents involving the same vehicle are to be counted separately. Multiple reports of the same incident are also to be counted separately (i.e., a consumer complaint and a field report involving the same incident in which a crash occurred are to be counted as a crash report, a field report and a consumer complaint).

In addition, for items “c” through “f” provide a summary description of the alleged problem and causal and contributing factors and GM’s assessment of the problem, with a summary of the significant underlying facts and evidence. For items “e/f” and “f, /g” identify the parties to the action, as well as the caption, court, docket number, and date on which the complaint or other document initiating the action was filed.

GM RESPONSE:

In response to subparts (a) through (g) for the Subject and Peer Vehicles, GM provides the following tables, which GM prepared by conducting a reasonable keyword search for potentially responsive claims² in several databases³.

TYPE OF REPORT	GM REPORTS	SUBCATEGORIES				
		CORRESPONDING TO NHTSA REPORTS (VOQ)	NUMBER WITH PROPERTY DAMAGE	NUMBER WITH CRASH	NUMBER WITH FIRE	NUMBER WITH INJURIES/ FATALITIES
Consumer Complaint	20	0	1	1	0	0
Field Reports	41	0	1	1	0	0
Not-In-Suit Claims	0	0	1	1	0	1
Third Party Arbitration Proceedings	0	0	0	0	0	0
Product Liability Lawsuits	0	0	0	0	0	0
Total Reports (Including Duplicates)	61	0	3	3	0	0
Total Vehicles with Reports (Unique VIN)	43	0	1	1	0	1

² GM did not identify and NHTSA did not provide any relevant Vehicle Owner Questionnaires (VOQs).

³ These databases include: Customer Assistance Center (CAC), Product Assistance Center (PAC), Business Resource Center (BRC), Technical Assistance Center (TAC), Field Information Network Database (FIND), COMPASS, Field Product Report Database (FPRD) and GM Legal records. GM was also provided records from Honda’s engineering databases.

**TABLE 2-1: SUMMARY OF CLAIMS RESPONSIVE TO REQUEST 2A-2G FOR THE SUBJECT AND
PEER VEHICLES**

As summarized in Table 2-1, GM is aware of 43 unique claims involving the Subject and Peer Vehicles that may be responsive to Request 2. In determining the responsiveness of a claim, GM erred on the side of coding the claim as responsive, even if the evidence in GM's possession linking the claim to the fracture of the internal EBCM spindle during an Automatic Braking System ("ABS") event (as defined in the Requests, the "**Alleged Defect**") was implausible, inconclusive, or circumstantial. Accordingly, the claim totals in Table 2-1 are conservative.

Additional information about the claims is available in the document production that GM is providing in response to Request 4, and GM's assessment of the Alleged Defect is provided in its Response to Request 16.

GM is aware of one alleged crash potentially related to the Alleged Defect involving VIN #1GYKPMRK7PZ000495. The driver alleges that the brakes failed to stop the vehicle in time and she hit the vehicle in front of her, which resulted in a soft tissue injury not requiring medical attention. The driver further claims there was no notification of a braking issue prior to the crash, but a brake system failure message appeared on the vehicle dash after the incident. Analysis of the crash incident determined that the brakes were not applied until 1.5 seconds prior to the vehicle contacting the preceding vehicle. Upon inspection, it was found that the vehicle had damage to the front fascia corner and that diagnostic trouble code ("**DTC**") C0021 was recorded, which is potentially related to the Alleged Defect. Given the timing of brake application prior to the crash, it cannot be determined whether the Alleged Defect contributed to the incident.

REQUEST 3:

Separately, for each item (complaint, report, claim, notice, or matter) within the scope of your response to Request No. 2, state the following information:

- a. GM's file number or other identifier used;
- b. The category of the item, as identified in Request No. 2 (i.e., consumer complaint, field report, etc.);
- c. Vehicle owner or fleet name (and fleet contact person), email address and telephone number (please use distinct fields for each data type);
- d. Vehicle owner or fleet, street address, city, state (postal abbreviation), ZIP code (please use distinct fields for each type);
- e. Vehicle's identification number (17-character VIN);
- f. Vehicle's make, model, and model year (please use distinct fields for each type);
- g. Vehicle's mileage at time of incident (numeric data type);

- h. Incident date (MM/DD/YYYY);
- i. Report or claim date (MM/DD/YYYY);
- j. EBCM software version on the vehicle at the time of the incident;
- k. Whether a crash is alleged;
- l. Whether a fire is alleged;
- m. Whether property damage is alleged;
- n. Number of alleged injuries, if any; and
- o. Number of alleged fatalities, if any.

Provide this information in Microsoft Access 2010, or a compatible format, entitled “REQUEST NUMBER TWO DATA.”

GM RESPONSE:

GM has produced the requested information for the Subject Vehicles in the G244857_1_GM folder in the subfolder labeled “Q_03”. Refer to the Microsoft Access 2010 file labeled “Q_03_REQUEST NUMBER TWO DATA.” In response to Request 3(j), GM has provided a column indicating whether the diagnostic software test was installed prior to the claim.

REQUEST 4

Produce copies of all documents related to each item within the scope of Request No. 2. Organize the documents separately by category (i.e., consumer complaints, field reports, etc.) and describe the method GM used for organizing the documents. Describe in detail the search methods and search criteria used by GM to identify the items in response to Request No. 2.

GM RESPONSE:

With respect to Request 4, GM CAC, PAC, TAC and Legal records are GM’s primary repositories of potentially responsive documents in the ordinary course of business. GM identified responsive documents by conducting a keyword search of these records for potentially responsive claims and reviewed the associated claim file to confirm the responsiveness of the claim. GM is producing the responsive, nonprivileged documents associated with responsive claims listed in Table 2-1 in the Microsoft Access file labeled “Q_03_REQUEST NUMBER TWO DATA” in the subfolder labeled “Q_03” in the G244857_1_GM folder. GM has organized the records by the GM file number.

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

REQUEST 5

State, by model and model year, a total count for all of the following categories of claims, collectively, that have been paid by GM to date that relate to, or may relate to, the alleged defect in the subject and peer vehicles: warranty claims; extended warranty claims; claims for good will services that were provided; field, zone, or similar adjustments and reimbursements; and warranty claims or repairs made in accordance with a procedure specified in a technical service bulletin or customer satisfaction campaign.

Separately, for each such claim, state the following information:

- a. GM's claim number;
- b. Vehicle owner or fleet name (and fleet contact person), email address and telephone number (please use distinct fields for each data type);
- c. Vehicle owner or fleet street address, city, state (postal abbreviation), and ZIP code (please use distinct fields for each data type);
- d. Vehicle identification number (17-character VIN);
- e. Repair date (MM/DD/YYYY);
- f. Vehicle mileage at time of repair (numeric data type);
- g. Repairing dealer's or facility's name, telephone number, city and state or ZIP code;
- h. Labor operation number(s);
- i. Problem code(s);
- j. Diagnostic trouble code(s);
- k. Replacement part number(s) and description(s);
- l. Concern stated by customer;
- m. Cause as stated on the repair order;
- n. Correction as stated on the repair order; and
- o. Additional comments, if any, by dealer/technician relating to claim and/or repair.

Provide this information in Microsoft Access 2010, or a compatible format, entitled "WARRANTY DATA."

GM RESPONSE

To collect warranty data responsive to this request, GM conducted a reasonable keyword search of the GM Quality Data and Analytical Platform Tool (“**QDAP**”), GM’s primary repository of potentially responsive warranty claim information in the ordinary course of business.

In determining the responsiveness of a claim, GM erred on the side of coding the claim as responsive, even if the evidence in GM’s possession linking the claim to the Alleged Defect was implausible, inconclusive, or circumstantial. Specifically, regardless of confirmation of a fractured spindle, all claims where dealer verbatims mentioned the recorded DTCs C0021, C2A60, and/or C055F, each of which could potentially involve a broken spindle, were included. These DTCs can be triggered by other issues with the eBoost/EBCM module or braking system, including internal seal failures, ruptured hoses, seized motors, and ABS valve failures. Accordingly, the claim totals in Table 5-1 are conservative.

Table 5-1, below, summarizes the warranty claims for the Subject and Peer Vehicles that may relate to the Alleged Defect.⁴ There are a total of 59 warranty claims with unique VINs that were categorized as responsive.⁵

MAKE	MODEL	MODEL YEAR		TOTAL
		2023	2024	
Cadillac	Lyriq	33	7	40
Chevrolet	Colorado	15	0	15
GMC	Canyon	2	0	2
Chevrolet	Blazer EV	-	2	2
TOTAL		50	9	59

TABLE 5-1: SUMMARY OF SUBJECT AND PEER VEHICLE WARRANTY CLAIMS

Table 5-2, below, summarizes the incidents per thousand vehicles (“**IPTV**”) for the Subject and Peer Vehicles at the appropriate months in service (“**MIS**”) by model year.

<u>MODEL</u>	<u>2023</u>	<u>2024</u>
Lyriq	10.42 @ 16 MIS	0.46 @ 6 MIS
Colorado	0.27 @ 12 MIS	0.00 @ 2 MIS
Canyon	0.07 @ 12 MIS	0.00 @ 2 MIS
Blazer EV	-	0.08 @ 1 MIS
All Subject and Peer Vehicles	0.76 @ 13 MIS	0.09 @ 3 MIS

⁴ QDAP does not contain the vehicle owner’s name or telephone number. Additionally, some replacement part numbers, part descriptions and customer concern code descriptions are not included in the GM warranty database. In response to subpart (j), the diagnostic trouble code (DTC) is not captured separately and, if available, is included in one of the verbatim fields.

⁵ GM identified responsive records based on the information supplied to GM by the servicing dealerships, which can contain material errors and omissions. Warranty records, for example, do not always accurately or completely describe the condition of the allegedly defective part at the time of the warranty correction, and service personnel may not consistently classify warranty repairs using the correct labor and trouble codes.

TABLE 5-2: SUBJECT AND PEER VEHICLE WARRANTY CLAIM RATE

As shown in Table 5-2, the rate of occurrence of the Alleged Defect in the Subject and Peer Vehicles is extremely low. The higher IPTV rate for MY2023 Lyriq vehicles reflects the very low volume of these vehicles produced for this model year.

GM has produced the requested information in subparts (a) through (o) in the G244857_1_GM folder in the subfolder labeled “Q_05”. Refer to the Microsoft Access 2010 file labeled “Q_05_WARRANTY DATA.” In response to subparts (l) and (m), GM has included in these records all available dealer-provided “verbatim text” in the QDAP database relating to the responsive claims that are currently in GM's possession⁶.

REQUEST 6

Describe in detail the search methods and search criteria used by GM to identify the claims in response to Request No. 5, including the labor operations, problem codes, diagnostic trouble codes, part numbers and any other pertinent parameters used.

GM RESPONSE:

To collect warranty data responsive to this request, GM conducted a reasonable keyword search of the GM QDAP tool, GM's primary repository of potentially responsive warranty claim information in the ordinary course of business.

In determining the responsiveness of the claim, GM erred on the side of coding the claim as responsive, even if the evidence in GM's possession linking the claim to the Alleged Defect was implausible, inconclusive, or circumstantial. Specifically, regardless of confirmation of a fractured spindle, all claims where dealer verbatims mentioned the recorded DTCs C0021, C2A60, and/or C055F, each of which could potentially involve a broken spindle, were included. These DTCs can be triggered by other issues with the eBoost/EBCM module or braking system, including internal seal failures, ruptured hoses, seized motors, and ABS valve failures.

REQUEST 7

Provide a list of all labor operations, labor operation descriptions, problem codes, and problem code descriptions, diagnostic trouble codes and diagnostic trouble code descriptions applicable to the alleged defect in the subject vehicles. State whether the diagnostic trouble codes are automatically reported to the warranty database electronically or manually entered into the warranty database by a claims administrator.

GM RESPONSE:

To populate Table 7-1, GM searched the QDAP warranty database for the labor codes that GM identified as potentially related to the Alleged Defect in the Subject and Peer Vehicles. These

⁶ The verbatim text is provided to GM by the dealer that serviced the warranty claim and reflects both dealer- and customer-provided comments relating to the claim.

labor codes are summarized in Table 7-1. Each warranty record may have up to five verbatim fields. All verbatim claim fields were read, and a claim was determined to be responsive if the verbatim indicated that the claim may have been related to the Alleged Defect in the Subject Component.

LABOR CODE	LABOR CODE DESCRIPTION
2441400	Brake Master Cylinder Replacement - With Power Brake Booster and Electronic Brake Control Module
2441430	Brake system module Replacement
2441440	Brake System Control Module Replacement

TABLE 7-1: LABOR CODES USED IN QDAP WARRANTY SEARCH

Table 7-2 summarizes the relevant diagnostic trouble codes that may be related to the Alleged Defect in the Subject and Peer Vehicles. The diagnostic trouble codes are manually entered into the warranty database in one of the five verbatim fields and may be subject to technician input error or omission.

DTC CODE	DTC CODE DESCRIPTION ⁷
C0021	Brake System Performance
C2A60	Brake Hydraulic Circuit Excessive Pressure
C055F	Brake System Control Module Hydraulic Unit Performance

TABLE 7-2: DTC CODES USED IN QDAP WARRANTY SEARCH

REQUEST 8

State, by make and model year, the terms of the new vehicle warranty coverage offered by GM on the subject vehicles (i.e., the number of months and mileage for which coverage is provided and the vehicle systems that are covered). Describe any extended warranty coverage option(s) that GM offered for the subject vehicles and state by option, model, and model year, the number of vehicles that are covered under each such extended warranty.

GM RESPONSE:

Table 8-1 summarizes the terms of new vehicle warranty coverage offered by GM and Honda on the Subject and Peer Vehicles:

MODEL YEAR	MAKE	MODEL	WARRANTY TYPE	WARRANTY TERMS
2023-2024	Cadillac	Lyriq	Limited Bumper-To-Bumper	4 year / 50,000 miles
2023-2024	Chevrolet	Colorado	Emissions Control System Warranty	8 year / 80,000 miles
2023-2024	GMC	Canyon	Emissions Control System Warranty	8 year / 80,000 miles
2024	Chevrolet	Traverse	Emissions Control System Warranty	8 year / 80,000 miles

⁷ The DTC description may vary based on the symptom code associated with the fault.

2024	GMC	Acadia	Emissions Control System Warranty	8 year / 80,000 miles
2024	Chevrolet	Blazer EV	Limited Bumper-To-Bumper	3 year / 36,000 miles
2024	Chevrolet	Equinox EV	Limited Bumper-To-Bumper	3 year / 36,000 miles
2024	Acura	ZDX	Limited Bumper-To-Bumper	4 year / 50,000 miles
2024	Honda	Prologue	Limited Bumper-To-Bumper	3 year / 36,000 miles

**TABLE 8-1: NEW VEHICLE WARRANTY COVERAGE OFFERED BY GM AND HONDA ON
SUBJECT AND PEER VEHICLES**

Many different optional extended warranty plans were available for the Subject and Peer Vehicles through GM and Honda dealerships. These plans were offered at different prices and for varying lengths of time.

REQUEST 9

Produce copies of all service, warranty, and other documents that relate to, or may relate to, the alleged defect in the subject vehicles, that GM has issued to any dealers, regional or zone offices, field offices, fleet purchasers, or other entities. This includes, but is not limited to, bulletins, advisories, informational documents, training documents, or other documents or communications, with the exception of standard shop manuals. Also include the latest draft copy of any communication that GM is planning to issue within the next 120 days.

GM RESPONSE:

GM has not identified any documents responsive to Request 9.

REQUEST 10

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 planned by, or for, GM. 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.

GM RESPONSE:

GM identified responsive investigations by conducting a reasonable search in GM’s Global Vehicle Safety-Case Observation Review and Evaluation (“**GVS-CORE**”) database, which is the primary electronic records database for GM’s Safety and Field Investigations organization, and other GM engineering databases. GM is aware of the following investigations conducted by GM or at GM’s direction that relate to the Alleged Defect:

<u>Action 10-A: GM Internal Investigation N23-239936</u>	
Start/End Dates	February 9, 2023 – July 26, 2023
Involved Engineering Groups	GM Global Safety and Field Investigations, GM Global Engineering
Description	GM investigated claims of loss of brake assist due to an alleged spindle fracture in the eBoost system in the Subject Vehicles and certain other GM and Honda vehicles.
Outcome	On July 26, 2023, upon review of the collected data, GM’s Safety Field Action Decision Authority (“ SFADA ”) decided to close the investigation without field action. GM closed this investigation based on, among other evidence, its field-data analysis, which indicated that the rate of relevant field complaints involving the Subject Vehicles was low and there was 1 alleged accident, 0 injuries, 0 fatalities and 0 fires. Where this condition exists, internal brake performance requirements are met during an ABS event. Reduced brake performance may occur after an ABS event and upon setting of a DTC code. At that point, the driver receives warning of the condition and speed is limited to 70kph. Vehicle performance still exceeds FMVSS requirements by a significant margin.
Associated Documents	Information and documents contained in GVS-CORE related to investigation N24-244709. The files are in the G244857_1_GM and G44857_2_GM_CONF folders labeled as 10A in the index file.
<u>Action 10-B: GM Internal Investigation N23-240898</u>	
Start/End Dates	May 1, 2023 – May 26, 2023
Involved Engineering Groups	GM Global Safety and Field Investigations, GM Global Engineering
Description	GM investigated vehicles shipped prior to E2 Hold Release with potential of loss of brake assist due to an alleged spindle fracture in the eBoost system in

	the 2023MY Chevrolet Colorado and GMC Canyon (a subset of the Peer Vehicles).
Outcome	On May 26, 2023, upon review of the effect of the condition, GM's SFADA decided to close the investigation without a field action. GM closed this investigation in part because if this condition exists, internal brake performance requirements are met during an ABS event. Reduced brake performance may occur after an ABS event and upon setting of a DTC code. At that point, the driver receives warning of the condition and speed is limited to 70kph. Vehicle performance still meets FMVSS requirements.
Associated Documents	Information and documents contained in GVS-CORE related to investigation N24-244709. The files are in the G244857_1_GM and G44857_2_GM_CONF folders labeled as 10B in the index file.
<u>Action 10-C: GM Internal Investigation N23-242591</u>	
Start/End Dates	September 28, 2023 – February 1, 2024
Involved Engineering Groups	GM Global Safety and Field Investigations, GM Global Engineering
Description	GM investigated claims of loss of brake assist due to an alleged spindle fracture in the eBoost system in certain GM vehicles.
Outcome	On February 1, 2024, upon review of the collected data, GM's SFADA decided to close the investigation without a field action. GM closed this investigation based on, among other evidence, its field-data analysis, in which there were no warranty cases in North America, and 0 accidents, 0 injuries, 0 fatalities and 0 fires. The condition declares to driver with a malfunction indicator lamp ("MIL"), and vehicle performance still meets FMVSS requirements.
Associated Documents	Information and documents contained in GVS-CORE related to investigation N24-244709. The files are in the G244857_1_GM and G244857_2_GM_CONF folders labeled as 10C in the index file.
<u>Action 10-D: GM Engineering Documents</u>	
Start/End Dates	2022-2024
Involved Engineering Groups	GM Engineering
Description	Investigation activities involved root cause analysis of the Alleged Defect and development of performance improvements.
Outcome	The conclusions are consistent with GM's Response to Requests 12 and 16 as it relates to causal or contributory factors, failure mechanisms, and failure modes.

Associated Documents	Information, documents, PRTS (Problem Resolution Tracking System), and emails related to root cause analysis and testing. The files are in the G244857_2_GM_CONF folders labeled as 10D in the index file.
<u>Action 10-E: GM Engineering RedX Study</u>	
Start/End Dates	March 10, 2023 - July 14, 2023
Involved Engineering Groups	GM Engineering, Red X Engineering
Description	Investigation activities involved root cause analysis of the Alleged Defect, Red X testing and action taken.
Outcome	The conclusions are consistent with GM's Response to Requests 12 and 16 as it relates to contributory factors, failure mechanisms, and failure modes.
Associated Documents	Information, documents, Problem Resolution Tracking System (PRTS) reports and emails related to root cause analysis and testing. The files are in are in the G244587_2_GM_CONF folder labeled as 10F in the index file.
<u>Action 10-F: GM Engineering Testing</u>	
Start/End Dates	March 2023
Involved Engineering Groups	GM Engineering
Description	Dynamic vehicle testing of 2023 Cadillac Lyriq vehicle demonstrating stopping distance delta for a vehicle with a good spindle compared to a broken spindle. Chart provides a visual representation of the DAP travel, vehicle velocity, vehicle deceleration, and boost pressure vs. time comparing a BOB vs. WOW vehicle.
Outcome	Testing identified a minimal 3.1m stopping distance delta for vehicles stopping on dry pavement.
Associated Documents	Documents related to dynamic vehicle testing and analysis. The files are in the G244857_2_GM_CONF folders labeled as 10G in the index file.
<u>Action 10-G: GM Internal Investigation N24-244709</u>	
Start/End Dates	April 12, 2024 – June 13, 2024
Involved Engineering Groups	GM Global Safety and Field Investigations, GM Global Engineering
Description	GM investigated claims of loss of brake assist due to an alleged spindle fracture in the eBoost system in the Subject Vehicles and certain other GM and Honda vehicles.

Outcome	On June 13, 2024, upon review of the collected data, GM’s SFADA decided to close the investigation without a field action. GM closed this investigation based on, among other evidence, its field-data analysis, which indicated that the rate of relevant field complaints involving the Subject Vehicles was low and there was 1 alleged accident, 0 injuries, 0 fatalities and 0 fires. Where this condition exists, internal brake performance requirements are met during an ABS event. Reduced brake performance may occur after an ABS event and upon setting of a DTC code. At that point, the driver receives warning of the condition and speed is limited to 70kph. Vehicle performance still exceeds FMVSS requirements by a significant margin.
Associated Documents	Information and documents contained in GVS-CORE related to investigation N24-244709. The files are in the G244857_1_GM and G244857_GM_2_CONF folders labeled as 10E in the index file.

TABLE 10-1: GM INVESTIGATIONS AND STUDIES OF THE ALLEGED DEFECT IN THE SUBJECT AND PEER VEHICLES

GM is producing the nonprivileged documents that are responsive to Request 10 in the G244857_1_GM and G244857_2_GM_CONF folders in the subfolders labeled “Q_10”. The index file PE24-011 Q10 Index provided is a directory of the files with the original file names and is labeled as listed in Table 10-1.

REQUEST 11

Describe in detail the manufacturing process for the subject component, including but not limited to quality control procedures to ensure the subject component meets part specifications.

GM RESPONSE:

Documents responsive to Request 11 can be found in the G244857_2_GM_CONF folder in the subfolder labeled “Q_11.” As discussed in detail in GM’s Response to Request 12, different versions of the Subject Component have been termed Pedigrees A, B, C, D, and E by the supplier. The manufacturing process for Pedigrees A, B, and C is discussed on page 2, the manufacturing process for Pedigree D is discussed on page 3, and the manufacturing process for Pedigree E is discussed on page 4 of the EBCM spindle process flowchart document found within GM’s production for Request 11.

REQUEST 12

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 subject component, as utilized in both subject and peer 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 organized by version of “pedigree”:

- 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 to the subject component;
- c. The reason(s) for the modification or change;
- d. The part number(s) (service and engineering) for all versions of the subject component;
- e. When each version of the subject component was withdrawn from production and/or sale;
- f. When each version of the modified subject component was made available as a service component; and
- g. Whether each version of the modified subject component can be interchanged with earlier production components in the subject or peer vehicles.

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 RESPONSE:

A spreadsheet summary of GM engineering work order history on the Subject Component in the Subject and Peer Vehicles is provided in the G244857_2_GM_CONF folder; subfolder labeled “Q_12”. The spreadsheet includes the part number and ECR progression for the different pedigrees.

GM and the suppliers have made continuous improvements to the Subject Component, resulting in five separate Subject Component “pedigrees.” Figure 12-1 shows the spindle pedigree definitions and each pedigree is discussed in detail below:

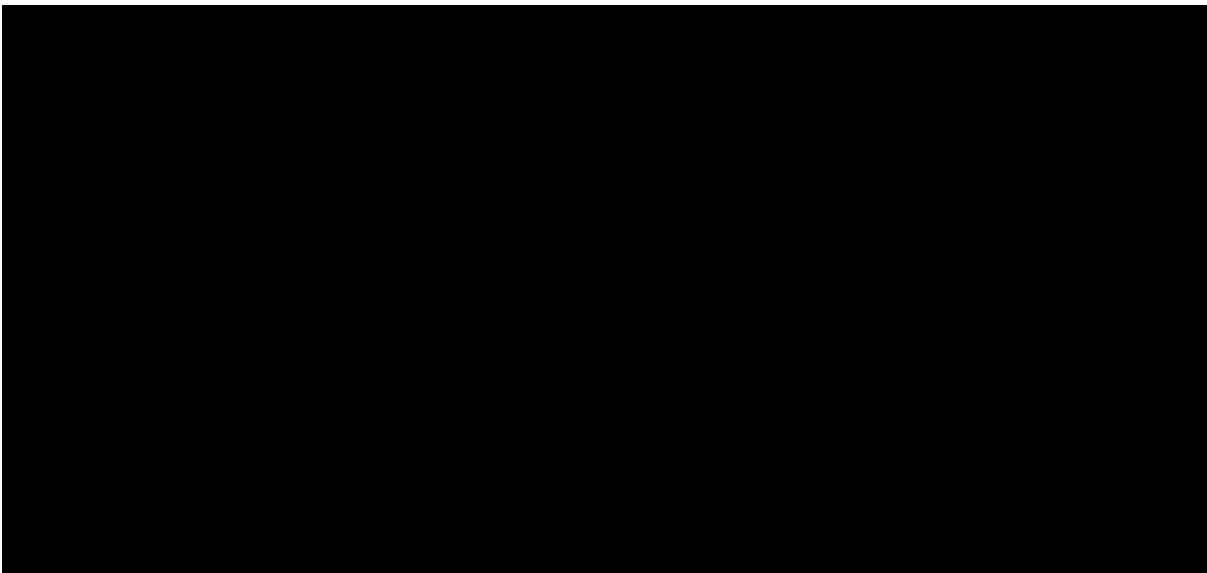


FIGURE 12-1: SPINDLE PEDIGREE DEFINITIONS CHART

Pedigree A

After discovering spindle fractures on early prototype Cadillac Lyriq vehicles, GM and the Tier 1 supplier of the eBoost/EBCM system determined that spindle fracture could occur from hydrogen embrittlement of the spindle material and that spindles with threads with high surface roughness have a higher likelihood of a spindle fracture. The Tier 2 spindle supplier moved the location of their machining process and adjusted their control plan for machining tool life limits and surface roughness audits starting in February 2023.

While working to implement pre-production checks to identify suspect spindle material, GM implemented a pass/fail test of all MY23 Cadillac Lyriq, Chevrolet Colorado, and GMC Canyon vehicles prior to shipment from the plant. Starting on March 6, 2023, every vehicle was subjected to three ABS-induced stopping events prior to shipment from the plant to check for a “Service Brake System” message in the driver information center (“**DIC**”) or related MILs that would result from spindle fracture. If a DIC and/or MIL occurred, the Subject Component was replaced prior to shipment. Subject Components subjected to this plant pass/fail test are termed Pedigree A parts. Pedigree A parts continued to be built into vehicles until approximately February 2023.

Pedigree B

In February 2023, in addition to the three ABS-induced stopping events, the Tier 1 supplier introduced a torque test in which a 20 Nm torque was applied to each spindle, held for 20 sec, followed by a 12 Nm torque; in this test, the torque angle was measured and required to not exceed 3.25 degrees. Subject Components subjected to this torque test and the three ABS-induced stopping events are termed Pedigree B parts. Pedigree B parts were introduced into the assembly plants in March 2023 through April 2023. The part number for Pedigree B parts did not change from Pedigree A parts as the fit, form, and function of the Subject Component did not change.

Pedigree C

In March 2023, the Tier 1 supplier implemented an inline air test of the Subject Component with 140 bar pressure induced in the module, with the spindle retracted like during an ABS event. Subject Components subjected to this inline air tests, the torque test and the three ABS-induced stopping events are termed Pedigree C parts. Pedigree C parts were introduced into the assembly plants in March 2023 through April 2023. The part number for Pedigree C parts did not change from Pedigree A parts as the fit, form, and function of the Subject Component did not change.

Pedigree D

In May 2023, the Tier 2 supplier introduced an additional baking process into the spindle manufacturing process to improve material robustness. Every spindle was tempered (baked) at 120-140 degree C for 4-4.5 hours. Subject Components with spindles subjected to this additional baking process are termed Pedigree D parts. The part number for the affected modules was changed to identify this manufacturing improvement. The three ABS-induced stopping event test was eliminated at this time, but the torque and pressure tests continued. Pedigree D parts were introduced in the assembly plants in May 2023.

Pedigree E

In April 2024, the Tier 2 supplier introduced a new baking process to improve material robustness, replacing the additional baking process used for Pedigree D parts. This process includes tempering of the spindle material to 160 deg C for 120 min. Subject Components with spindles subjected to this new baking process are termed Pedigree E parts. At this time, the torque test was eliminated from the Tier 1 manufacturing testing schedule.

REQUEST 13

Describe in detail how the subject component and eBoost system perform during an anti-lock braking event when operating optimally.

GM RESPONSE:

Figure 13-1 depicts a cross section of the eBoost module. The Subject Component is identified as the spindle in Figure 13-1 and is part of an assembly identified as the dual action plunger (“DAP”), which includes the piston, rod, barrel, spindle, and nut.



FIGURE 13-1: CROSS SECTION OF EBOOST MODULE

During a brake apply event in normal vehicle operation, the eBoost motor will energize, rotating the spindle and moving the DAP in the forward direction to generate pressure to assist vehicle braking. During this forward motion, the Subject Component is under compression as it compresses the fluid on the face of the plunger. For most braking events, sufficient pressure to

fulfill the braking demand will be generated with the forward motion of the DAP only. When braking (deceleration) demand exceeds what the road surface can support and there is wheel slip, ABS will engage.

While ABS is engaged, a pair of control valves for each of the four brakes will cut off pressure from the eBoost unit to the wheel end brakes and release pressure as needed to maintain wheel control. Once wheel slip is controlled, the valves that cut off pressure to the wheel end brake re-open, the valves that release pressure close, and high-pressure fluid from the DAP flows into the wheel end brake. The motor energizes, rotating the Subject Component and moving the DAP to maintain pressure as fluid flows from the DAP to the wheel end brake.

As the ABS event continues, the DAP may reach its limit of forward travel. When this occurs, the motor stops and reverses, moving the DAP in the reverse direction. DAP reversal occurs due to the need for more fluid as the ABS system continues to cycle. This movement puts the Subject Component into tension as the fluid on the opposite side of the DAP is compressed. Actuation of valves in the system allow pressure to build on this reverse stroke movement. This cycle of forward and reverse DAP travel is known as ABS cycling and can continue as long as necessary to maintain pressure throughout the braking event, until the vehicle comes to a stop.

REQUEST 14

Describe in detail the effect of a fractured subject component on the braking system and the anti-lock braking system of the subject and peer vehicles.

GM RESPONSE:

As discussed in GM's Response to Request 13, during ABS cycling, DAP reversal occurs at high speed under high load. In rare instances, due to the high loads on the reverse side of the head of the DAP during reversal, the Subject Component can fracture. Figure 14-1 summarizes the driver and vehicle effect of the Alleged Defect, described in detail below.

CUSTOMER AND VEHICLE EFFECT DUE TO SUBJECT CONDITION

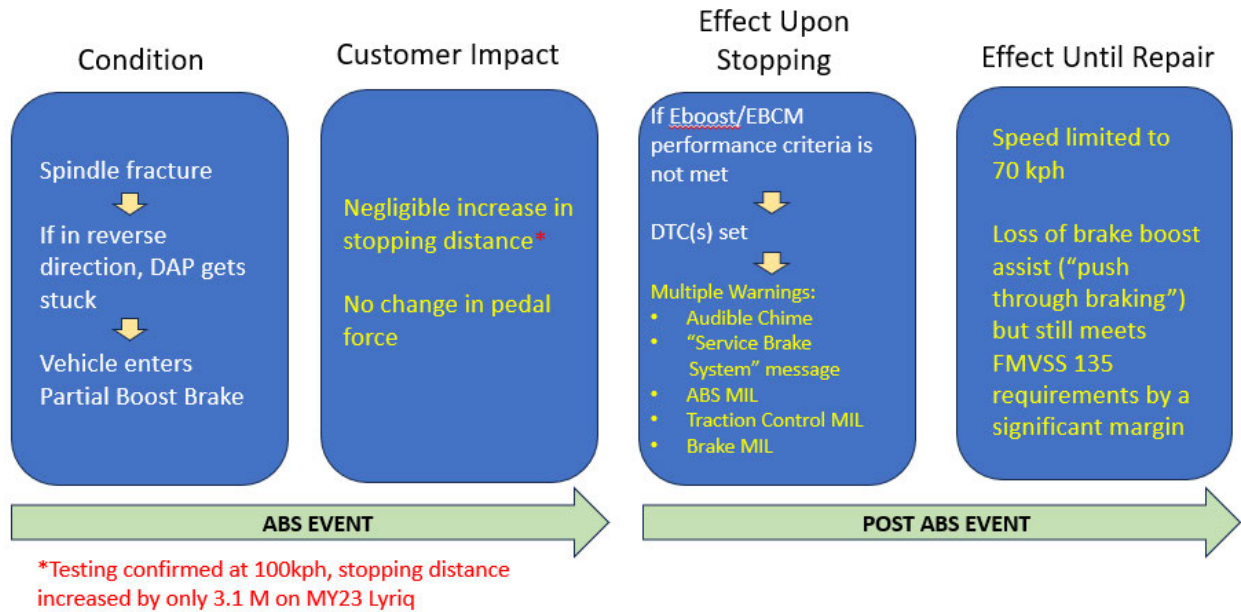


FIGURE 14-1: DRIVER AND VEHICLE EFFECT OF ALLEGED DEFECT

After spindle fracture, ABS cycling continues to consume fluid, but the broken spindle means the DAP remains frozen in the reverse direction, which does not allow the DAP to build additional pressure. The pressure in the system will drop until all four tires no longer have ABS engaged, after which the corner pressures stabilize at a value just below the ABS control for the duration of the brake apply.

For this reason, if a spindle fracture occurs during a braking event, the impact of the fracture on braking performance during that braking event is insignificant. As depicted in Figure 14-2 below, testing at GM demonstrated that, although the pressure in the system drops, it does not drop below the ABS level until after the vehicle comes to a complete stop. Accordingly, if spindle fracture occurs while driving, brake assist is largely retained during the ABS event leading to fracture because sufficient pressure will have already been generated in the eBoost system. This testing, which was completed with a starting velocity of 100 kph, demonstrated that spindle fracture during an ABS event only results in a negligible increase in stopping distance of only 3.1 meters. (See Response 10, Section 10-F, and Figure 14-2 below, which visually depicts the DAP travel, vehicle velocity, vehicle deceleration and eBoost pressure versus time during dynamic vehicle testing). This increase would be imperceptible to the driver, and spindle fracture during the ABS event would have an undetectable impact on brake performance and perceived pedal force.

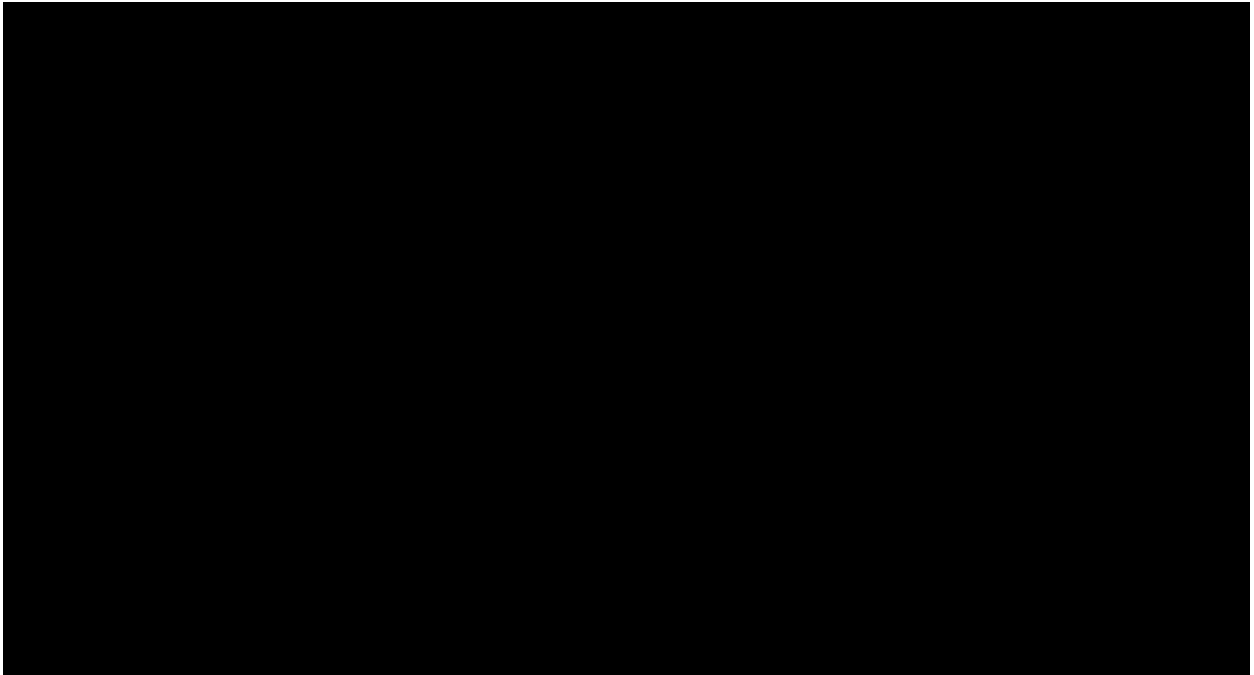


FIGURE 14-2: DYNAMIC VEHICLE TESTING GRAPH

Brake assist is only lost after the vehicle comes to a complete stop and the vehicle sets one of three DTCs based on EBCM performance criteria not being met. These DTCs, in turn, cause several driver alerts to activate: an audible chime, a visual “Service Brake System” message in the DIC, and multiple illuminated MIL lights for the ABS, Traction Control, and Brakes to illuminate. The vehicle speed will also be limited to 70 kph. The brakes, however, remain fully operable while unassisted, referred to as “push-through braking.” Even without brake assist, vehicle stopping distance for all Subject and Peer Vehicles remains well within FMVSS 135 regulated limits by a significant margin.

REQUEST 15

Describe all modification of changes made by, or on behalf of, GM in the software which relates to the EBCM. For each such modification or change, provide the following information:

- a. The date or approximate date on which the modification or change was released to consumer vehicles;
- b. Was the software change made via over-the-air (OTA);
- c. Completion rate(s) of the software modifications or changes;
- d. A detailed description of the modification or change;
- e. The reason(s) for the modification or change;
- f. The part number(s) / identification number(s) of the modified software; and

- g. Whether similar software changes have been, or are planned to be, released for peer vehicles.

GM RESPONSE:

A spreadsheet summary of the GM engineering work order history, part number changes and approximate implementation dates for the diagnostic software change in the Subject and Peer Vehicles related to the Alleged Defect is provided in the G244857_2_GM_CONF folder; subfolder labeled “Q_15”.

A software diagnostic test was developed to run at each key off cycle to detect a broken spindle through a reverse spindle actuation as it would occur during an ABS event. This is supplemental to the EBCM module software on all Subject and Peer Vehicles described above that will identify and set DTCs based on EBCM performance criteria not being met after an ABS braking event. If the diagnostic test detects a broken spindle, it does so while the vehicle is parked and off and will set a DTC (C0021, C2A60 and/or C055F, depending on vehicle model). At the next key on event, the driver will be immediately notified via an audible chime, a “Service Brake System” message in the DIC, and multiple related MIL lights. In addition, the vehicle will be speed limited to a maximum of 70 kph when driven until the vehicle is repaired. Figure 15-1 describes the software diagnostic test and the effect on the driver and vehicle.

SOFTWARE DIAGNOSTIC TEST

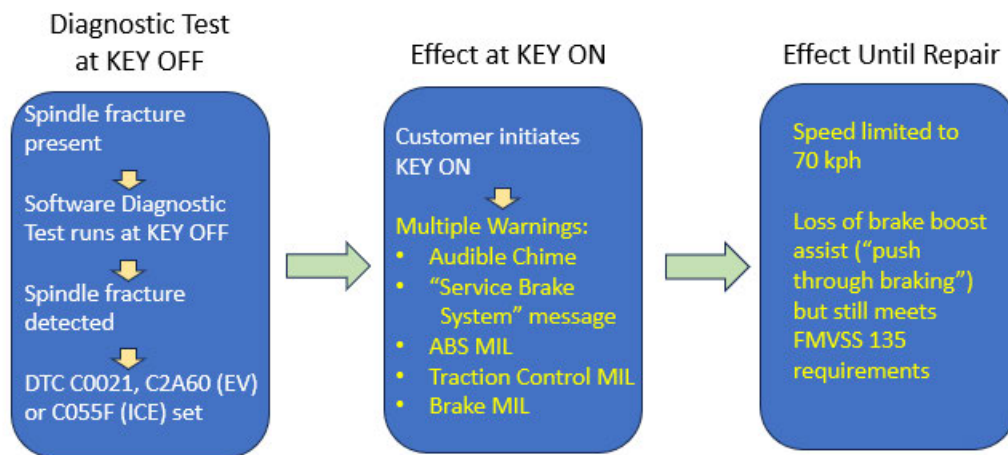


FIGURE 15-1: SOFTWARE DIAGNOSTIC TEST

The new software was implemented into the Subject and Peer vehicles starting in June and July 2023, with different breakpoint dates depending on plant and vehicle model. Most of the MY2023 Cadillac Lyriq, Chevrolet Colorado, and GMC Canyon vehicles were built prior to the implementation of the software diagnostic test.

For MY2023 Cadillac Lyriq vehicles, an over-the-air (“OTA”) software update program was initiated in July 2023 to remotely update several of the modules including the EBCM as part of a vehicle software configuration management (“VeSCoM”) update package, to include the

software diagnostic test. This VeSCoM was approved by SFADA on June 13, 2023, as part of Investigation N23-241208. All vehicles had updates installed from VeSCoMs 34.00, 34.10, and 35.00 updating 9 different modules. The completion rate of this software OTA program was 81.7%.

For MY2023 Chevrolet Colorado and GMC Canyon vehicles, the diagnostic test software change was implemented in production in July 2023. Vehicles built prior to this breakpoint will have the diagnostic test manually installed at a dealership during the installation of a separate VeSCoM update. This update, which was approved by GM's SFADA in June 2024 as part of Investigation N24-245103, will make all MY2023 Chevrolet Colorado and GMC Canyon vehicles capable of accepting future OTA updates.

All MY2024 vehicles in the Subject and Peer Vehicle populations, with the exception of the Cadillac Lyriq, started production with the diagnostic software installed at the start of regular production ("SORP"). The MY2024 Cadillac Lyriq vehicles implemented the new diagnostic software in production in June 2023. Any vehicles built prior to this breakpoint will have the diagnostic software installed during a dealership VeSCoM update, which was approved by GM's SFADA in April 2024, as part of Investigation N24-244296, to make all MY2024 Cadillac Lyriq vehicles capable of accepting future OTA updates.

REQUEST 16

Furnish GM's assessment of the alleged defect in the subject vehicles, including:

- h. The causal or contributory factor(s);
- i. The failure mechanism(s);
- j. The failure mode(s);
- k. The risk to motor vehicle safety that it poses;
- l. 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
- m. The reports included with this inquiry.
- n. The difference and/or similarities in the subject component between the subject vehicle and peer vehicles.

GM RESPONSE:

The main failure mode of the Subject Component is fracture of the spindle internal to the eBoost/EBCM during the high loads created by an ABS event, eventually leading to loss of brake assist. During an ABS event, pressure is initially generated in the eBoost/EBCM by forward travel of the DAP, which includes the Subject Component. For most braking events, sufficient pressure

to fulfill the braking demand will be generated with the forward motion of the DAP only. If the DAP reaches its limit of forward travel, it will move in the reverse direction to maintain sufficient pressure. It will then cycle between forward and reverse travel as needed, depending on the length of the ABS event and braking demand. When the DAP moves in the reverse direction during an ABS event, the Subject Component is under high tension and load and can, in rare circumstances, fracture.

The Alleged Defect can occur due to reduced ductility strength of the material from hydrogen embrittlement and an irregular surface finish of the threads of the spindle. As discussed in GM's Response to Request 12, subsequent pedigrees of the Subject Component utilize improved manufacturing processes to improve both the material strength and surface finish and incorporate increased material testing by the supplier. In addition, as discussed in GM's response to Request 15, the EBCM software has been or will be upgraded in almost all Subject and Peer Vehicles to run a diagnostic test that will detect a spindle fracture even outside of a braking event, while the vehicle is parked and off, and provide warning.

The Alleged Defect does not pose a risk to motor vehicle safety. As shown in GM's Response to Request 5, the rate of occurrence of the Alleged Defect in the Subject and Peer Vehicles is extremely low. If the Alleged Defect occurs while driving, testing demonstrates that the impact on brake performance, stopping distance, and pedal force—even at high speed—are negligible and imperceptible. Brake assist will only be lost after the vehicle comes to a complete stop and DTCs are set. At this point, the driver will receive numerous warnings and alerts that the vehicle's braking system has experienced a malfunction and requires service: a chime alert, multiple MILs, and a "SERVICE BRAKE ASSIST" message on the DIC. The vehicle speed will automatically be limited to 70 kph. And even without brake assist, the brakes remain operable and provide stopping-distance performance that is within FMVSS 135 requirements by a significant margin.

This conclusion is confirmed by GM's field-data analysis. Out of 252,701 Subject and Peer Vehicles, there has been only one reported crash that is even arguably relevant to the Alleged Defect. But given the timing of brake application prior to the crash, it cannot be determined if the Alleged Defect contributed to the crash.

CONCLUSION

While GM will continue to monitor the performance of the Subject Component in the Subject and Peer Vehicles in the field, GM concludes, based on current data, that the Subject Component in the Subject and Peer Vehicles is not defective and does not pose an unreasonable risk to motor vehicle safety. GM's Responses are based upon its investigation to date and reflect its current information and assessment. GM reserves the right to supplement or amend its Responses as appropriate.

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

Letter to Sharon Yukevich
PE24-011 Response
June 27, 2024

Sincerely,



Sabrina Groshek, Executive Director
Global Systems and Product Investigations

cc: Ms. Sharon Yukevich
Antonio Moore
ODI_IRresponse@dot.gov

Enclosures

G244857_1_GM – Public copy of GM’s document production