Exhibit F

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF MICHIGAN
SOUTHERN DIVISION

WESLEY WON, *et al.*, individually and on behalf of all others similarly situated, Plaintiffs, v. GENERAL MOTORS, LLC, Defendant.	Civil Action No. 2:19-cv-11044

Report of William Mark McVea

I. QUALIFICATIONS

1. My name is William Mark McVea. I have multiple accredited degrees from various technical colleges and universities, culminating in a Ph.D. from Purdue University. All academic pursuits have been in and / or related to Mechanical Engineering, with focus on mechanical power transmission (e.g. manual and automatic transmission design and development for both automotive and non-automotive systems, traction aiding differential systems, engine design, axle design, gear design, development, analysis, etc.). I also have additional studies specific to gear technology and NVH (Noise, Vibration and Harshness) investigated in conjunction with OSU (Ohio State University) AGMA (American Gear Manufacturers Association), SAE International (Society of Automotive Engineers). My full CV is provided in Attachment A. Applicable excerpts from my curricula vita include:

a. Master Instructor for SAE International, with over 20 years of teaching experience and 17 discrete courses I solely developed,
b. Over 10 years of involvement in the continuing improvement of AGMA, as well as 5 course titles I solely developed,
c. I developed and taught courses in vehicle dynamics at both RIT (Rochester Institute of Technology, Rochester, NY) and Purdue University (West Layfette, IN),

d. I founded and continue as a Principal Engineer for KBE^{+}, Inc., a consulting firm engaged in the design, development, analysis, testing and forensic engineering of mechanical power transmission systems. KBE^{+} also provides course work for the continuing education of practicing engineers worldwide. I have presented corporate specific coursework in 10 countries plus the USA,

e. As of 2021 we have developed 5 transaxles for EVs (Electric Vehicles).

f. I personally designed, developed, tested (cooperatively) 3 different torque converters,

g. I worked as part of a team to reverse engineer and analyze multiple existing transmissions as the pre-work for conversion from wrought and cut gears to PM (Powdered Metal) gears and other components; and,

h. I designed multiple components within an automotive transmission to reduce and / or mitigate NVH.

2. In addition, I have personally designed multiple automotive and off-highway transmissions as well as contributed and led design teams in similar pursuit.

3. I have also provided expertise to clients as related to reverse engineering, design optimization, powertrain system integration.

4. I have worked closely with multiple lubricant additive manufacturers to improve their efforts to finetune the chemistry and process engineering to manufacture stable and reliable product, specifically ATF (Automatic Transmission Fluid).

5. I have worked with and advised multiple automotive automatic transmission component manufacturers in terms of specifics and nuanced requirements of their component(s) in the larger system.

6. I co-developed techniques to substitute PM for cut & wrought materials in manual, automatic and transaxles for EV applications to reduce energy consumption, thus emissions, and improve NVH performance.

7. I hold patents (as Principal Investigator or significant / sole contributor) for mechanical power transmission systems in automotive applications including Patent Number US8070641B2 (Differential Gear Assembly).

8. I am a SAE International Master Instructor and McGoon Award winner and SAE International Transmission Academy Lead Presenter.

II. ASSIGNMENT

9. I was asked by Counsel for the Plaintiffs to evaluate GM (General Motors, LLC) transmissions from MY2015 to MY2019 in vehicles that contain 8L

product family of automatic transmissions to determine if the design and / or architecture had a common defect causing NVH (Noise Vibration Harshness) or handling issues including in lower gears, surging, lurching, jerking, lunging, rough coast downs, and at higher gears, shuddering or shaking at steady state speeds.

10. For my assignment I looked at the following;

a. GM documents and test data,

b. NHTSA complaints,

c. My own inspections of the Plaintiffs' vehicles, where possible,

d. GM's inspections of the Plaintiffs' vehicles,

e. Testimony of witnesses,

f. GM's warranty data, both summed up by Plaintiffs' expert and contained in documents produced and provided by GM.

11. For my investigative and analysis work I charged $250.00 (USD) an hour. The results of my opinion did not determine in my compensation.

III. SUMMARY OF OPINIONS

12. The 8L series of automotive based automatic transmission developed and sold by GM has exhibited undesirable operational and functional characteristics at a failure rate consistent with a design flaw or other design related issue(s). These transmission systems are a class of product used for MY15-MY19 vehicles. These transmissions (specifically the 8L90 and 8L45 generic model

designates) made use of a patented and proprietary PAO-based synthetic automatic transmission fluid (ATF) as required in the specifications issued by GM. It was suspected and has now become apparent that GM did not fully validate the automatic transmission system (noted as the 8L series) and / or the component interactions specific to the clutch friction materials and the ATF (Automatic Transmission Fluid). It was further suspected and subsequently proven that GM paired friction materials with an ATF not specifically formulated for use with said friction material that in service did not / does not provide adequate performance and / or service life as implied by statements made by GM regarding vehicle operational characteristics and vehicle life expectancy (i.e. powertrain warranty claims). In this context 'vehicle life expectancy' according to GM, GM documentation and predictive analysis of product / sub-system service life expectancy of 10 years. For example, the Weibull analysis done by GM in a report for the Safety & Field Action Decision Authority (SFADA) covers an analysis range through 10 years and / or 120,000 miles. PX121 at 47-56. This indicates that there is an expectation of some significant percentage of the population surviving to and beyond these life predictions. Furthermore, EPA requirements predict a useful life of the major systems within the vehicle (as they pertain to emissions) must perform adequately for 10 years or 120,000 miles (2015 requirement).

13. The ATF, which was supposed to be fill-for-life (120,000 miles or more) according to GM, degraded prematurely over time and in the presence of water typically caused by humidity at levels even below specifications written by GM, and well before the useful life of the vehicle. GM abandoned its patented ATF in 2019, six years after witnessing excessive shuddering and unacceptably harsh shifts. As of September 2021, I understand that GM has not made that new ATF available (either by informing owners of its existence and / or making it readily available) to all owners of affected vehicles who have experienced or are likely to experience the defective friction system within the 8L product family automatic transmissions. Based on my observations, research and documents provided by and internal to GM, GM knew the combination of their specified ATF and friction material used knew that this combination was / is not compatible and therefore defective.

14. Further the GM plan for "Generation 2" of the 8L transmissions includes hardware and software components to address ongoing drive quality issues. The warranty data, customer complaints to GM, NHTSA, and GM Speak Up For Safety (SUFS) documents demonstrate that GM was repeatedly told about jerking, lurching, surging, shudder and other poor shift quality problems with the vehicles equipped with 8L transmissions. While GM has rejected these as a safety concern, it did acknowledge that the problems were a source of customer

dissatisfaction and occurred so frequently that they were "common" or "almost certain" to occur. Yet I understand that GM continues to sell vehicles equipped with the 8L transmissions which it knows needs a major redesign for MY23.

15. In my opinion, GM should replace the transmission system for current owners that have the defective ATF / friction material combination (collectively "friction system") and / or poorly performing components. This means employing, for free, TSB 18-NA-355 – a triple flush of the Option B or 212b with Mod1a – a GTL-based ATF that is more robust to water. This is a known marginal fix for a known significant problem. GM knows that operating transmissions with its prior PAO-based fluids will lead to degradation of slip control that will manifest as shudder. Once that shudder becomes noticeable to the customer, damage to the friction materials has already occurred. If not corrected, the clutch materials may glaze and require replacement of the torque converter. To be clear, flushing and replacing the ATF with any formulation other than the original fill is only a partial fix and only a temporary solution to the root cause. Shudder, typically emanating from the torque converter, but these comments are applicable to any frictional interface exposed to the Option B or 212b ATF, is the end result of the failure of the interaction of the ATF and friction material used in the clutch.

16. Development and specification of the friction material and lubricant formulation (of the ATF) must be a combined effort. It is not uncommon in the

automotive industry that various separate companies will formulate the friction material (the chemistry) from those companies that formulate the additive package that is used / mixed with the base oil to create the ATF lubricant. However, there is tight collaboration between the two groups to ensure that the combined effect of the friction material and lubricative properties of the ATF provide the requisite response of the friction system. I will discuss the slope of the friction response curve (or friction curve) in more detail later; suffice it to say for the moment that the slope of this curve, for desirable and controllable response, must remain positive through all operational modes of the transmissions system, under any and all expected environmental conditions (e.g. normal humidity ingestion as opposed to complete submersion of a transmission in water). The additive package contains certain chemicals that are used to inhibit (or reduce) the adverse effect of water (anti-whetting agents) ingestion into the fluid. Water degrades other additive chemicals that are designed and used to control the slope of the friction curve (friction modifiers, VI enhancers, etc.). As the anti-whetting agents are depleted and thus their function, the moisture that does eventually combine with the ATF changes the effective slope of the friction curve, and generally in an undesirable manner. ATF (the combination of a base oil and the additive package) should not be assumed to 'last forever', however the industry has determined that it should be

considered a ‘fill-for-life’ component. That is generally accepted to mean over 100,000 miles of adequate service for typical use for the vehicle.

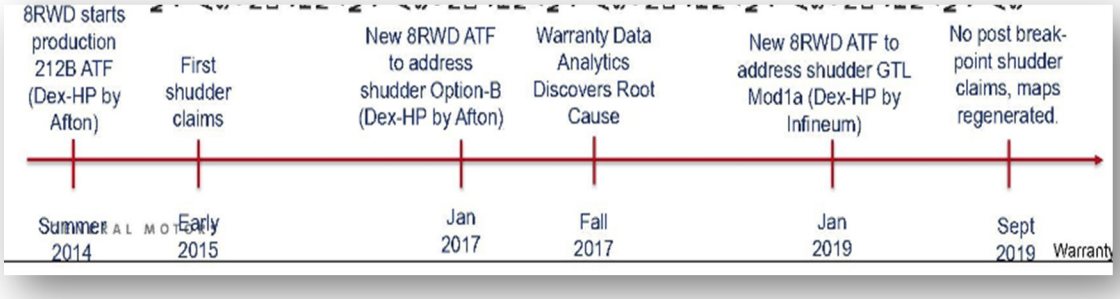
17. Second, to mitigate the harsh shift problems, GM should where possible retrofit the MY15-MY19 8L vehicles with the hardware and software GM has developed for MY20 and the Gen2 redesign of the 8L transmission. GM has even priced out this process but concluded reducing the shifting problems of its customers, many who are exiting their warranty limits, isn’t worth the cost to GM.

18. Third, GM should tell customers about the transmission problems before they buy a vehicle equipped with an 8L transmission.

IV. OPINIONS

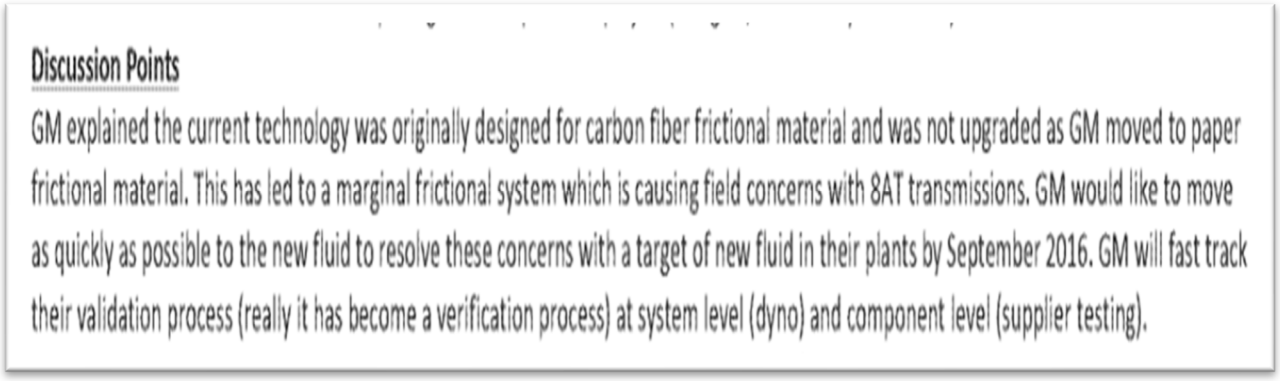
A. GM Required ATF and Friction Materials

19. GM has used three different automatic transmission fluids for the 8L vehicles. Two were poly-alpha-olefin (PAO) based oils, one patented by GM: 212b. PX1 (GM000284020) at 4. When 212b failed to provide an adequate friction slope, GM replaced it with a modified version in 2017 that it called Option B. Then in 2019, GM introduced a more traditional gas-to-liquid (GTL) fluid it called Mod1a. A timeline in PX576 at 5 shows the following:



20. The PAO-based oils are sensitive to water. The water can displace the friction modifiers in the ATF. GM learned this about 212b as early as 2016. PX562 (GM000107979). Option B, also PAO-based, is also sensitive to water. See, e.g. GM000560986.

21. GM utilized LuK WFP6300 material. This is a paper friction material. In 2012, GM switched the friction material from BW6100 to WFP6300 to reduce costs. PX198 at 1. GM paid less as LuK was also supplying the torque converters, which used the same material in the torque converter lockup clutch (TCC), saving about $2.00 per vehicle. GM000055284 at 1. However, its durability is questionable in a fill-for-life system. As GM explained to Afton in June of 2016:



Discussion Points

GM explained the current technology was originally designed for carbon fiber frictional material and was not upgraded as GM moved to paper frictional material. This has led to a marginal frictional system which is causing field concerns with 8AT transmissions. GM would like to move as quickly as possible to the new fluid to resolve these concerns with a target of new fluid in their plants by September 2016. GM will fast track their validation process (really it has become a verification process) at system level (dyno) and component level (supplier testing).

PX236 at 1 (AFTON_0016195.)

22. Others at GM suggested more robust materials like the Borg Warner BW6100, which was being used in 6L transmissions that previously had shudder, and in vans. Anguish Dep. at 40:20-41:4; 52:9-24. GM engineer Randy Melanson called the LuK paper "shit material" due to the friction data. GM000072917 at 2. However, improving the material would have led to a cost increase in the torque converters of two to three dollars with little benefit. Melanson Dep. at 67:12-68:16. In 2015, he described the 212b/WFP6300 as "the worst friction system we got, and it's only going to get worse with mileage, regardless what we do … we need to soften 212B and go to a better friction material such as BW6100 that **improves** with age, regardless of oil." GM000552284 at 1.

B. TCC Shudder

23. Some background information regarding the onset of shudder and how it manifests at a later date (mileage, etc.). As described previously, the friction system is the combination of the friction material and the ATF. The

actuation and control of a shift event also requires the controlled application of the apply piston that drives a normal force into the clutch pack (most automatic transmissions use multi-plate clutch pack, which means multiple friction plates and reaction discs (steel plates)). Theoretically the first time a clutch system is actuated under an applied torque load the surface of the friction material is changed according to both the mechanical burnishing due to the physical interaction with the steel reaction discs. In addition, the chemical condition of the surface of the friction material is altered by the interaction with the ATF. In essence this why the friction system is the functional combination of both the friction material and the chemical composition of the ATF. Once the two materials come together under normal load and as the surface contact temperature increases as a function operational model of a clutch, the chemical elements in the ATF impregnate and alter the surface condition and composition of the friction material.

24. Torque Converter shudder occurs when the friction plate and the reaction disc "slip" rather than come in contact as designed. The shudder from a friction-based device (a clutch or other similar device) is an outcome of the interaction between the various contacting members. In our case whether the clutch packs (multiplate friction and reaction members) or the lock-up clutch (typically single plate) in the torque converter are designed and function to bring two masses rotating at different speeds to one common speed. Think about the

main clutch in a car with a manual transmission. At a stop light, the clutch is disengaged, the engine is running and rotating at idle speed (say 800 rpm) and the transmission shafts are not rotating or rotating with zero speed, thus the vehicle is not moving. When it is time to go, the driver engages the clutch by slipping and the engine rotational speed (output) and the transmission rotational speed (input) are brought together to rotate as one; zero slip-speed. In a manual transmission the clutch surfaces are usually dry, meaning dry-friction, or no lubricant present. In an automatic transmission the clutches (TCC or ratio change clutches) are wet; meaning they are covered in a lubricating fluid or ATF. The function of any lubricant is to generate and maintain an elastohydrodynamic shear layer with a defined lubricant film thickness. The job of a lubricant such as ATF is to keep the various components (friction plates and reaction discs) from touching. For components such as gears and bearings, etc., this is what is needed to provide long life (as defined by the manufacturers stated warranty period, etc.) or the expected service life of the device.

25. For a clutch however, this will not work. The elastohydrodynamic shear layer of lubricant will always be dissipating energy ('dynamic' means in motion, 'shear' means sliding which is an energy dissipater) thus will add to the overall inefficiency of the system. So, what is done is the lubricant is used to smooth the shift during the 'shear' portion of the clutch engagement and then the

surface of the clutch friction plates are designed in such a manner as to channel the thin layer of ATF (the 'lubricant shear layer film thickness') and allow intimate contact of the friction material on the reaction plates to contact the reaction steel discs (the terms 'friction material' and 'steel' are used as placeholders for whatever material is used in the clutch to accomplish these tasks). This is where all the lubricant formulation and friction material chemistry come into play.

26. The lubricant here is the chemical combination of a base oil used as a carrier to bring the additive pack chemistry into and out of the regions within the device that need to be 'lubricated'; the ATF at issue is a highly refined base oil with a very carefully defined and refined additive package of chemicals designed to enhance friction, improve thermal transport, shed water, and many other functions. The general nature of common lubricants, simple oils is to provide a shear layer between two moving parts, moving at different speeds. One common characteristic of these simple oils is that the coefficient of dynamic friction is higher than that of its static coefficient. Meaning that as the clutch is sliding it provides more resistance to this relative motion and is more efficient at dissipating the relative speed as heat. When the oil has nearly dissipated all the energy of the relative motion, its effective coefficient of friction, transitions from dynamic (moving / sliding) to static (stationary or no motion). So, what happens in a clutch is that during this transition from dynamic sliding to relative static the ability of the

clutch to ‘hold’ the two bodies relativity stationary drops (transition from the high coefficient of friction in dynamic motion to the lower coefficient of friction as static) which causes the clutch to go back to sliding. Sliding causes the coefficient of fiction to increase (dynamic), which causes the clutch to try to lock-up, causing the coefficient of friction to drop (static) which allows the clutch to slide again. This ‘stiction’ is very dynamic and it happens tens if not hundreds of times a second (~10 to 100 Hz). The more energy the clutch is trying to absorb (remember, the clutch is an absorber; it absorbs the energy as defined by the speed difference between the two rotating bodies times their relative mass, which is loosely defined as energy, and converts it to heat.) the higher the magnitude of vibration and its effect on response frequency.

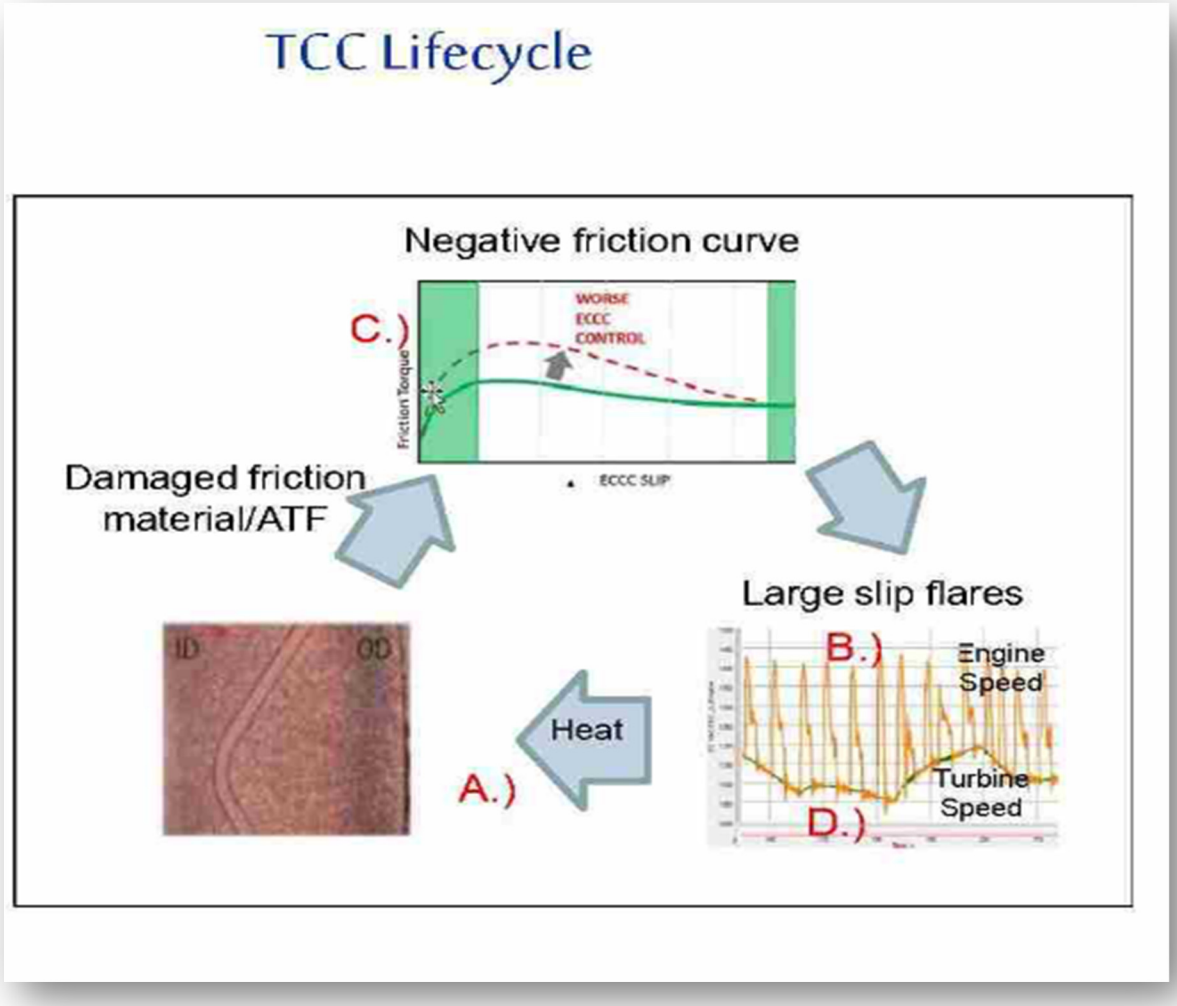
27. Now, applying all this to the current case and the design of the clutches in the GM 8L series of transmissions; the combination of the friction material and the chemistry of the ATF are designed in concert in an effort to minimize the difference between the coefficient of dynamic versus static friction of the system, enhance the heat transport capacity of the ATF (the lubricant is the primary thermal transport mechanism due to the very short duration thermal generation event; a clutch engagement should only take a fraction of a second for a normal shift) and typically raise both effective coefficients to increase clutch capacity or allow the designer to require a smaller package size for the clutch.

28. A noticeable shudder is a symptom of the failure to minimize the difference between the coefficients. By the time shudder is felt, the slipping between the friction plates and the reaction discs has already begun and will only get worse / more noticeable as the interface between the friction material and the steel reaction disc face, in the presence of the ATF lubricant film, degrades further each time the clutch is engaged or disengaged. This degradation (mechanical wear of the friction material and thermal / chemical / mechanical breakdown of the ATF as a lubricant) is caused by repeated unanticipated engagements of the surfaces; essentially the bouncing of the clutch due to stiction. As the system degrades what is actually happening is the surface of the friction material is being mechanically worn away and the surface finish is degraded (made rougher), the ATF is also being degraded which reduces both its service life and its effectiveness in terms of smoothing the clutch engagement. The 'rougher shift' becomes more pronounced until it becomes noticeable to the driver / occupants. The takeaway from all of this is that the phenomenon of 'shudder' is actually ever present. In a well-designed and maintained system, it is unnoticeable to the user over the intended life of the device. However, as the various components 'wear' (friction surface degrades or more commonly the lubricant degrades, and in our case the ATF is very susceptible to degradation due to water diminishing the effectiveness of certain of the additive package components) the magnitude of shudder (due to stiction)

becomes more pronounced until such time as it becomes noticeable. This leads to the logical conclusion that at some point in time (time here is defined as the collective effect of the number clutch engagements and disengagements, the chronological age of the ATF and the external environmental effects) these systems will exhibit some form of stiction induced shudder. From an engineering standpoint, the trick is to make the onset of this beyond the expected service life of the product as a whole.

29. Here, the friction system in question (212B/WFP6300) *started* with friction curve that was a "knife's edge" ("knife edge" being used as a delineator between acceptable and unacceptable performance) and could and did quickly turn the slope of the friction curve negative, which furthers the degradation of the friction system. A degraded friction curve can lead to glazing, which in turns leads to more negative friction curves, further reducing controllability and accelerating the glazing of the friction material. PX564 (GM000043080) at 2. Radecki Dep. at 141:12-141:23.

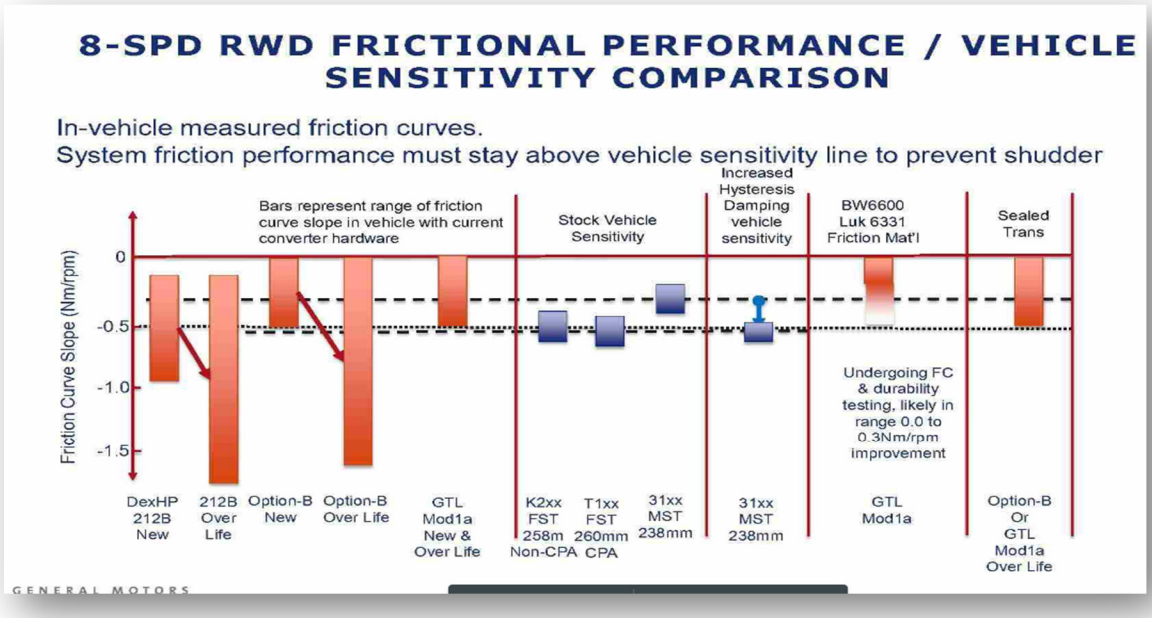
30. Peter Radecki of GM explained this in the "Shudder 101" presentation shared with his colleagues. He depicted how a negative friction curve – like the friction system in the 8L transmissions – can lead to large slip flares, to more heat, then to more damage friction material/ATF, thereby worsening the curve:



PX570 at 15 and 16. Radecki Dep. at 192:20-193:24 (discussing the life cycle becoming a "death spiral."). In this picture, "C.)" is a representation of a marginal friction curve in solid green and an unacceptable curve shown as a dotted black line. In context with the technical description of the interaction of the friction material and ATF as degraded by water in the mix during shift events, the surface of the friction material is changed / worn to the condition shown in "A.)". The surface condition and the material properties shown in "A.)" is what causes both

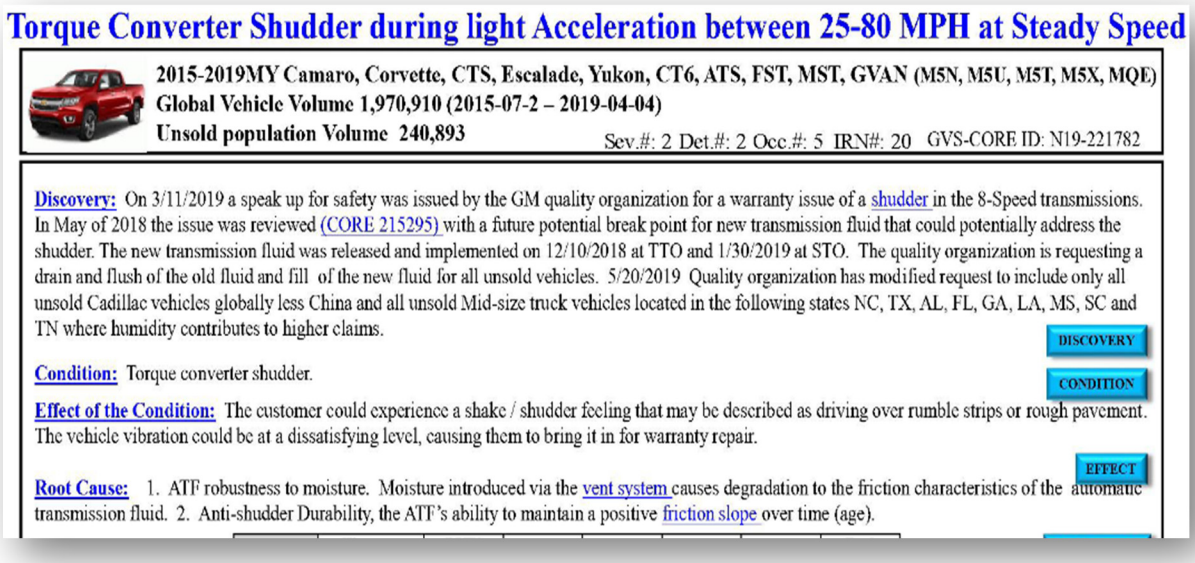
"B.)" and "D.)" as explained by Radecki. To add to the discussion, note the frequency response most noticeable in "B.)". This is a visual representation of stiction in action, and for this clutch design (friction system) the frequency is in the range of 10 to 35 (Hz). In most of the frequency plots recorded by the PICO system, there are prominent frequencies in this range. This statement applies to both the data I recorded and the of the data I reviewed as provided by GM. A more complete summary of the data I recorded, and my review of the data GM presented will be provided in Section IV.D and Appendix 1.

31. The 8L family of transmission systems, which began with 212B/WFP6300, was already degrading to a negative slope even before water or time degraded it. Option B had a better curve at its start, but over its life degraded. Not until GM switched to a Mod1a did it pair an ATF with the friction material that could maintain a positive friction curve. PX570 at 20.



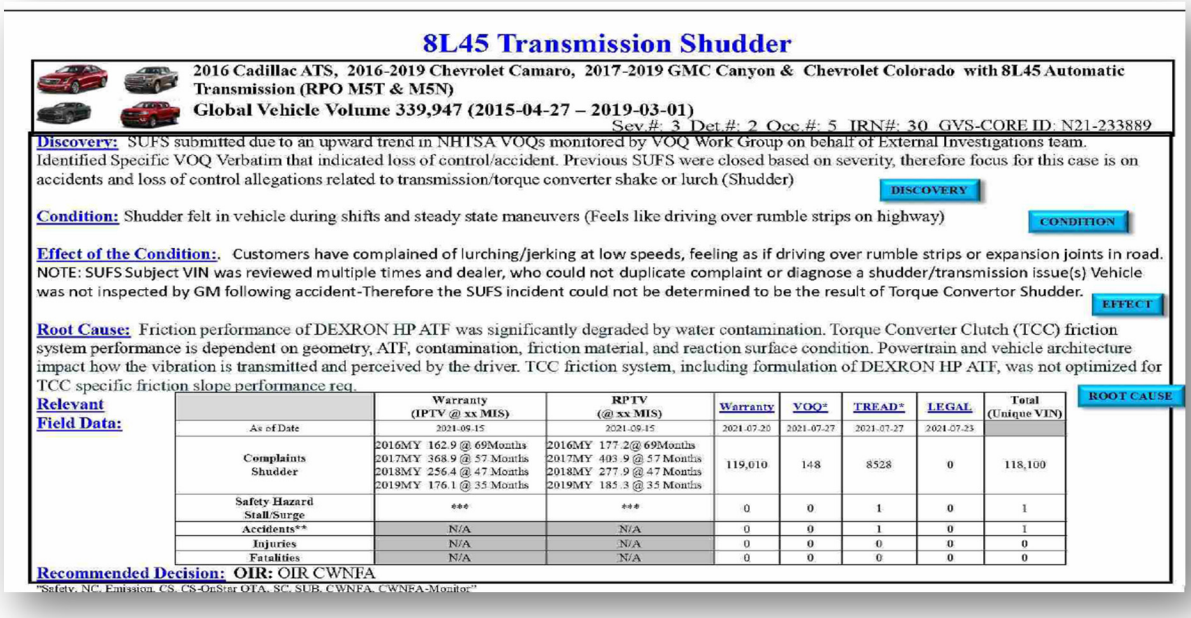
1. Root Cause

32. GM described the shudder issues on the 8L transmissions in a document to SFADA – GM Safety & Field Action Decision Authority. PX578 at 24. GM attributed the effects and root causes of shudder as follows:



PX121 at 1. GM graded the frequency of shudder among the MY15-MY19 8L vehicles as "Occ[urrence] #5." In GM metrics that means a warranty level of >111 IPTV (Incidents Per Thousand Vehicles, or greater than 11% claims rate), or "extremely high rate" categorized as "almost certain." PX578 at p. 28. A Weibull analysis performed by GM and listed at the time of this report (June 2019) predicted more than 11% claims just for shudder in Cadillac and mid-size trucks with 8L transmissions within 2-4 years of ownership. PX121 at 47-50.

33. GM knows friction material and ATF are both critical to friction system design. GM000845734; 845735. GM completed another "Step Up for Safety" report on shudder in September of 2021. There too, in root cause, GM noted the TCC friction system on the 8L transmissions were not properly "optimized for specific friction slope performance":



8L45 Transmission Shudder

2016 Cadillac ATS, 2016-2019 Chevrolet Camaro, 2017-2019 GMC Canyon & Chevrolet Colorado with 8L45 Automatic Transmission (RPO M5T & M5N)

Global Vehicle Volume 339,947 (2015-04-27 – 2019-03-01)

Sev #: 3 Det #: 2 Occ #: 5 IRN#: 30 GVS-CORE ID: N21-233889

Discovery: SUFS submitted due to an upward trend in NHTSA VOQs monitored by VOQ Work Group on behalf of External Investigations team. Identified Specific VOQ Verbatim that indicated loss of control/accident. Previous SUFS were closed based on severity, therefore focus for this case is on accidents and loss of control allegations related to transmission/torque converter shake or lurch (Shudder) DISCOVERY

Condition: Shudder felt in vehicle during shifts and steady state maneuvers (Feels like driving over rumble strips on highway) CONDITION

Effect of the Condition:. Customers have complained of lurching/jerking at low speeds, feeling as if driving over rumble strips or expansion joints in road. NOTE: SUFS Subject VIN was reviewed multiple times and dealer, who could not duplicate complaint or diagnose a shudder/transmission issue(s) Vehicle was not inspected by GM following accident-Therefore the SUFS incident could not be determined to be the result of Torque Convertor Shudder. EFFECT

Root Cause: Friction performance of DEXRON HP ATF was significantly degraded by water contamination. Torque Converter Clutch (TCC) friction system performance is dependent on geometry, ATF, contamination, friction material, and reaction surface condition. Powertrain and vehicle architecture impact how the vibration is transmitted and perceived by the driver. TCC friction system, including formulation of DEXRON HP ATF, was not optimized for TCC specific friction slope performance req. ROOT CAUSE

Relevant Field Data:

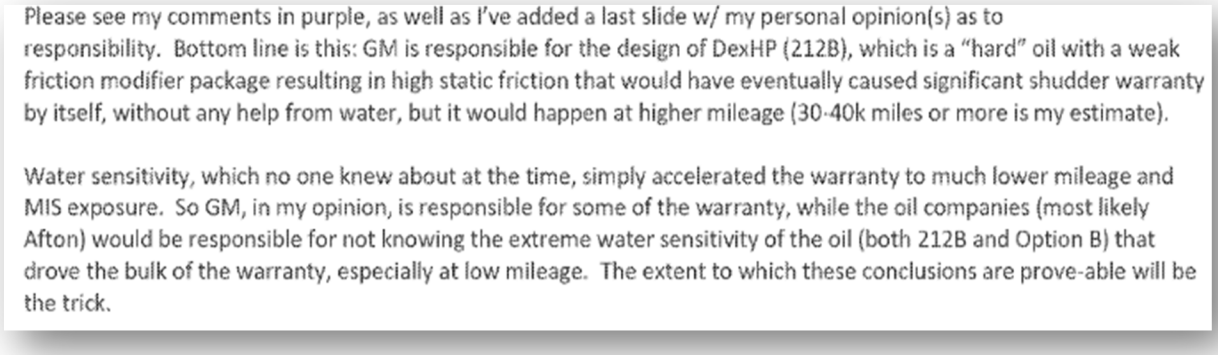
	Warranty (IPTV @ xx MIS)	RPTV (@ xx MIS)	Warranty	VOQ*	TREAD*	LEGAL	Total (Unique VIN)
As of Date	2021-09-15	2021-09-15	2021-07-20	2021-07-27	2021-07-27	2021-07-23	
Complaints Shudder	2016MY 162.9 @ 69Months 2017MY 368.9 @ 57 Months 2018MY 256.4 @ 47 Months 2019MY 176.1 @ 35 Months	2016MY 177.2@ 69Months 2017MY 403.9 @ 57 Months 2018MY 277.9 @ 47 Months 2019MY 185.3 @ 35 Months	119,010	148	8528	0	118,100
Safety Hazard Stall/Surge	***	***	0	0	1	0	1
Accidents**	N/A	N/A	0	0	1	0	1
Injuries	N/A	N/A	0	0	0	0	0
Fatalities	N/A	N/A	0	0	0	0	0

Recommended Decision: OIR: OIR CWNFA

"Safety, NC, Emission, CS, CS-OnStar OTA, SC, SUB, CWNFA, CWNFA-Monitor"

34. GM chose and / or did not completely validate the operational interaction of these two critical components of the friction system within the 8L series of automatic transmissions.

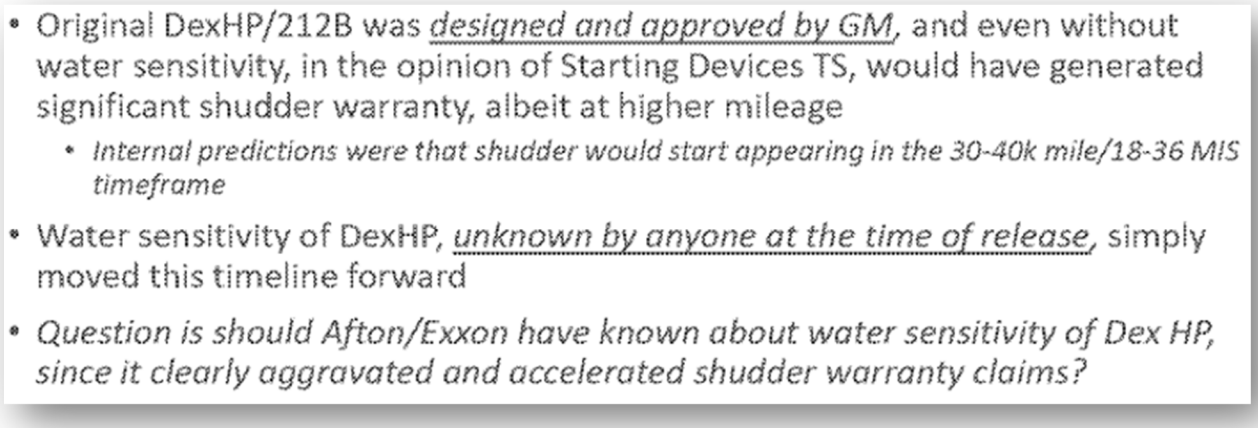
35. When asked about the shudder issues on the 8L transmissions, a GM Chief Engineer admitted that the transmissions did not meet GM targets or customer expectations. Bulloch Dep. at 189:22-190:7. I agree, the system was pushed together near the end of validation, and while GM switched materials to save money, it stuck with its ATF even though a BW6100 paired with a ULV mineral-based fluid was working better for Ford. GM000072917 at 2. It appears moisture only hastened the degradation of the ATF. As Randy Melanson of GM noted in 2018:



Please see my comments in purple, as well as I've added a last slide w/ my personal opinion(s) as to responsibility. Bottom line is this: GM is responsible for the design of DexHP (212B), which is a "hard" oil with a weak friction modifier package resulting in high static friction that would have eventually caused significant shudder warranty by itself, without any help from water, but it would happen at higher mileage (30-40k miles or more is my estimate).

Water sensitivity, which no one knew about at the time, simply accelerated the warranty to much lower mileage and MIS exposure. So GM, in my opinion, is responsible for some of the warranty, while the oil companies (most likely Afton) would be responsible for not knowing the extreme water sensitivity of the oil (both 212B and Option B) that drove the bulk of the warranty, especially at low mileage. The extent to which these conclusions are prove-able will be the trick.

PX109 at 1. Melanson summarized in a document called the "Final Comments on History of Dex-HP/212b":



PX109 (GM000562557) at 10. I also agree with Mr. Melanson's assessment.

2. GM's Knowledge of its 8L Transmission's Susceptibility to TCC Shudder

36. In 2013, GM encountered shuddering at low-mileage (generally accepted as well before the end of the factory or standard warranty period) and in low gears (generally referring to first or second or maybe third gear wherein the applied torque is quite high) in its first application of the 8L transmission, in the pre-production of the 2014 Corvette. For example:

- A 6/24/2013 email noted that "the shudder is terrible" in the Corvette. PX196 at 1. Minutes from a "Corvette driveline disturbance work group" dated "26JN13" stated "the driveline shudder appears to be similar to the 2014 6-speed issue that was experienced. Root cause of the 2015 program has not been identified but is believed to be the flat/negative friction slope of the LuK WFP friction material." GM000972478.

- A 7/24/13 email suggesting "we should test the 8L45 vehicles to see if they have shudder like the 8L90 vehicles." PX197 at 1.
- A 7/24/2013 email attributing the shudder to "an interaction of TCC friction material characteristics and 212B trans fluid." PX102 at 2.
- A series of September 2013 emails where A.C.E Bill Goodrich described "classic slip/stick [shudder] and not just a transient event" and discussed replacing the friction material or a top treat." PX58 at 1-3.
- A February 2017 presentation on 8L90 Shudder Overview admitting "Shudder was found in low gear states during development of the 8L90 LTI Corvette. Mitigated the issue by not allowing torque converter clutch operation in gears 1-5." PX165 at 4.

37. GM "production direction … [was] to run with open TCC in gears 1-4 to avoid the shudder area." GM000018905 at 1. However, concerns remained that the friction systems (then 212B and LuK WP6300), would still cause shudder. PX162 at 1. GM was weighing whether to use a "top treat" to directly address concerns about a negative friction curve. PX162 at 1. Witnesses testified that GM essentially "cal'd out" (calibrated out) the pre-launch shudder but it was the result of the same root cause that would be seen after launch. Melanson Dep. at 211:17-25. ("Q. But the specific issue that was originally causing the shuddering in the Corvette was the transmission fluid, which was not fixed. It was some other

alteration that addressed the shuddering, i.e., the cal change. Correct? A. yes. yeah. The shudder is a system-related issue, but the biggest handle to eliminate that is to have a positive friction curve in the first place, which we did not have with 212B, yes."); Radecki Dep. at 58:13-61:6.

38. GM likely chose to calibrate out TCC lockup in gears 1-4 because the high torque leads to high heating if the TC shifts, that pushes the curve more negative. In the higher gears, there is generally lower torque, so less of a chance of slipping or heat generation will generally will not push to a negative slope.

39. By the Fall of 2015, GM started seeing a spike in warranty claims for shudder in 8L vehicles. PX230 at 1 (AFTON_0015096). GM began having meetings with more senior engineers across disciplines to try to solve the problem, often multiple times a week. Melanson Dep. 151:1-152:13. By February of 2016, the "TCC shudder on 8-speed" became urgent. PX54 (GM000025690). By this point, GM had already begun a "RedX" study to try to determine the root cause of the 8-speed shudder. (GM000028435). While GM understood that the shudder followed the oil (*id.*), in February 2016, the members of the RedX team performing the study had not identified the root cause. *Id.*

40. By March of 2016, GM was referring to the "8 speed shuddering crises" GM000104616. "8spd shudder is #1 warranty item in the company!!!" PX 231 (AFTON_0011800) at 1.

41. By May of 2016, Afton, the supplier of 212b, noted that even small amounts of water in the fluid can cause shudder (reminder that shudder is due in large part if not in whole as the response of a friction curve with a negative slope). PX234 (AFTON_0000818). GM engineers had already found that adding water could cause shudder but found it a "really eye opening" how water was impacting the ATF even with more robust friction materials. Afton warned, "Water clearly is extremely detrimental to friction and must be avoided at all opportunity." The "RedX" team similarly concluded that the presence of water, even in small concentrations, in the ATF caused shudder. GM000034501. GM was investigating "water intrusion" as a possibility for shudder as early as April of 2016. PX9 at 3.

42. In the Spring of 2016, some GM engineers surmised that the esters (binders) holding the friction materials could get hydrolyzed in the presence of water. GM000108008 at 1. Dr. Radecki suggested further water testing of Option B – another PAO-based ATF that had an additional "top treat" compared to 212b to boost the friction slope of the ATF. Radecki Dep. at 293:5-297:16; GM000998232.

43. In July of 2016, Afton reiterated its "working theory that ester in the 212B/Option B is hydrolyzing" leading to shudder. PX237 (AFTON_0016462) at 1. GM and Afton knew that as little as 0.1% water could disrupt friction or degrade materials. PX237 at 12. The two had already discussed higher warranty

claims in Florida and whether dew point temperatures or humidity could be a causal factor in the 8L shudder claims. PX 237 at p. 13.

44. By October of 2017, based upon warranty analysis of regions and seasonal trends, GM engineer Dr. Peter Radecki concluded that moisture entering the transmission via humidity was the main pathway that ATF degradation would occur. PX567 (GM000558884). Even then, the shudder / TC warranty rates nationally for the MY15 8L90 models were at 227 IPTV – or 22.7%. PX575 (GM000462395) at 4.

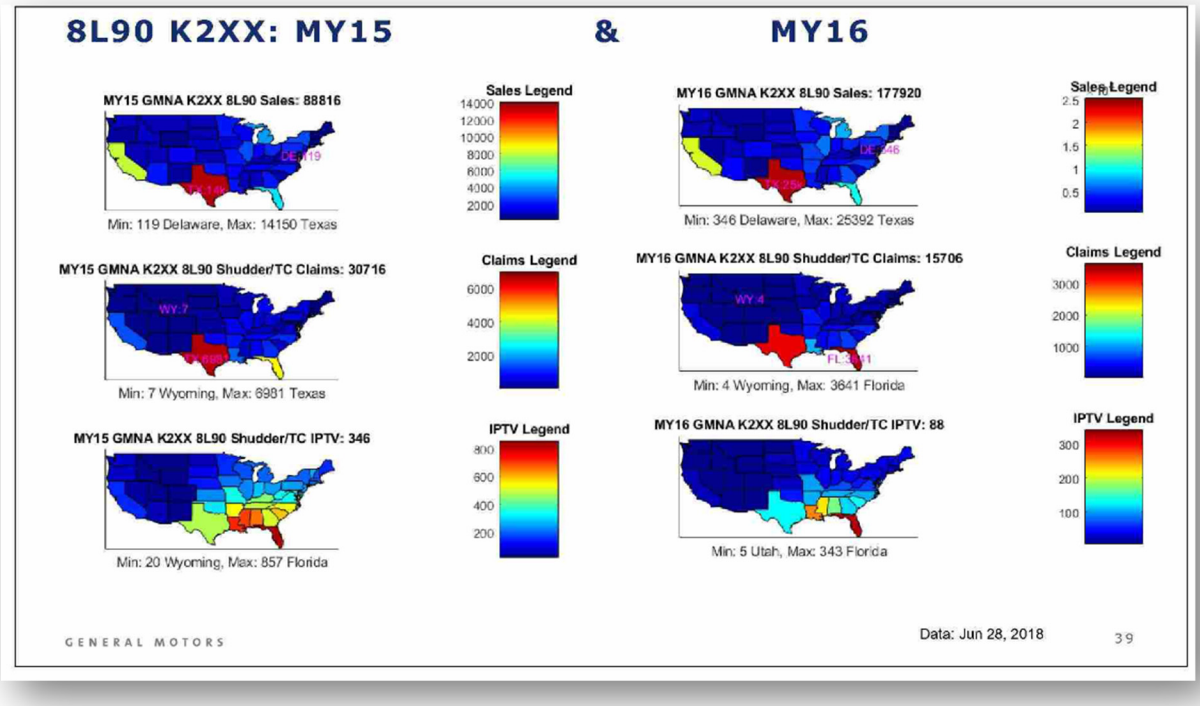
45. By December of 2017, GM concluded Option B had little to no impact (reduction) on warranty claims. PX568 (GM000050284) at 1.

46. By February of 2018, Afton confirmed that "while Option B is a better friction system than 212b, GMWEAR tests with 1,000 (ppm) water indicate a propensity for shudder." PX242 (GM000560986) at 6. While Afton could not determine exactly how water contributed to the failure of the PAO-based fluids, its leading theory was that water displaces the friction modifiers on friction material surface. PX242 at 6. "Ester plays a role." PX242 at 19.

47. Also in February of 2018, GM had determined that the high warranty claims for TCC shudder was the result of "the ATF's (Dexron HP) sensitivity to moisture being inhaled thru the corporate vent system design via daily cycles of air temperature and humidity degrading the friction characteristics of the oil w/

samples having estimated range of water between 400-1200 ppm." PX96 (GM000813024) at 2. GM was finding many customers would come back repeatedly for the issue. PX96 at 1 (noting 15% of customers with 8L45 would require service at 60 months of service, and 68% will return a second time.).

48. Dr. Radecki continued to update his warranty tracking of TCC shudder / torque converter replacements by regions to educate his colleagues. He helped create a "Shudder 101" tutorial for other engineers that showed higher warranty rates for TCC shudder / TC replacement associated with higher dew points and humidity, but also showed generally warranty levels well above GM targets. For example, by January of 2018, the IPTV for the MY15 8L90s was 299 or about 30% claims rate nationally. However, in Florida it was 777, or 77%. PX3 (GM000230201) at 25. By June of 2018, the national rate for MY15 8L90 on the K2XX platform grew to 346 (34.6%) with a Florida level at 85.7%. PX570 (GM000055894) at 39.



49. By September 2019, Dr. Radecki's warranty data showed the claims for TCC shudder / TC replacement were at 56% nationally for many MY 15 8L90 models. PX575 (GM000462395) at 27. The IPTV for MY16 8L90 Shudder / TC was 290, or 29% in less than 48 MIS (Months In Service). PX575 at 28. The MY17 models were also above 111 IPTV. PX575 at 29.

50. Radecki later "ballparked" the Florida IPTV for shudder at 5 years at 2000 IPTV. PX574 (GM000462395) at 1. As he put it; on average, each Florida buyer would have two transmission repairs just for TCC shudder. Radecki Dep. at 284:9-285:2.

51. But moisture was not the sole cause of shudder. As noted, above, the root cause was moisture **and** age. These are unsealed systems that had a poorly validated ATF and a marginal friction material. As Randy Melanson of GM explained to Peter Radecki and Max Burgman in April of 2018, it was only a matter of time before they fail, and shudder follows:

> Max and Peter, I think you're both right. And I'm not just handing out participation trophies here. On 8-speed, original 212B does not need water to shudder, it will do that very nicely on its own, thanks to insufficient friction modifiers designed into the additive package. If we had a sealed trans and no water contamination, we would still see shudder developing at ~ 20-40k miles, and eventually they'd all pop, given enough time. Since our trans is not sealed, water simply accelerates the friction curve degradation depending on how much and how fast net accumulation occurs. In summary, it's the combination of a poorly designed FM package and PAO fluid sensitivity to water (from high ester levels) that is behind the huge shudder IPTV we're seeing in 2015-2017 MY's.

PX108 (GM000560880) at 3. Melanson's recapitulation of the history demonstrates to me that GM long knew that the friction system was faulty from the start.

> It would take a while to fully answer your questions. Suffice it to say we noticed something wrong with both fluids (but mostly 212B) back in early 2013 on bench testing. By summer 2013, pre-production C5 8-speed corvettes were shuddering w/ 212B/Luk WFP6300 material. We recommended a 5% softer fluid, tried it in vehicle, found it reduced shudder amplitude, but didn't clean kill it. Recommended going further to a 10% softer fluid (where Option B is today), but Bill was reluctant to put it in vehicle because of fear of slipping the shifting clutches. They ended up escaping the corvette issue w/ a cal change. When I challenged him (in a lengthy, back and forth email chain) that high volume 8-speed trucks would still be at risk and we needed to fix the oil, he refused to even discuss the issue w/ Larry Diemer, we went into production w/ 212B in 2015 trucks, and to this day are still bleeding shudder warranty to the tune of ~ $6+M/month.....

PX108 at 2. To add to the discussion regarding the onset of TCC shudder and that it is not the root cause, merely a symptom of the real problem. Shudder is present from very early on in the life of the transmission (colloquially, 'from the first shift') it is simply not noticeable until the magnitude of the shudder increases enough to be noticed above all the other sources of vibration in the vehicle. Stated another way; shudder will continue to get more noticeable / worse as more miles are accumulated on the vehicle.

52. Finally, in March of 2019, GM introduced a GTL ATF Mod1a into service. By all accounts, the shudder claims fell. It went down with respect to midsize trucks from 255 IPTV to 18. PX128 (GM000858066) at 2. Dr. Radecki and others testified it was / is one of the best ATF formulations available and should be used in all 8L vehicles. Radecki Dep. at 325:19-328:19; 334:17-334:25; Anguish Dep. at 177:4-9.

53. GM, through TSB 18-NA-355, recommends that all MY15-MY19 8L vehicles with shudder receive a fluid flush with Mod1a. GM000402765. However, GM opted not to do a field campaign or a customer letter alerting purchasers of a successful known fix to a known problem. Instead, GM decided to only replace the defective fluid in unsold Cadillacs and trucks in certain regions – some 6,800 vehicles – to save money. PX121 at 1-2.

54. GM knows the shudder problems stem from its own design choices. The lessons learned by GM as to how it failed to properly validate both 212b and then Option B with regard to water sensitivity and degradation include the following:

55. The GM water limit was set at 1,000 parts per million or .1%. GM determined that its "current specification limit for water in ATF is insufficient to prevent shudder." PX178 (GM000374910) at 8. That was twice as high as that set by competitors like Ford. PX3 at 43.

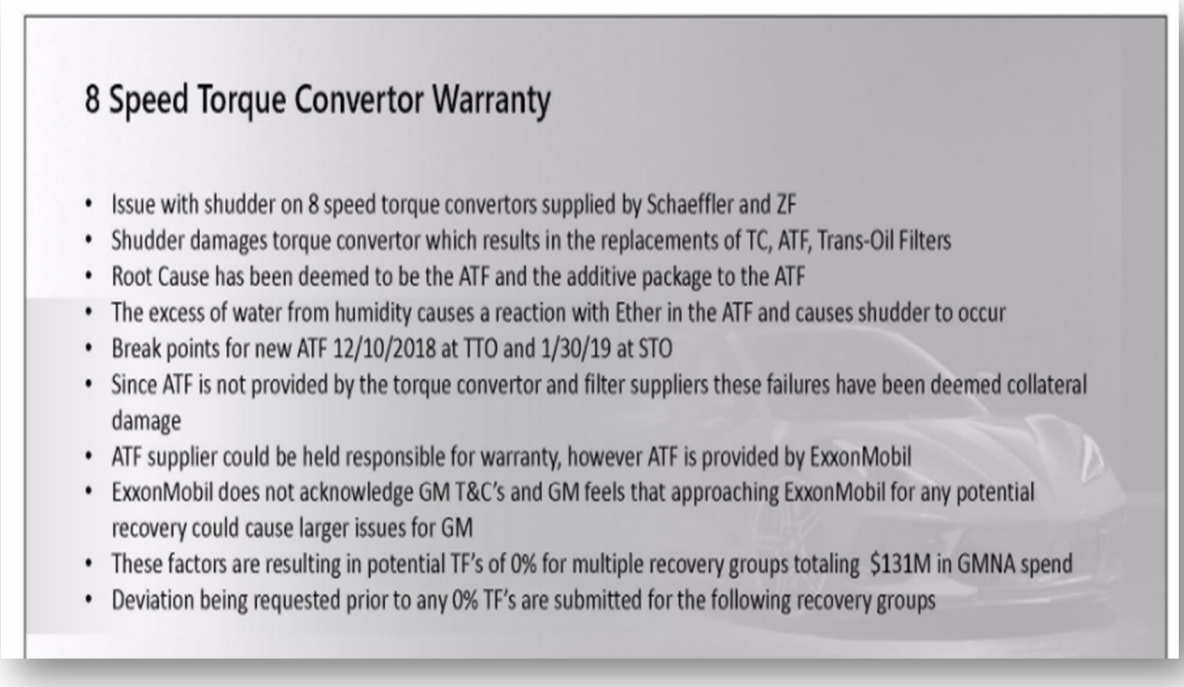
56. GM learned that its proprietary PAO-based oils were sensitive to water after it went into the field and thousands of customers had TCC shudder when the friction modifiers in the ATF were effectively washed out.

57. GM did not even have a water test as part of its validation process at the time it was introducing its new ATF, 212B. PX109 at 4.

58. The duty cycles GM used to test Option B were not consistent with ordinary driving. PX179 (GM000504041) at 5. GM test drivers would drive two trips of 350 miles a day, rather than multiple trips of under 16 miles. These shorter trips matched what ordinary drivers would do, and the moisture generated during those harsher duty cycles triggered shudder more quickly. GM learned (too late) that "Fiat-Chrysler ran a duty cycle more like what our customer data represents. That is 30-minute drive cycle with 4-6 hours of vehicles parked outside to take

advantage of environmental effects (high humidity) of the region on the subsystem(s) within the vehicle as a function of more thermal cycles." PX179 at 5.

59. Also telling is that GM concluded that in August of 2019 that the shudder defect could damage torque convertors supplied by Schaeffler and ZF and GM could not seek contribution from the TCC suppliers and were reluctant to approach ExxonMobil (the ATF supplier). PX190 at 2.



60. When GM asked its engineers, they agreed that since the ATF supplier made the ATF to GM specifications, they had little grounds to seek contribution for warranty claims and would have "eat the warranty" all by itself. PX186.

61. GM has also acknowledged that that customer, aside from perhaps living in a humid region that exacerbates the sensitivity of the ester-based ATFs, had done nothing wrong to trigger TCC shudder. Bulloch Dep. at 93:17-95:3.

C. Poor Drive Quality - Harsh Shifts

62. An additional problem with the GM 8L transmission is poor drive quality. This is the umbrella term GM uses to describe transmission shift issues like harsh shifts, first shift of the day, garage shift, rough coast downs, surges, lurches, and jerks. PX137 (GM000494541). These have been described as "feeling like being rear-ended," PX573 (GM000053785), or a Donkey kick. Radecki Dep. at 265:4-267:1.

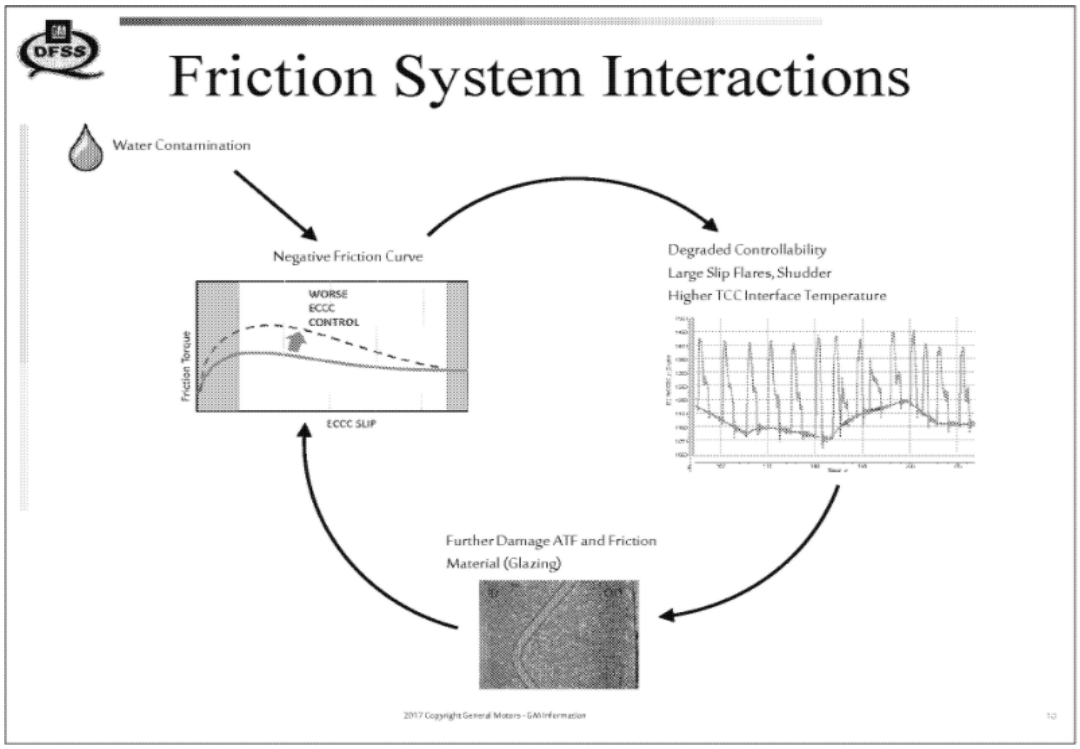
63. Unable to come up with a fix, GM often tells customers that the slipping, abnormal upshifts or downshifts are just "normal operation." See, e.g. GM000046284. However, GM knows that harsh shifts dating back to 2015 have "improved but still not acceptable to the customer." PX219 at 4. An "Overall Summary" of the 8 RWD transmissions shows that for every model year from MY15 to MY19, "product engineering" was in the "red", or below targets set by GM, attributable in part to shudder and drive quality problems, for every year the Class Vehicles were sold. PX223. Keenan Dep. at 240:2-257:22.

1. Root Cause

64. GM has tried to claim several different items contribute to the drive quality issues. However, a marginal friction system seems to be the most common and continues through Generation 1. As explained below, design changes for Generation 2 show a major redesign is needed to finally address the complaints of rough upshifts and downshifts.

65. From a fluid standpoint, the poor choice in ATF affected TCC controllability throughout. As Dr. Radecki explained, "[If] the fluid's bad, it's going to hurt all the clutch performance the transmission box. Radecki Dep. at 266:19-267:1.

66. In a Six Sigma presentation that Dr. Radecki prepared for Bob Gonzales in May of 2017, he also linked the ill effects of water on the ATF to degradation of shift quality, the emergence of shudder, and overall damage to the friction system.



GM000055668 at 10.

67. Mark Gordon, a Brand Quality Manager for GM noted in February of 2019 that despite attempts at improving clutch performance, GM had no answers for customers:

Shift quality issues are an ongoing concern with the 8 Speed transmission. Unfortunately these issue have been through an Op-ex and a service solution is not going to be developed due to cost. Hardware and calibration improvements were implemented in 2018 and a new "wet" characterization process is coming for 2020.

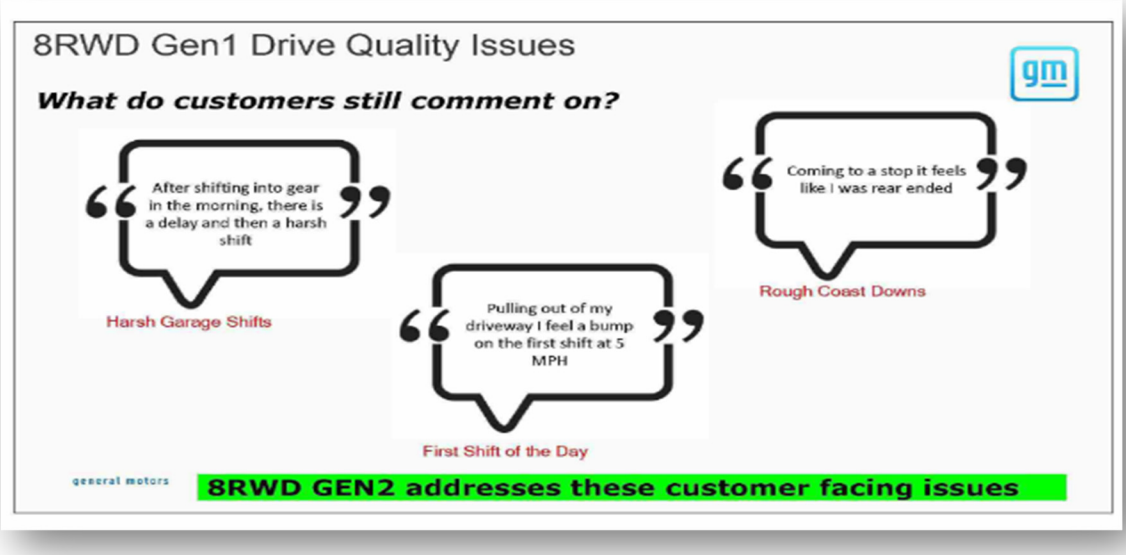
If completing the Drive Learn Procedure (16-NA-019) improves/corrects the customers condition for a short period of time there is a issue deeper in the transmission. This is most likely clutch related. I've had some success in resealing the effected clutch and others we've replaced complete transmission. Also if learning a clutch or clutches corrected the condition short term the valve will not likely correct the issue.

Replacing valve bodies has had mixed results on shift quality in general.

Unfortunately the shift quality of this vintage of 8 speed transmission does not meet the expectations of our customers.

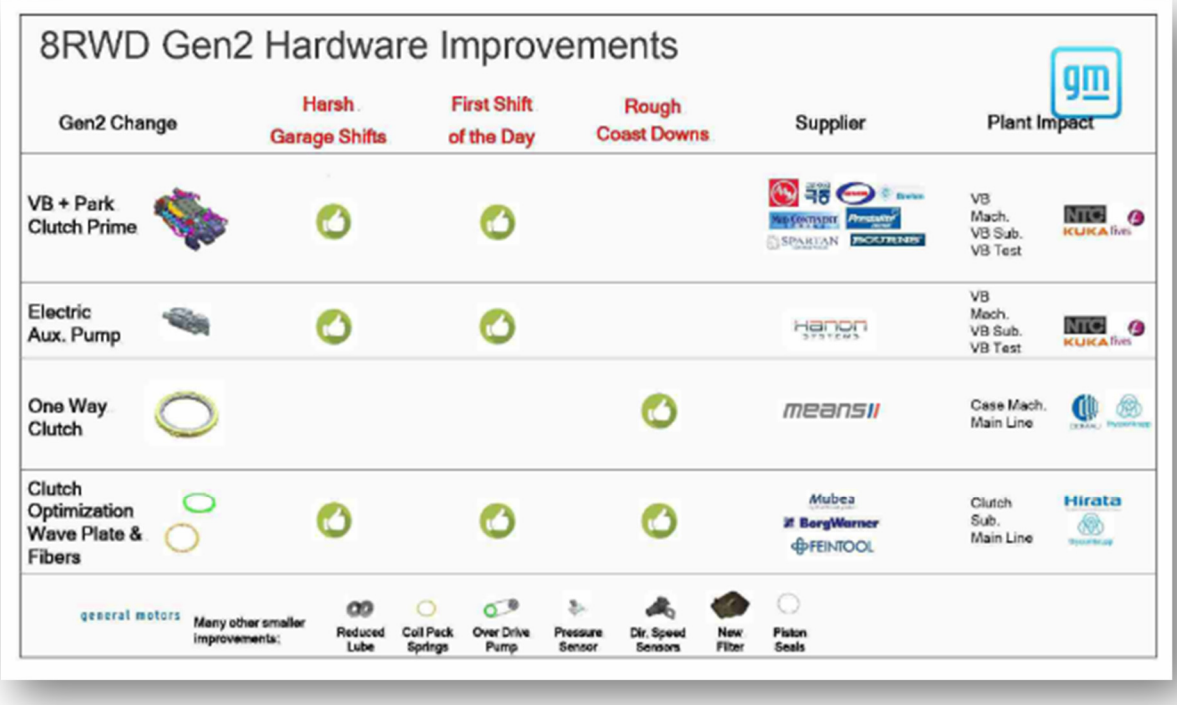
PX39 at 1.

68. GM is still seeing the same complaints from customers in 2021.



PX123 (GM000875195) at 5.

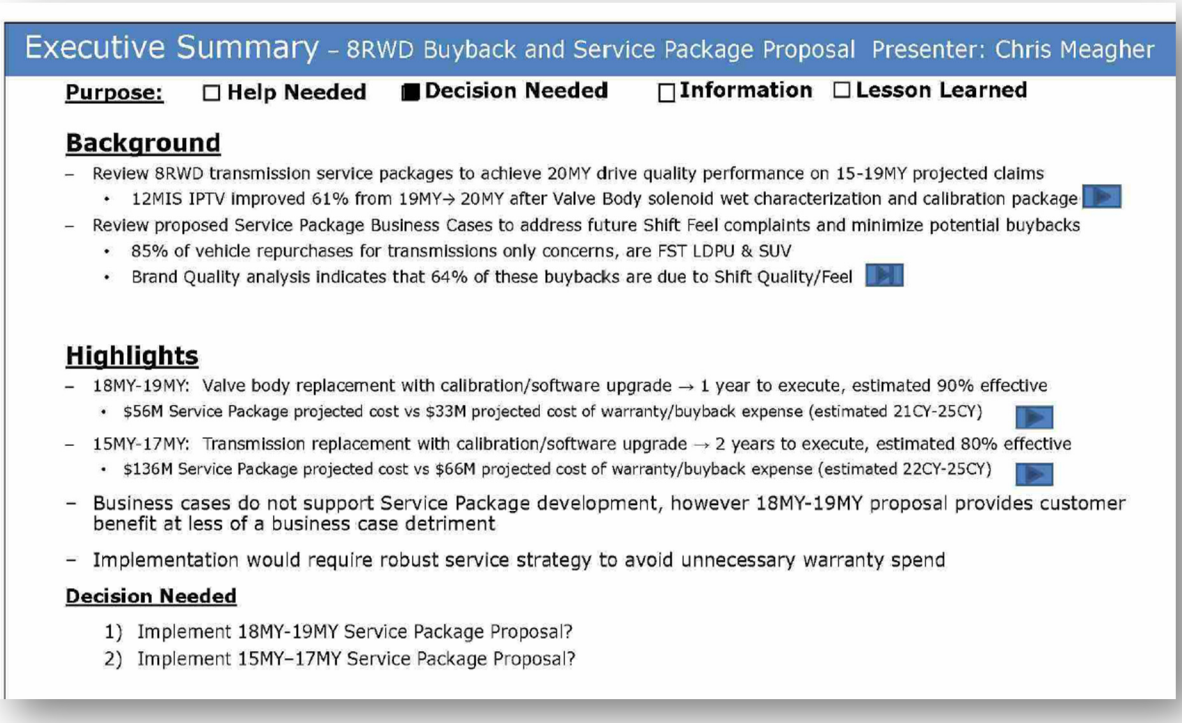
69. The hardware and software discussed for MY23 include:



PX123 at 6.

70. These changes may improve drive quality. If so, they should be made available to all existing customers free of charge.

71. GM has also identified changes in MY20 that have improved shift quality and considered service proposals to existing customers to mitigate the shift quality issues. PX 225 at 2. This included "$1550 for valve body replacement" and "$4450 for transmission replacement." PX225 at 1. GM decided not to proceed with any of the proposals as the improvements to 2015-2017 vehicles would not even get those vehicles to the MY20 level:



Executive Summary – 8RWD Buyback and Service Package Proposal Presenter: Chris Meagher

Purpose: ☐ Help Needed ■ Decision Needed ☐ Information ☐ Lesson Learned

Background

- Review 8RWD transmission service packages to achieve 20MY drive quality performance on 15-19MY projected claims
  - 12MIS IPTV improved 61% from 19MY→ 20MY after Valve Body solenoid wet characterization and calibration package
- Review proposed Service Package Business Cases to address future Shift Feel complaints and minimize potential buybacks
  - 85% of vehicle repurchases for transmissions only concerns, are FST LDPU & SUV
  - Brand Quality analysis indicates that 64% of these buybacks are due to Shift Quality/Feel

Highlights

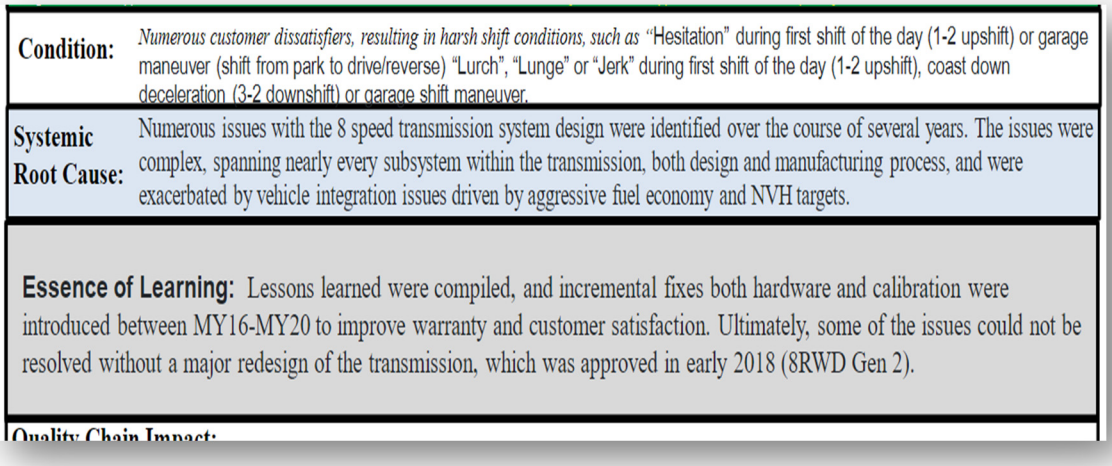
- 18MY-19MY: Valve body replacement with calibration/software upgrade → 1 year to execute, estimated 90% effective
  - $56M Service Package projected cost vs $33M projected cost of warranty/buyback expense (estimated 21CY-25CY)
- 15MY-17MY: Transmission replacement with calibration/software upgrade → 2 years to execute, estimated 80% effective
  - $136M Service Package projected cost vs $66M projected cost of warranty/buyback expense (estimated 22CY-25CY)
- Business cases do not support Service Package development, however 18MY-19MY proposal provides customer benefit at less of a business case detriment
- Implementation would require robust service strategy to avoid unnecessary warranty spend

Decision Needed

1) Implement 18MY-19MY Service Package Proposal?
2) Implement 15MY–17MY Service Package Proposal?

GM000891280 at 1.

72. As of June 30, 2021, GM admitted it has no present solution for previous customers and awaits a "major redesign of the transmission" to correct drive quality issues:



Condition:	*Numerous customer dissatisfiers, resulting in harsh shift conditions, such as* "Hesitation" during first shift of the day (1-2 upshift) or garage maneuver (shift from park to drive/reverse) "Lurch", "Lunge" or "Jerk" during first shift of the day (1-2 upshift), coast down deceleration (3-2 downshift) or garage shift maneuver.
Systemic Root Cause:	Numerous issues with the 8 speed transmission system design were identified over the course of several years. The issues were complex, spanning nearly every subsystem within the transmission, both design and manufacturing process, and were exacerbated by vehicle integration issues driven by aggressive fuel economy and NVH targets.
Essence of Learning: Lessons learned were compiled, and incremental fixes both hardware and calibration were introduced between MY16-MY20 to improve warranty and customer satisfaction. Ultimately, some of the issues could not be resolved without a major redesign of the transmission, which was approved in early 2018 (8RWD Gen 2).	
Quality Chain Impact:	

PX153 at 20.

2. GM Knowledge of Drive Quality with 8L Transmissions

73. Even before launching the Corvette in 2014, GM test riders complained that the downshift to 1st gear was a "neck snapper," and that "tap shift no throttle 4-5, 5-6, 6-7, 7-8 kicks you in the butt really bad." PX134 (GM00087212) row 85 and 96.

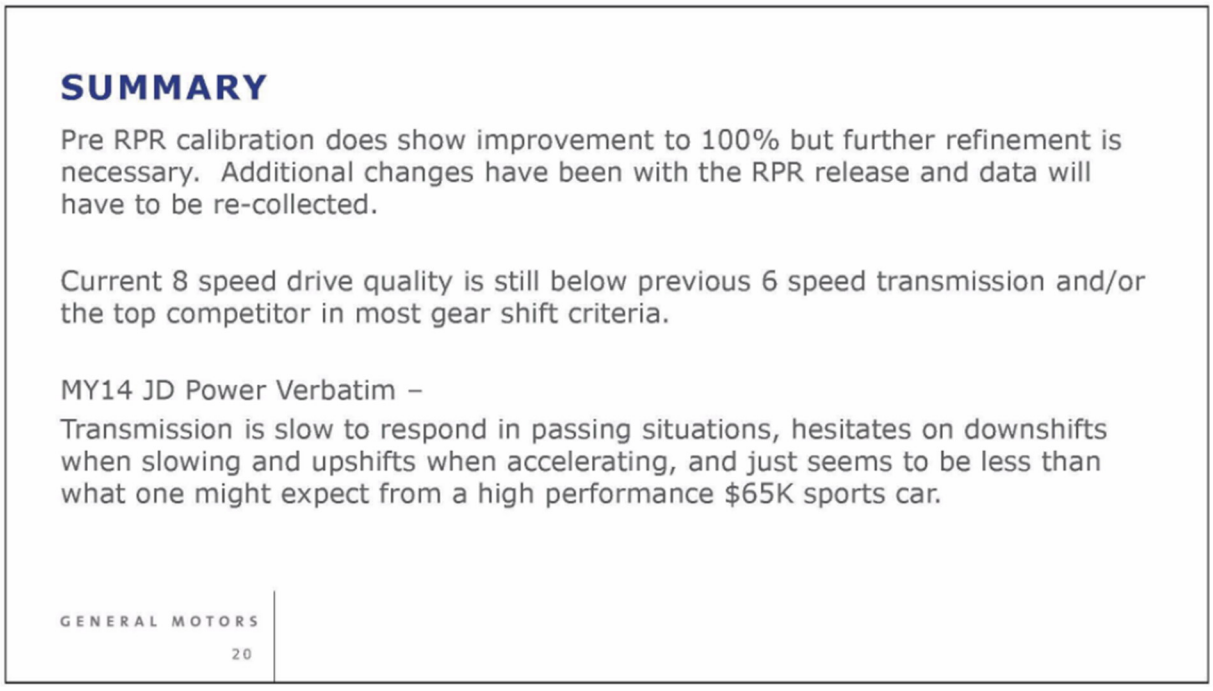
74. There were also complaints in May of 2014 where riders experienced "a 3 second delay while in 4Lo going from N to D. They think they are in gear when they put the selector in D then step on the gas. At that point they get a delay,

flare, and a quick harsh engagement which causes the vehicle to lurch." PX202 at 1. One vehicle even "lurched" off right off rollers into a post. PX201.

75. The "garage shift" issue was also known in the Corvette pre-launch. GM000088542 (also noting downshift bumps on coast down and a 3-2 surge/decel).

76. In July of 2014, Tadge Juechter, the Chief Engineer for the Corvette, wrote GM Chief Engineer Kavoos Kaveh about his concerns over harsh shifts including 3-1 coast downs. PX195 at 1. He was so concerned about the drive quality he raised delaying the "SORP" ("start of regular production.").

77. Early comments from customers by JD Power were very poor on the drive quality. (GM000590092 at 20):



SUMMARY

Pre RPR calibration does show improvement to 100% but further refinement is necessary. Additional changes have been with the RPR release and data will have to be re-collected.

Current 8 speed drive quality is still below previous 6 speed transmission and/or the top competitor in most gear shift criteria.

MY14 JD Power Verbatim –

Transmission is slow to respond in passing situations, hesitates on downshifts when slowing and upshifts when accelerating, and just seems to be less than what one might expect from a high performance $65K sports car.

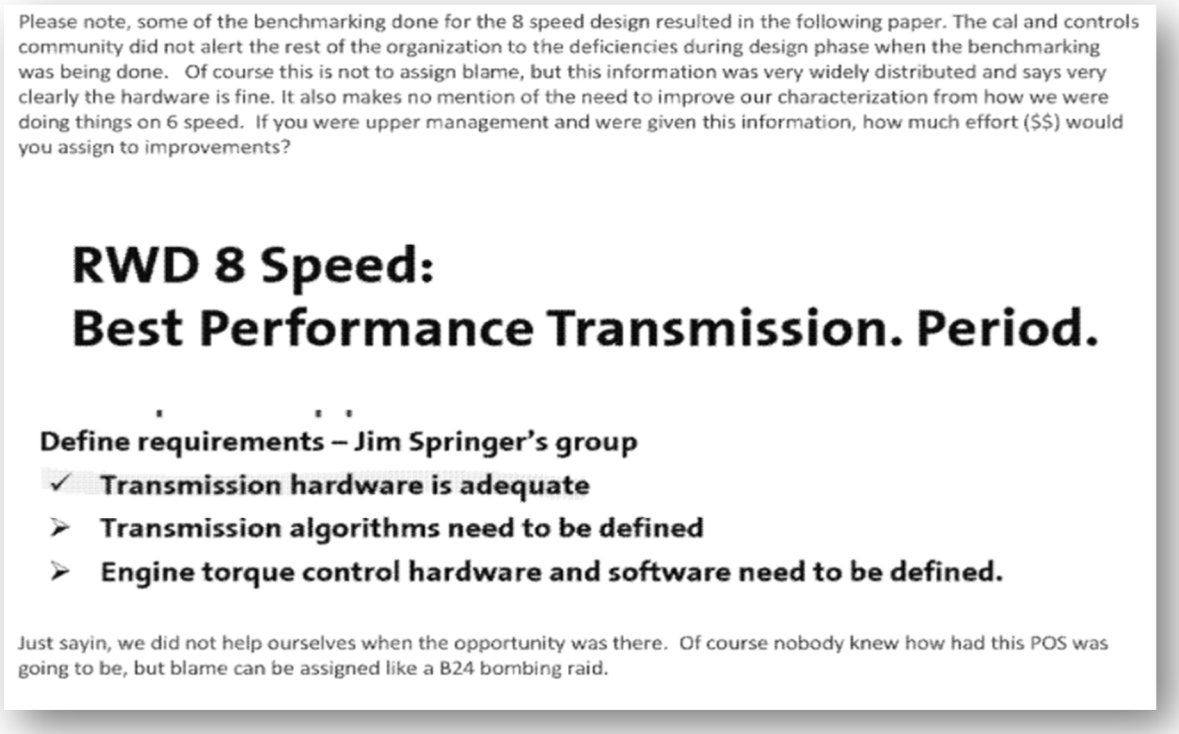
GENERAL MOTORS

20

78. In May of 2015, additional feedback showed "We are not making progress" and the complaints included 1-2 / 3-1 Rough Shift concerns. PX207 at 5.

79. GM early Technical Service Bulletins addresses garage shifts, delayed engagement and other shift quality issues. See, e.g., GM00002297 (firm garage shifts); GM000025412 (harsh shifts, slips, or flares); GM000039463 (delayed engagement); GM000002332 (Harsh 1-2, Harsh 3-1 Decel Downshift, Harsh Downshifts); GM000134618 (Information on Transmission Harsh 1-2 Shift Upon First Start Up/Shift of the Day); GM000002329 (Harsh Shift, Delayed Shift, Unwanted Downshift, Transmission Stuck in One Gear).

80. GM employees have criticized the shift quality. Even as it claimed it saw improvements in 2016, it knew that MY16 and MY17 would not meet "benchmarking levels." GM000043487 at 2. It also concluded that its aggressive attempts at better fuel economy compromised customer drivability. GM000043487 at 25. In one email, an engineer who worked on calibration named Chris Webert correctly observed that engineers not complaining to management sooner may have delayed GM from addressing the problems:



Please note, some of the benchmarking done for the 8 speed design resulted in the following paper. The cal and controls community did not alert the rest of the organization to the deficiencies during design phase when the benchmarking was being done. Of course this is not to assign blame, but this information was very widely distributed and says very clearly the hardware is fine. It also makes no mention of the need to improve our characterization from how we were doing things on 6 speed. If you were upper management and were given this information, how much effort ($$) would you assign to improvements?

RWD 8 Speed:
Best Performance Transmission. Period.

Define requirements – Jim Springer's group

- ✓ **Transmission hardware is adequate**
- ➢ **Transmission algorithms need to be defined**
- ➢ **Engine torque control hardware and software need to be defined.**

Just sayin, we did not help ourselves when the opportunity was there. Of course nobody knew how had this POS was going to be, but blame can be assigned like a B24 bombing raid.

PX194 at 1.

81. In July of 2016, Mark Gordon gave a presentation on "8L90 Poor Shift Quality – On Going Improvements" that had "no correction" or "first shift of the day 1-2 flare" as a "TSB in process." GM000036362 at 4. As to the poor shift quality on 3-1 downshift, all GM could offer was a "learn procedure." GM000036362 at 9.

82. In May of 2017, GM had little confidence in hardware solutions and software solutions to deal with TCC slip in its 8L45 transmissions. GM000046209.

83. Between 2017 to 2021, numerous SUFS on harsh shifts had been created by GM employees for review. These all noted problems with lurching, hesitation, and surging. PX148; PX149; PX153; PX578.

D. My Inspections

84. My inspections confirmed the complaints and aligned with the service records of the named plaintiffs who complained of shudder, harsh shifts, or both. My inspections were usually conducted at and around their home at a location of their choosing. All my driving assessments were conducted on public roads and / or in public parking lots. At the vehicle owner's discretion, I accommodated them as a passenger if they would rather drive (not allow me to drive) their vehicle. If they choose to drive, I would discuss my intentions and requirements for the drive cycle in detail prior to starting the assessment and if needed, coach them through the various maneuvers when appropriate. For my inspection I did the following;

- **Pre-Entrant Into Vehicle:** Per protocol and CDC guidelines, I wiped the entirety of the inside of the vehicle where I would be involved and / or need to contact during my assessment.
- **Vehicle Preparation:** If possible, I would keep the vehicle 'cold', meaning I would attempt to have the vehicle not driven past the evening of the prior day, I would not start the vehicle until I was completely ready to drive, etc. Not running the vehicle from at least

the day before was a means to keep the ATF at ambient temperatures and recreate the 'first shift in the morning' scenario if possible. My suspect was that one or more of the clutch apply piston reservoirs was draining more than anticipated, which would cause the 'first shift', the volume behind the apply piston plate, to take a longer than expected time to engage the clutch. If the TCU did realize that the clutch fill rate to first friction plate contact was taking longer than expected, the ECU might let the engine flare and when the clutch finally engaged it would produce the 'hard first shift' event. The 'hard first shift' event feels much like dropping the clutch in a manual transmission and in fact and function, it is much the same shock to the driveline.

- **Observational Data Collection Prior to Assessment Drive:** I would discuss the situation with the owner, specifically asking about the complaint(s) they had made, ask them to describe what they felt in detail, discuss vehicle history with emphasis on maintenance and use practices, and I would try to deduce how much of their description was of their own thoughts versus what they might have read, etc.
- **Initial (prior to assessment drive) Information and Data Collection:** I have a standardize form which I use to capture all the above and then document specific information about the vehicle;

- Owner name, address, etc.
- Inspection date
- Make and model of vehicle to be inspected
- VIN
- Mileage
- Whether the vehicle has had any modifications from OEM (either by the owner and / or third party), and if there have been modifications to the vehicle, do they or could they potentially have an effect on the powertrain (i.e. replacement tires of near similar size and specifications – No / CAI, Cold Air Intake – Yes, etc.)
- Statement of owner observed issue(s)
- Whether I have access to all repair orders (provided by Gordon & Partners)
- A description of what I observed during my test drive (filled in later, after test drive)

- **Photo-Documentation:** I would take a series of photographs around and in the vehicle; generally capturing the outside from all angles (to document any damage such that I would not be assigned responsibility, etc.). I would also capture the VIN plate from the

dashboard through the windshield, as well as tire data from the sidewall

- **Setup Instrumentation:** GM GDS 2, PICO NVH Analyzer. I have developed a procedure wherein I can monitor both vibration (PICO meter) and vehicle operational parameters (GM GDS 2) simultaneously. The accelerometer was placed (magnetically attached, thus limited to approximately 1 kHz) on the seat frame rail of the inboard passenger seat. The 'X' axis was situated as forward in the vehicle, the other axes follow an orthogonal axis format. All except Cadillac models, wherein the accelerometer was placed inverted on the sunroof frame rail, due to limited access to the seat frame rail. Both instruments were attached to and input through a laptop to the applications that support the various instruments.
- **Initial Static Data Collection:** I would power up the vehicle, without starting the engine. Using the GM GDS 2 system, I would collect all TCU / PCU data as data dumps to the PDF format (See Exhibit A to Appendix 1). I would also verify, if the vehicle was equipped with either cylinder deactivation and / or engine off during a stop that these functions were turned off (disabled).

- **Dynamic Data Collection:** The GM GDS 2 and PICO NVH system were setup to collect pertinent data to driveline performance (See Exhibit B to Appendix 1). A third application was used to capture all video activity on the laptop screen (I was capturing the visual output from both the GM GDS 2 and PICO system) the screen capture application also recorded audio within the vehicle occupant compartment, which I used to log information and observations. I would also describe the drive cycle I was conducting. As I was not on a controlled closed course driving environment, I would describe the driving situation I took the vehicle through (or coached the owner / driver through) including any obstructions to planned maneuvers.
- **Drive Cycle:** First, I (from here on out I will use only 'I', which will imply the owner / driver if that was the particular situation) attempted to drive in a manner that would exhibit the 'first hard shift' issue to be evidenced. A simple low speed maneuver (forward or reverse depending on the position of the vehicle and proximity of a clear drive path, etc.) similar to any description the vehicle owner provided. Next, I would conduct neighborhood / city-like driving to assess general shift quality and vehicle drivability. During all these maneuvers I would be collecting data in terms of various powertrain

function. I would record transmission function (shift times, ATF pressure in the various passages and to various solenoids, speed ratio selection and the effect on implementation, etc.). I would also record various rotational speed information (e.g. clutch slip speeds, torque converter slip speed, etc.) in order to assess effectiveness of command and control of the PCU / TCU.

Once the transmission was brought to operating temperature and general / gentle to moderate acceleration maneuvers were complete, I would put the vehicle through a series of straight-line acceleration maneuvers; light throttle (throttle position and axle torque were generally monitored to verify control and level), moderate and hard acceleration. Generally during these maneuvers, I would monitor axle torque, shift times and the various differential rotational speeds within the transmission.

Finally, and usually last to minimize the effect of heating the ATF, I would perform a series of rapid large throttle excursions. Not necessarily 0% to 100% throttle position, but something on the order of ~20% low vehicle speed to ~80% hard acceleration for short periods of time. The actual throttle positions varied by my ability to control (foot control of pedal position) and the performance ability of

the vehicle. It was not my intent to accelerate overly aggressively and / or to cause the drive tires to break traction, etc. These were, after all, other people's vehicles, nor did I need excessively levels of acceleration to collect and record primarily shift times and speed ratio command and control. Specifically, what I was looking for was hard up or down-shifts as a function shift times and / or skip shift command and effectivity of implementation.

If possible, I would also try a series of tight turns during moderate acceleration to assess the effect of traction control over typical transmission operation. This series of assessments and maneuvers would take from 1 to 1.5 hours generally.

- **Post-Assessment Vehicle Closure:** After I removed all my equipment, per protocol and CDC guidelines, I wiped the entirety of the inside of the vehicle where I had contacted any surface.
- **Post-Assessment Data Verification and Storage:** After returning the vehicle to the owner and / or representative, I review all collected data, copied all data to a second secure location and properly closed all applications. At a later time, I would also incorporate all photos taken into the report document.

85. My inspections mostly confirmed the owners' complaints of shudder or poor shift quality. **See Appendix 1.** In some instances, the owner had already had the Mod1a flush, so shudder was not evident. See, e.g. Chi Kim Ho, row 32.

E. GM's Inspections

86. Inspections by representatives of GM likewise verified that plaintiff vehicles suffered from poor shift quality and transmission operation. Although GM personnel or their representative followed a similar protocol, there were some differences. Generally, the Field Service Engineer (FSE) representative from GM and / or a mechanic from the dealership assigned to assist with the inspection would conduct one of two multi-point vehicle inspections. They would either conduct the typical GM 29-point inspection or a more complete 129-point vehicle inspection. Both seemed to be defined by GM for their dealer network. The GM FSE and / or mechanic would also check a number of vehicle wear components (i.e. brakes, tire tread depth, etc.).

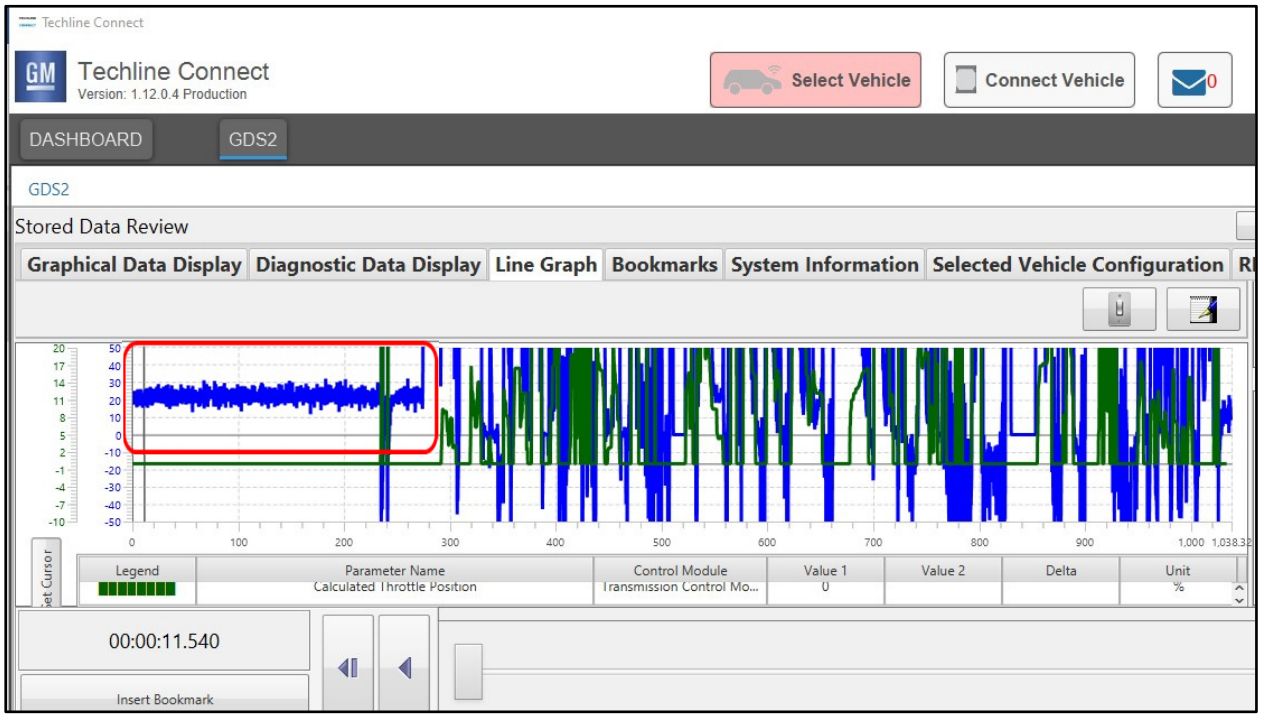
87. Generally, these activities were non-intrusive, however on at least one occasion the mechanic was instructed to add ATF to the transmission as it was found to be below the acceptable limit during the inspection. I objected based on the premise that the ATF formulation that was to be added was not the formulation that was in the vehicle (the original fill 212, or the first attempt to address the problems with the Option B ATF, or perhaps even the current final solution for the

ATF fill of Mod1a). My position on this matter and any other that would substantially alter the condition and / or operation of the vehicle by anyone was unacceptable. Further, and again, my position is that if the vehicle on-board sensor(s) and / or monitoring system(s) had not alerted the owner / operator then the vehicle was operating within acceptable parameters and could be driven and evaluated as is.

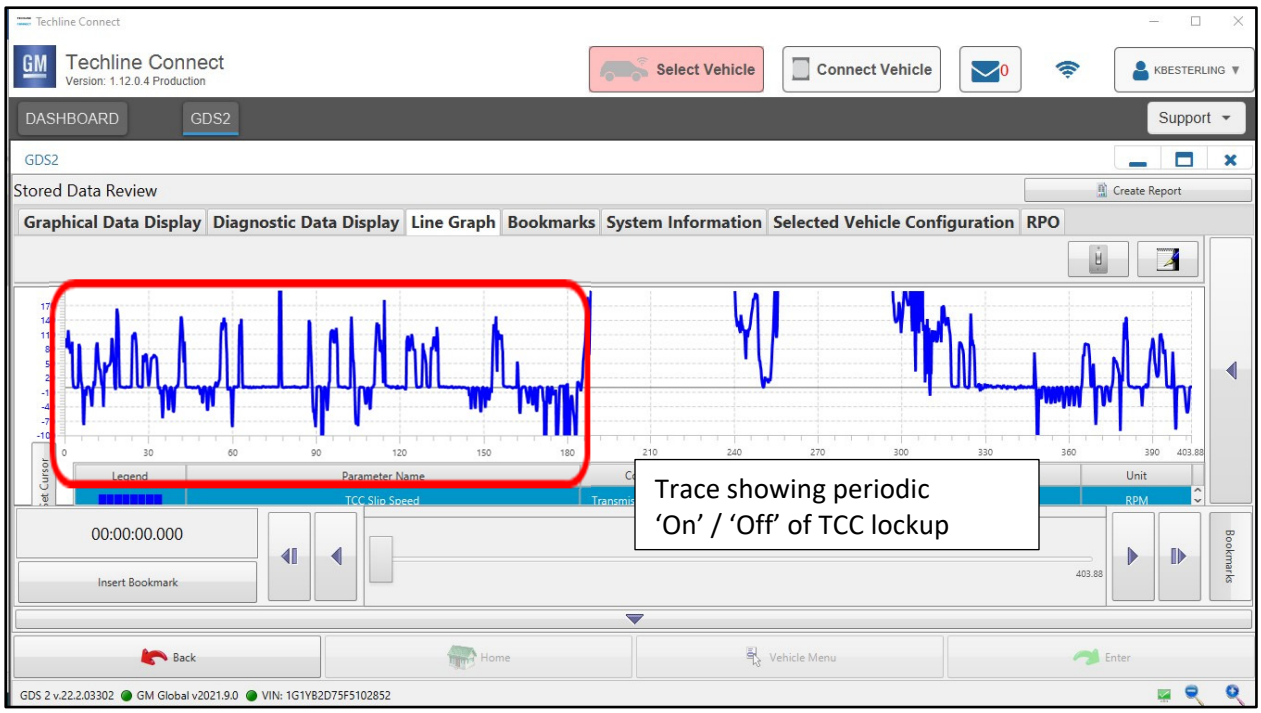
88. Per the protocol, I was not allowed to ride with the GM FSE during their evaluation, nor was I allowed to review the data they had collected. This was to be provided to me for review during discovery. I have no knowledge of what either the GM FSE and / or mechanic did during the drive. I also did not give any instructions, advise or requirements to either the GM FSE or mechanic before or after their drive time. If either the GM FSE or mechanic asked me any questions, within the bounds of what I had been instructed by the attorneys representing the plaintiff were permissible topics, I would answer, but not advise or opine on any matter associated with the case, the vehicle, its owner or the activities to be conducted. Since the inspections, I have not had any contact with any of the GM FSEs or mechanics I met during my time working on the case.

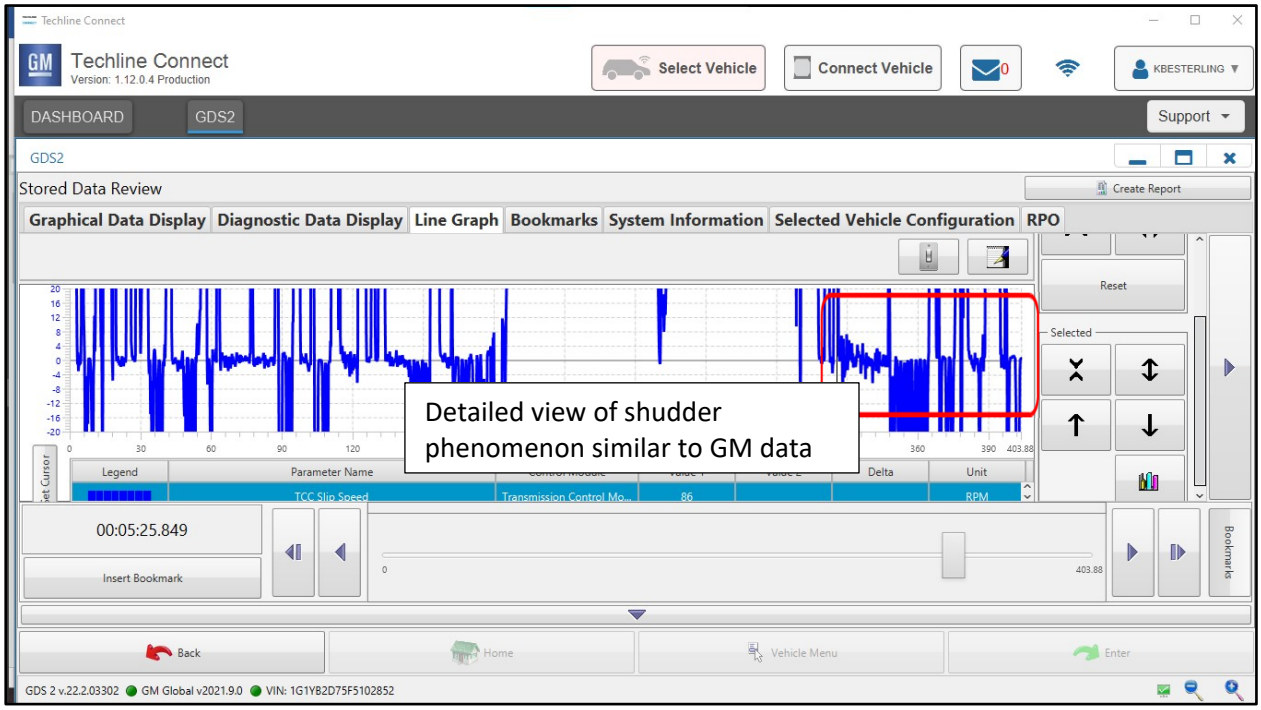
89. My review of some of the results from inspections performed by GM technicians or FSE indicated TCC shudder. As an example, in one data capture the following trace of TCC Slip Speed in green (the difference between the output

rotational speed of the engine / input to the torque converter and the rotational speed of the torque converter turbine / output from the torque converter; this is the slipping speed across the TCC while engaged) as a function of Calculated Throttle Position in blue:



The highlighted section (red box) indicates TCC shudder. This observed phenomenon is evident and similar to data I collected as shown below.


Techline Connect
Version: 1.12.0.4 Production
Select Vehicle
Connect Vehicle
KBESTERLING
DASHBOARD
GDS2
Support
GDS2
Stored Data Review
Create Report
Graphical Data Display
Diagnostic Data Display
Line Graph
Bookmarks
System Information
Selected Vehicle Configuration
RPO
Legend
Parameter Name
Unit
TCC Slip Speed
RPM
00:00:00.000
Insert Bookmark
Bookmarks
Back
Home
Vehicle Menu
Enter
GDS 2 v.22.2.03302
GM Global v2021.9.0
VIN: 1G1YB2D75F5102852
Trace showing periodic
'On' / 'Off' of TCC lockup


Techline Connect
Version: 1.12.0.4 Production
Select Vehicle
Connect Vehicle
KBESTERLING
DASHBOARD
GDS2
Support
GDS2
Stored Data Review
Create Report
Graphical Data Display
Diagnostic Data Display
Line Graph
Bookmarks
System Information
Selected Vehicle Configuration
RPO
Reset
Selected
Legend
Parameter Name
Delta
Unit
TCC Slip Speed
Transmission Control Mo...
86
RPM
00:05:25.849
Insert Bookmark
Bookmarks
Back
Home
Vehicle Menu
Enter
GDS 2 v.22.2.03302
GM Global v2021.9.0
VIN: 1G1YB2D75F5102852
Detailed view of shudder
phenomenon similar to GM data

F. Transmission Teardown

90. On September 27 and 28, 2021 I examined four transmissions in Auburn Hills, Michigan provided by GM that were pre-2019. My protocol and observations are contained in **Appendix 2.**

91. The friction material had been adversely affected the ATF and caused debris in the filter. The ATF had burnt and oxidized, no other observed sources for this (bearings, seals, valve body, etc.) were fine. In one (No. TEARDOWN000001083 Francis_Trans5_Carpenter001) the ATF had not degraded to the same degree, but the friction material showed the onset of surface distress.

92. This supports my opinion on the flawed selection of WFP6300 and ester-based ATF for a friction system.

G. The Poor Shift Quality and Shudder Could Present a Safety Issue

93. I have been asked to opine if in addition to being a customer dissatisfaction issue, if the operational problems endemic to the 8L transmission present a safety issue. In sum, it is my opinion that the transmission issues can startle or surprise the driver, despite a record of only a few reported incidents attributed to the issues. In addition, the issues addressed in this report are sporadic in nature, which means for example the hard shift / lurch issue may manifest itself during an attempt by the driver to pull-out into traffic. If it happens during one

attempt and then does not happen during the next, the driver may attempt to anticipate the surge and when it does not happen, react in a manner not coincident with safe driving. I can state that when I drove many of these vehicles, beyond becoming familiar with each specific vehicle, I was 'caught off guard' and did not always correctly anticipate how the vehicle was going to respond to my commanded input. This is one of the driving reasons I choose open areas and as lightly travelled roads as possible. To be clear, I have driven many different vehicles, many times 'back-to-back' either as in use of rental cars (during my discovery activities for this case I drove over 30 different vehicles) and / or as part of my activities in my career.

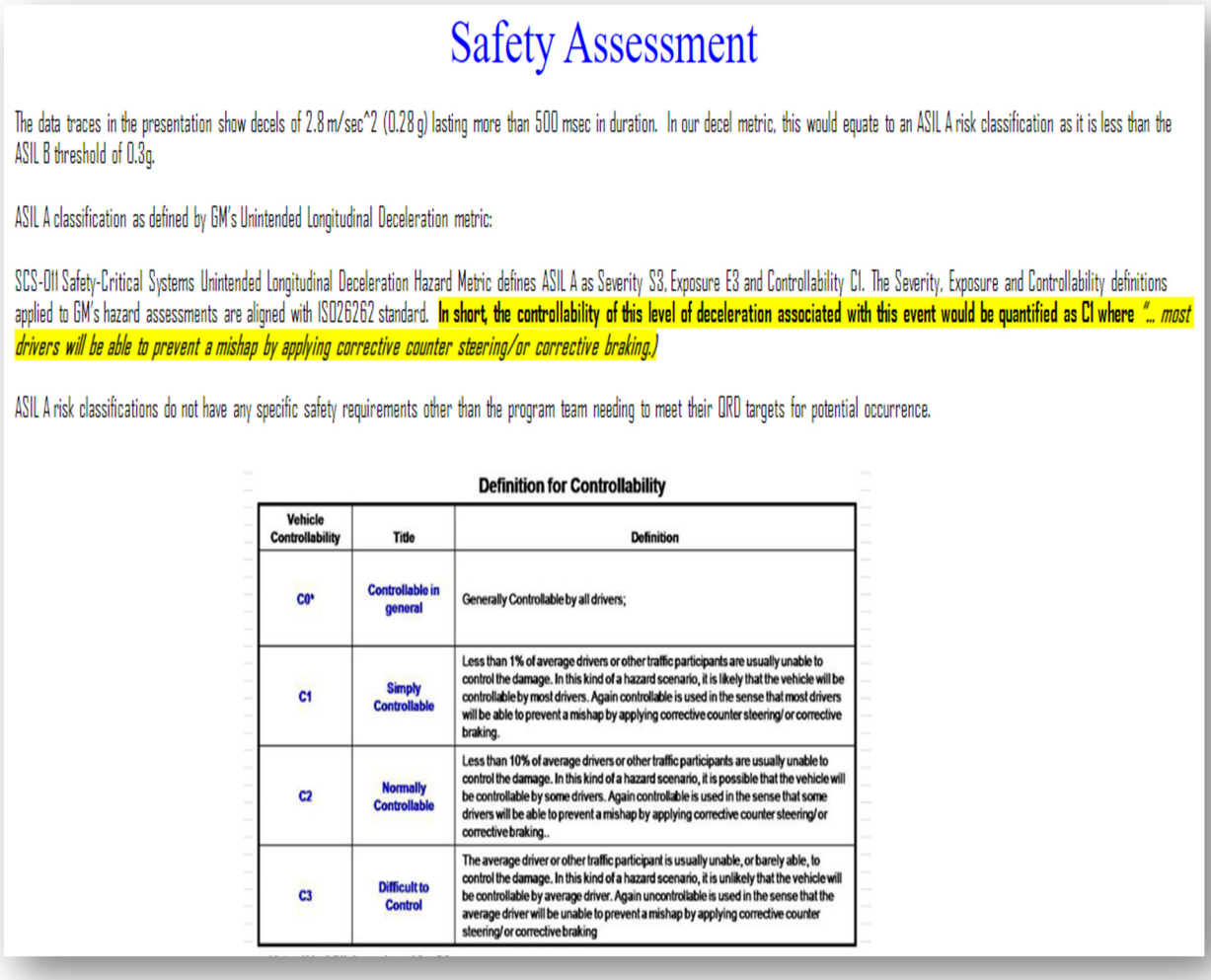
94. Customers have complained to the National Highway Traffic Safety Administration (NHTSA) about 8L transmissions repeatedly. These include complaints about accidents with minor injuries due to the distractive nature of the shudder/surges/lurches/jerks associated with the transmissions. PX135.

95. Some dealers have complained to GM as well that the surges/lurches/jerks presented a safety issue. For example, when an engineer went to drive a GMC Sierra with harsh shifting problems, the dealer told him, "the vehicle 'isn't right' and all of the vehicles on his lot with an eight speed transmission are dangerous when started because they lurch or jump." The technician found that the vehicle "operates as a like vehicle" and did not

recommend a buyback. Mark Gordon of GM noted "Some owners do not expect the engagement time on the 8-speed transmission. I understand their position, unfortunately we can only work with what the transmission is capable of delivering." GM000134675 at p. 2. Gordon knew dealers would complain about shift quality and responses that these shifts were "normal characteristics" were frustrating those concerned. GM000035741.

96. During the 2019 investigation of "alleged Lunge/Lurch/Hesitation Upon Shifting" of Silverado trucks with 8L90 transmissions, the investigator considered describing the condition as "vehicle lunges/surges while coming to a stop. This condition is primarily associated with 3-1 downshift, potentially perceived by some operators as a "surge" in a startling effect." PX147, GM000550216. However, the final version removed the words "surge" and "startling effect". The matter was "closed with no further action" despite 34 accidents associated with it. PX150 (GM000472493 tab "Decisions").

97. In a 2021 investigation on almost the exact same topic of Lunge/Lurch/Hesitation/Rough Coast-downs, GM included a Safety Assessment. The assessment showed a safety risk at a very low level. (PX153).



Safety Assessment

The data traces in the presentation show decels of 2.8 m/sec^2 (0.28 g) lasting more than 500 msec in duration. In our decel metric, this would equate to an ASIL A risk classification as it is less than the ASIL B threshold of 0.3g.

ASIL A classification as defined by GM's Unintended Longitudinal Deceleration metric:

SCS-011 Safety-Critical Systems Unintended Longitudinal Deceleration Hazard Metric defines ASIL A as Severity S3, Exposure E3 and Controllability C1. The Severity, Exposure and Controllability definitions applied to GM's hazard assessments are aligned with ISO26262 standard. **In short, the controllability of this level of deceleration associated with this event would be quantified as C1 where** *"... most drivers will be able to prevent a mishap by applying corrective counter steering/or corrective braking.)*

ASIL A risk classifications do not have any specific safety requirements other than the program team needing to meet their QRD targets for potential occurrence.

Definition for Controllability

Vehicle Controllability	Title	Definition
C0*	Controllable in general	Generally Controllable by all drivers;
C1	Simply Controllable	Less than 1% of average drivers or other traffic participants are usually unable to control the damage. In this kind of a hazard scenario, it is likely that the vehicle will be controllable by most drivers. Again controllable is used in the sense that most drivers will be able to prevent a mishap by applying corrective counter steering/ or corrective braking.
C2	Normally Controllable	Less than 10% of average drivers or other traffic participants are usually unable to control the damage. In this kind of a hazard scenario, it is possible that the vehicle will be controllable by some drivers. Again controllable is used in the sense that some drivers will be able to prevent a mishap by applying corrective counter steering/ or corrective braking..
C3	Difficult to Control	The average driver or other traffic participant is usually unable, or barely able, to control the damage. In this kind of a hazard scenario, it is unlikely that the vehicle will be controllable by average driver. Again uncontrollable is used in the sense that the average driver will be unable to prevent a mishap by applying corrective counter steering/ or corrective braking

(highlights in the original). So, GM did not conclude the surge presented no risk, but that all but 1% of average drivers would be unable to avoid a mishap.

98. Based upon the above and my own experience in the 8L vehicles, I can appreciate how drivers might feel unsafe and startled by some of the rough upshifts and downshifts. However, the risk of an accident due to the transmission problems is plausible. That is why so many riders, dealers, customers and even the

GM employees who opened the SUFS, have raised safety concerns about the 8L transmission's performance.

V. RECOMMENDATIONS

99. I am not going to opine on diminution of value or repaying a portion of purchase price. What I can recommend as an engineer are the following fixes that may form a cost of repair. The costs for those repairs are included in warranty data collected and maintained by GM or projections on back servicing or retrofitting.

100. First, GM should replace the ATF in all GM vehicles currently with Option B or 212B. It is a known fix for a known problem that was solely of making and thus the responsibility of GM. Mod1a certainly seems to have significantly reduced shudder, with returns on vehicles that flushed and filled with Mod1a falling to .05%, from a 50% rate. Anguish Dep. 173:20-174:10; 178:8-181:5. GM requires Mod1a in all vehicles with 8L starting by at least March 1, 2019. GM amended its TSB to not even require a diagnostic test to show shudder so as to save it money. PX172. GM knows that driving with shudder can cause permanent damage or glazing to the friction materials, PX565, meaning it should be caught early. GM000236999. By the time shudder is felt, the cycle of slip flares -> heat -> damaged friction material -> worsening friction curve is already underway. Aware of high warranty rates for shudder for 8L vehicles, GM flushed

and filled selected **unsold** vehicles in 2019. PX121. I don't agree with GM Chief Engineer, that GM should not tell customers that a replacement ATF exists that can possibly fix or prevent shudder, and GM's only obligation is to fix a shudder if it comes to a dealership while the vehicle is still under warranty. Bulloch Dep. at 267:25-271:1. GM should treat existing customers the same way it did the unsold vehicles in 2019.

101. I also note several of GM engineers who dealt with the shudder problems for years have either testified or wrote that they thought GM should make Mod1a available to all customers with 8L transmissions free of charge. GM000873082 (Mark Gordon, a brand quality manager texted he didn't like that no "special policy" existed so that customers out of warranty could not get the shudder fixing fluid); PX159 (Tim Anguish told supplier for Afton a fluid fix that correct shudder should be made available to all customers; Anguish Dep. at 141:16-142:19 (saying the same about Mod1a).

102. Second, GM should retrofit with any MY22 or MY23 8L improvements as to drive quality. GM knows they do not have a solution yet for harsh shifts yet and have been masking them for years with little success. GM000078322. MY23 is supposed to have fixes for them. If the new hardware and software improve things– prime pack, new fibers, and wave plates (PX123) – should put in older vehicles. As noted, GM has already weighed service packages

based upon valve body replacements or transmission replacements. PX225. These types of retrofits are feasible for GM and would improve drive quality at least closer to MY20.

103. Third, GM should alert its past and future customers of these vehicles to the problems and their solutions. GM has very specific proprietary knowledge of the transmission issues and how to correct them, or when they might be corrected. GM can issue customer letters to inform their customers so they can make decisions on whether to buy a vehicle equipped with an 8L transmission, trade it in, get it serviced with Mod1a, or extend its warranties.

Date: October 8, 2021

By: 

William Mark McVea