UNITED STATES DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

In re:

Docket No. NHTSA-2016-0124

GENERAL MOTORS LLC'S PETITION FOR INCONSEQUENTIALITY REGARDING CERTAIN GMT900 VEHICLES EQUIPPED WITH TAKATA "SPI YP" AND "PSPI-L YD" PASSENGER INFLATORS SUBJECT TO JANUARY 2019 TAKATA EQUIPMENT DIR FILINGS

General Motors LLC ("**GM**") hereby petitions the National Highway Traffic Safety Administration ("**NHTSA**") under 49 U.S.C. §§ 30118(d), 30120(h) and 49 C.F.R. part 556 with respect to the Takata "SPI YP" and "PSPI-L YD" model front-passenger airbag inflators installed as original equipment in the GM vehicles covered by Takata's equipment defect information reports ("**DIRs**") filed on January 2, 2019.

In support of this petition (the "**Fourth Petition**"), GM relies on: (i) the arguments and engineering analysis summarized in this Petition; (ii) the information that GM has submitted to the Agency during periodic briefings on the status of its Takata inflator investigation; (iii) the full administrative record; and (iv) the arguments, data, and analysis that GM has supplied to the Agency in connection with its (a) November 15, 2016 Petition for Inconsequentiality and Request for Deferral of Determination Regarding Certain GMT900 Vehicles Equipped with Takata "SPI YP" and "PSPI-L YD" Passenger Inflators (the "**First Petition**"), (b) the January 11, 2017 Petition for Inconsequentiality and Request for Deferral of Determination Regarding Certain GMT900 Vehicles Equipped with Takata "SPI YP" and "PSPI-L YD" Passenger Inflators Subject to January 2017 Takata Equipment DIR Filings (the "**Second Petition**"), (c) GM's August 25, 2017 Supplemental Brief filed in support of the First Petition and Second Petition, and (d) GM's January

9, 2018 Petition for Inconsequentiality Regarding Certain GMT900 Vehicles Equipped with Takata "SPI YP" and "PSPI-L YD" Passenger Inflators Subject to January 2018 Takata Equipment DIR Filings (the "**Third Petition**," and together with the First Petition, Second Petition, and Fourth Petition, the "**Petitions**").

I. Introduction

This is GM's fourth inconsequentiality petition relating to the Takata "SPI YP" and "PSPI-L YD" model front-passenger airbag inflators installed as original equipment in GM's GMT900[1] trucks and sport utility vehicles (the "**GMT900 Inflators**"). This Petition relates to the vehicles covered by the Takata equipment DIRs filed on January 2, 2019. GM's four petitions collectively cover the following populations of GMT900 vehicles (the "**GMT900 Vehicles**"):

	Zone A States	**Zone B States**	**Zone C States**
First Petition	2007 - 2011 model year	2007 - 2008 model year	N/A
Second Petition	2012 model year	2009 model year	2007 - 2008 model year
Third Petition	2013 model year	2010 model year	2009 model year
Fourth Petition	2014 model year	2011 – 2014 model year	2010 – 2014 model year

In the First and Second Petitions, GM requested that NHTSA defer a decision on the merits until after the competition of the first phase of Orbital ATK's (now Northrop Grumman) long-term aging study, which was intended to definitively assess the long-term safety of the GMT900 Inflators, which are unique to the GMT900 Vehicles. As more fully summarized in GM's August 25, 2017 Supplemental Brief and the Third Petition, the Northrop Grumman study subjected test

[1] The GMT900 is a specific vehicle platform that forms the structural foundation for a variety of GM trucks and sport utility vehicles, including the Chevrolet Silverado 1500, GMC Sierra 1500, Chevrolet Silverado 2500/3500, GMC Sierra 2500/3500, Chevrolet Tahoe, Chevrolet Suburban, Chevrolet Avalanche, GMC Yukon, GMC Yukon XL, Cadillac Escalade, Cadillac Escalade ESV, and Cadillac Escalade EXT.

inflators to an estimated 30 years of aging, including moisture levels and temperatures significantly worse than real-world conditions in the GMT900 Vehicles in the highest risk "Zone A" region. NHTSA granted this request for deferral and consolidated both Petitions under NHTSA Docket NHTSA-2016-0124.[2]

As GM explained in the prior Petitions, the originally planned Northrop Grumman study demonstrated that the GMT900 Inflators, which have not ruptured in the field or in ballistic testing, will continue to operate safely for decades, even in the highest temperature and humidity regions. All of the GMT900 Inflators in the study safely deployed without any ruptures despite three decades' worth of extreme exposure to humidity- and temperature-related propellant degradation. The recalled non-GMT900 Takata inflators in the comparison group, by contrast, experienced ruptures and abnormal deployments, at rates and times consistent with ballistic test data generated by the same type of inflators recovered from the field.

After the filing of the Third Petition, GM and Northrop Grumman continued to investigate and analyze the long-term performance of the GMT900 Inflators. Northrop Grumman continued to age the GMT900 Inflators left over from the original aging study to an estimated 35-years of extreme field exposure. Consistent with prior results, this additional aging produced more ruptures in the comparison group non-GMT900 Takata inflators but no ruptures in the GMT900 Inflators. Northrop Grumman also applied its recently developed predictive-rupture model, which uses empirical data to predict the long-term performance of specific inflators in specific vehicle applications, to the GMT900 Inflators. Consistent with the results generated by the long-term

[2] *See* General Motors LLC, Receipt of Petition for Inconsequentiality and Decision Granting Request To File Out of Time and Request for Deferral of Determination, 81 Fed. Reg. 85681 (Nov. 28, 2016); General Motors LLC, Receipt of Petition for Inconsequentiality and Notice of Consolidation, 82 Fed. Reg. 42718 (Sept. 11, 2017).

aging study, the model predicted that the GMT900 Inflators will not reach a threshold risk level within 30 years of environmental field exposure in Miami, Florida.

The completion of these projects marks the culmination of a multi-year investigation aimed at answering a question expressly left unaddressed in the 2016 risk assessments that originally led to the inclusion of the GMT900 Inflators in the Amendment to November 3, 2015 Consent Order between NHTSA and TK Holdings Inc. (the "**Amendment**").[3] While the failure mechanism—long-term exposure to temperature cycling in the presence of environmental humidity—was generally understood, these assessments explicitly did not, and could not at the time, fully account for vehicle- and inflator-design differences. With respect to the GMT900 Vehicles, that analytical gap has been filled; the various experts, industry, and NHTSA now understand a great deal more about the effect of different inflator designs, vehicle types, and propellant shapes on rupture risk generally, and have data substantiating the robustness of the GMT900s Inflators specifically.

Through field data, ballistic testing, long-term aging, and state-of-the-art predictive modeling, GM has established that worse-than-worst case humidity exposure and temperature cycling will not cause inflator ruptures in the GMT900 Vehicles at any point within even unrealistically conservative vehicle-service life estimates.[4] For these reasons, and for the reasons set forth herein and in the supporting administrative record, GM respectfully requests that NHTSA grant this Fourth Petition and the prior Petitions.

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[3] *See, e.g.*, Expert Report of Harold R. Blomquist, Ph.D. at ¶ 18.b.iv, In re: Airbag Inflator Rupture (No. EA15-001) (hereinafter the "**Blomquist Report**"); EXPONENT, INC., INVESTIGATION OF TAKATA INFLATOR RUPTURES 26 (Jul. 2016) (hereinafter the "**EXPONENT REPORT**").

[4] *See* Third Petition at 9 (Dkt No 144) (discussing the service-life expectations of the safety systems in the GMT900 Vehicles); GM's September 29, 2017 response to NHTSA's September 15, 2017 Information Request (Dkt No 67) (same).

II. Background

A. GM's January 2019 DIRs

GM filed three DIRs on January 11, 2019, following Takata's filing of its January 2019 DIRs under the Amendment. Like GM's previous DIRs covering the GMT900 Vehicles, GM's DIRs explain that GM does not believe that a defect that poses an unreasonable risk to safety exists in the GMT900 Vehicles, that GM has not determined that such a defect exists, and that GM would be contemporaneously filing this Petition. Nothing in this Petition or in the act of filing this Petition or the DIRs is an admission, implied or otherwise, that such a safety defect exists.

B. The significance of manufacturing, inflator-design, and vehicle-integration differences

Takata PSAN inflators from different inflator models, families, variants, and build periods vary greatly—in design, quality, and long-term performance and safety.[5] The impact of these design and vehicle-integration differences is profound.[6] Takata PSAN driver-side inflators recovered from certain 2001-2003 Honda and Acura vehicles—part of the so-called "Alpha" vehicle population—"contain a manufacturing defect which greatly increases the potential for dangerous rupture when a crash causes the air bag to deploy"; in ballistic testing, these inflators have "explosion rates of 50% or higher."[7] Other non-Alpha Takata inflators in different vehicles and with different characteristics have far lower energetic deployment rates.

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[5] *See* Third Petition at 4 (Dkt No 144).

[6] *See, e.g.*, TK Global July 25, 2018 Presentation to NHTSA at 6 (submitted by TK Global to NHTSA under 49 C.F.R. part 512 on or about July 30, 2018).

[7] THE INDEPENDENT MONITOR OF TAKATA AND THE COORDINATED REMEDY PROGRAM, THE STATE OF THE TAKATA AIRBAG RECALLS 5 (Nov. 15, 2017), https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/the_state_of_the_takata_airbag_recalls-report_of_the_independent_monitor_112217_v3_tag.pdf; Press Release, National Highway Traffic Safety Administration, New test data on particular subset of Takata air bag inflators shows substantially higher risk (June 20, 2017), https://www.nhtsa.gov/press-releases/nhtsa-new-test-data-particular-subset-takata-air-bag-inflators-shows-substantially.

Even in isolation, vehicle integration is a significant variable: as Northrop Grumman noted in its September 2016 root-cause assessment, one Takata passenger inflator variant "shows a higher rate in one vehicle model, lower rates in three others, and a zero rate in two more models."[8] The GMT900 Inflators, as more fully discussed below, have not ruptured, to GM's knowledge, in the field or during ballistic testing.

C. Unique GMT900 Inflator and vehicle characteristics

The first GM-manufactured vehicles to utilize Takata PSAN inflators were model year 2007 GMT900 vehicles and 2006 model year Saab 9-3/9-5 vehicles.[9] This occurred many years after Takata began producing PSAN inflators; after Takata had made most of its design, quality, and process improvements in its PSAN inflator production operation; and only after Takata could meet GM's stringent validation requirements.

The GMT900 Inflators, moreover, are unique to GM vehicles, and have multiple unique design differences when compared to other Takata PSAN inflator variants—even inflators of the same Takata inflator family. These GM-unique design differences were purposeful: To meet GM's airbag inflator sourcing requirements, which were some of the most exacting in the industry when the GMT900 vehicles were being developed, GM required Takata to heavily modify the characteristics of their standard SPI and PSPI-L inflators. These modifications included, among other things, lighter, thinner propellant wafers that have more predictable ballistic properties and

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[8] *See* TAKATA INFLATOR RUPTURE ROOT CAUSE SUMMARY REPORT 3 (Sept. 2016), https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/orbital_atk_research_summary.pdf (hereinafter the "**OATK ITC REPORT**") ("Examples of the same prefix inflator show significantly different ED rates from field returns. PSPI AB shows a higher rate in one vehicle model, lower rates in three others, and a zero rate in two more models. Different vehicles reach different maximum temperatures under same test conditions.").

[9] GM recalled these vehicles in early 2016. *See* NHTSA Recall 16V063.

which create less excess surface area as they degrade[10]; stainless steel instead of aluminum inflator end-caps, which improved the inflators' hermetic seals and resistance to high-internal pressures; and a greater vent-area-to-propellant-mass ratio for more efficient burning and deployment.[11]

Further, as noted in the First and Second Petitions, the physical environment in GMT900 Vehicles better protects the front-passenger inflator from the extreme temperature cycling that causes propellant degradation and has led to inflator rupture in other OEM vehicles. GMT900 Vehicles, which are light trucks and SUVs, have larger interior volumes than smaller passenger cars, and are equipped with standard solar-absorbing windshields and side glass,[12] all of which significantly reduce interior-vehicle temperatures.[13] Peak-inflator temperatures during daily cycling has been identified as a significant root cause of propellant degradation by various experts investigating Takata inflators, including Northrop Grumman, Exponent, and Dr. Harold R. Blomquist.[14]

D. The Northrop Grumman long-term aging study

In May 2016, GM retained Northrop Grumman, a third-party engineering firm with recognized ballistics expertise, to conduct a study that would evaluate the long-term performance

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[10] TK Global July 25, 2018 Presentation to NHTSA at 6 (on file with NHTSA, *see supra*, note 6).

[11] *See also* GM's September 29, 2017 Responses to NHTSA's September 15, 2017 Information Request at 4–5 (Dkt No 67); GM's August 23, 2017 Presentation to NHTSA at 81 – 83 (Dkt No 39); TK Global July 25, 2018 Presentation to NHTSA at 14 (on file with NHTSA, *see supra*, note 6).

[12] Solar-absorbing glass does not appear to have been standard in many non-GM vehicles that utilized Takata non-desiccated PSAN inflators.

[13] *See* GM's June 8, 2018 Presentation to NHTSA at 76-80 (Dkt No 163); GM's July 20, 2018 Responses to NHTSA's July 10, 2018 Information Request at 23-24 (Dkt No 175) (discussing in-vehicle temperature differences).

[14] *See, e.g.*, Blomquist Report at ¶ 18.b.iv ("[S]olar loading aggravates the high temperature value during the diurnal cycle which drives the extent to which booster propellant desorbs moisture, increasing the moisture level in the space around the main propellant."); EXPONENT REPORT at 26 ("The degradation of the propellant arises from diurnal and seasonal temperature cycling, and it is exacerbated by higher peak cycle temperatures and increased moisture content in the inflator."); OATK ITC REPORT at 3 (stating that propellant degradation "requires moisture and temperature cycling such as in High Absolute Humidity (HAH) areas," and that "[d]ifferent vehicles reach different maximum temperatures under same test conditions").

of the GMT900 Inflators through simulated laboratory aging. To artificially age the inflators, Northrop Grumman exposed groups of inflators, both GMT900 Inflators and a comparison group of recalled non-GMT900 Takata inflators, to 1680 4-hour temperature cycles at moisture levels and temperatures significantly worse than real-world conditions in the GMT900 Vehicles in the highest risk "Zone A" region. The study was designed to induce propellant degradation in the test inflators sufficient to cause inflator ruptures and energetic deployments, and to simulate 30 years of aging—twice the service-life design practices for safety systems in these vehicles and five years longer than the end point in NHTSA's 2006 vehicle survival probability schedules (which provide survivability estimates only out to 25 years in service).[15]

Takata specially constructed the inflators used in the study.[16] The primary chambers in these inflators contained three different levels of moisture: (i) normal-build chambers with no additional moisture added; (ii) chambers with internal moisture approximately equal to 90th percentile moisture levels in GMT900 Inflators returned from Zone A; and (iii) chambers containing moisture levels approximately two-times higher than the highest level ever measured in a GMT900 Inflator recovered from Zone A. The secondary chambers in these inflators contained moisture levels equivalent to the highest values measured in inflators returned from the field from any vehicle. During the study, Northrop Grumman exposed these beyond worst-case inflators to abusive, worst-case temperatures—temperatures exceeding the highest temperature

[15] *See* Third Petition at 9 (Dkt No 144). As GM stated in its September 29, 2017 response to NHTSA's September 15, 2017 Information Request (Dkt No 67), GM believes that current attrition tables, including the July 2016 NHTSA/EPA/CARB data and the 2006 Vehicle Survivability and Travel Mileage Schedules published by NHTSA's National Center for Statistics and Analysis, significantly overstate the likely long-term survivability of the GMT900 Vehicles, which rely more heavily on interconnected electronic control modules than earlier generation trucks and SUVs.

[16] *Id.* at Ex. C (Dkt No 147).

that GM has ever recorded on a GMT900 Inflator in Zone A by 11 degrees Celsius.[17] This process had a specific engineering objective: to cause inflator failures during ballistic testing. Pushing the inflators in the study beyond the anticipated breaking point was intended to generate data that could be used to help estimate the actual service life of GMT900 Inflators in the field.

To validate this accelerated aging test procedure, Northrop Grumman included Takata PSPI-L FD inflators, which were used in the Pontiac Vibe as well as in other OEM vehicles (the "**Vibe/Other OEM Inflators**"), as a comparison group in the study. Several factors made the PSPI-L FD ideal for this purpose. First, the PSPI-L FD inflators are from the same Takata inflator family as the GMT900 light-duty inflator; but while they have certain similarities in design and construction, they lack the critical design elements that, in GM's view, distinguish the GMT900 Inflators from other Takata non-desiccated PSAN inflators and make the GMT900 Inflators resistant to the risk of energetic deployment, even after the PSAN propellant has been damaged or degraded. Second, and unlike the GMT900 Inflators, PSPI-L FD inflators returned from the field have consistently experienced ruptures during ballistic testing and have also ruptured in the field during crashes.

E. The original 30-year Northrop Grumman long-term aging study confirmed that the GMT900 Inflators will operate safely well into the future

1. The Northrop Grumman artificial aging process produced propellant degradation that replicated real-world PSAN propellant degradation

The data generated by the Northrop Grumman long-term aging study confirmed one of the study's core design assumptions: that subjecting Takata PSAN inflators to 56 four-hour

[17] In August and September 2015, GM left a GMT900 vehicle outside in Miami, Florida—facing south, exposed to direct sunlight, behind a windbreak, during the hottest part of the year, for 30 days—and collected temperature and humidity measurements from sensors placed directly on the inflator housing. The highest temperature that GM measured on the inflator was 59.5 Celsius.

temperature cycles would approximate one year of real-world aging in worst-case environments like Miami. The Northrop Grumman aging process caused propellant wafer outside diameter (OD) growth—an accepted measure of propellant degradation—at levels and rates that parallel, and in some cases mirror, propellant degradation observed in returned field inflators.[18]

2. The results from the Vibe/Other OEM Inflator comparison group

The results from the Vibe/Other OEM Inflator comparison group further validated the study's design and the soundness of Northrop Grumman's aging methodology. The Northrop Grumman artificial aging process caused the outside diameters in the Vibe/Other OEM Inflator comparison group to expand beyond 29.2 millimeters—the point at which the Vibe/Other OEM Inflators recovered from the field have ruptured and abnormally deployed during ballistic testing. When the Vibe/Other OEM Inflators in the comparison group reached this threshold during the Northrop Grumman aging process, they began to rupture and abnormally deploy. During the original 30-year phase of the study, seven Vibe/Other OEM Inflators in the comparison group ruptured or abnormally deployed during ballistic testing, and these events produced pressure traces that closely resemble pressure traces that Takata has collected on abnormal deployments and ruptures of Vibe/Other OEM Inflators returned from the field.[19]

3. The results from the GMT900 inflator groups

Three decades of simulated aging in Zone A or worse-than-Zone A conditions produced propellant wafers with larger outside diameters than GM has recovered from GMT900 Vehicles in the field. Despite this propellant degradation, all of the GMT900 Inflators in the study deployed normally and safely—even the inflators containing twice the moisture found in field-return

[18] *Id.* at 13-14 (Dkt No 144).

[19] *Id.* at 14 (Dkt No 144).

inflators that were exposed to hotter temperatures than have ever been measured in a GMT900 Vehicle in the field.[20]

III. Discussion

A. Basis for Petition (49 U.S.C. § 30118(d) and § 30120(h); 49 C.F.R. Part 556.4(b)(5))

To petition for an exemption under sections 30118(d) and 30120(h) of the Safety Act, NHTSA's regulations require the manufacturer to file a DIR pursuant to 49 C.F.R. part 573. 49 C.F.R. § 556.4(c). If the manufacturer has not itself determined that a defect exists, filing a DIR does "not constitute a concession by the manufacturer of, nor will it be considered relevant to, the existence of a defect related to motor vehicle safety or a nonconformity." *Id.* GM has not determined that a defect that poses an unreasonable risk to safety exists in the GMT900 Vehicles covered by Takata's January 2019 DIRs or in any of the GMT900 Vehicles covered by one of the Petitions, and this Petition does not constitute a concession by GM of the existence of a defect in any of the GMT900 Vehicles, as permitted by 49 C.F.R. § 556.4(c). As in the case of defect determinations under the Safety Act generally, the application and use of a component is relevant to—and, in this case, determinative of—whether the component poses a safety risk within a certain population of vehicles. *U.S. v. General Motors Corp.*, 518 U.S. 420, 439 n.88 (D.C. Cir. 1975); *see also Ctr. For Auto Safety, Inc. v. NHTSA*, 342 F. Supp. 2d 1, 14 (D.D.C. 2004), *aff'd sub nom.*, 452 F.3d 798 (D.C. Cir. 2006) ("[U]sage is clearly relevant to a determination of whether a vehicle contains a safety-related defect.").

[20] *Id.* at 14-15 (Dkt No 144).

B. Field data demonstrates that the GMT900 Inflators are currently performing as designed

1. An estimated 66,894 Takata passenger airbag inflators have deployed in GMT900 vehicles without a single reported rupture

As part of its Safety and Field Investigations process, GM actively monitors vehicle-performance data for evidence of potential safety issues, including incidents of inflator rupture. This dataset includes customer complaints, GM Technical Assistance Center logs, warranty claims, legal claims, field investigations, and NHTSA VOQs. Although these sources do not track airbag deployments in the field, it is possible to estimate field deployments using accident rate and severity information published by NHTSA (NASS). Using this method, GM estimates that over 66,894 PSPI-L and SPI inflators have deployed in GMT900 vehicles since model year 2007, the first model year that GMT900 vehicles utilized these inflators. GM is not aware of a single confirmed rupture report involving a Takata SPI YP or PSPI-L YD inflator in a GMT900 vehicle.

2. GM has analyzed and safely deployed approximately 4,270 Takata SPI YP and PSPI-L YD inflators from the oldest affected GMT900 vehicle population in the highest-risk region

The results from GM's ballistic testing is consistent with the field data. Since November 2014, GM has sent PSPI-L YD and SPI YP inflators from GMT900 vehicles in the field to Takata for ballistic testing and analysis. To date, Takata has conducted ballistic tests on 4,270 GMT900 Inflators, and none have ruptured.[21] These deployed inflators included a significant number of GMT900 Inflators that, according to the Blomquist Report, would be at the highest risk of rupture.[22] The majority of these inflators—1,197 PSPI-L YD and 2,249 SPI YP inflators—came

[21] On information and belief, Takata has provided NHTSA with the data associated with these ballistic tests. For this reason, GM has not submitted this data with its Petition. GM can provide this data on request.

[22] *See* Blomquist Report ¶ 17.

from Zone A GMT900 vehicles recovered from 2007-2008 model year vehicles, which are the oldest population of GMT900 vehicles in the field with Takata passenger airbag inflators.

C. The final results of Northrop Grumman's 35-year long-term aging study: multiple new failures in comparison Pontiac Vibe inflators but no failures in GMT900 Inflators

Following the filing of the Third Petition, GM directed Northrop Grumman to continue the long-term aging study by aging the remaining test GMT900 Inflators beyond the original 30-year test plan. This testing was in keeping with one of the study's original objectives: aging the GMT900 Inflators to failure. After an additional five years of estimated aging in conditions more extreme than conditions observed in Miami, Florida, the testing produced six additional ruptures in the 21 remaining comparison-group Vibe/Other OEM Inflators but no ruptures in the 45 remaining GMT900 Inflators.

In the final analysis, the aging study produced results that are remarkably consistent with data generated by field-return inflators and existing research[23] regarding the PSAN degradation process:

- The study produced propellant growth rates that match the average measured growth rates in field returns of the same inflator variant.[24]
- The aging process initially produced suppressed internal pressures and propellant-gas generation rates, duplicating the results of field-return measurements[25] and as predicted by existing research indicating that the propellant-aging process results in reduced breakup on ignition, which depresses gas-generation rates.[26]
- This initial-suppression effect was, also as expected, more pronounced on wafers that were exposed to higher temperature/moisture levels, which would tend to

[23] *See, e.g.*, TK Global July 25, 2018 Presentation to NHTSA at 6 (on file with NHTSA, *see supra*, note 6).

[24] Third Petition at Ex. D (Dkt No 147).

[25] GM's August 23, 2017 Presentation to NHTSA at 16 – 18 (Dkt No 39).

[26] GM's June 2017 PAB Testing Update to NHTSA at 13-21 (Dkt No. 42); TK Global July 25, 2018 Presentation to NHTSA at 25 (on file with NHTSA, *see supra*, note 6).

produce more degradation, and on the thinner wafers in the GMT900 Inflators, which rely more on initial breakup to generate surface area.[27]

- Consistent with prior research indicating that thinner propellant degrades more slowly in response to moisture and temperature cycling,[28] the artificial aging process produced slower degradation rates in the GMT900 Inflators' thinner propellant wafers compared to the thicker Vibe/Other OEM Inflators' wafers.[29]

- The study produced 13 ruptures in the Vibe/Other OEM Inflators, at times and rates that are comparable to ruptures in Vibe/Other OEM Inflators returned from the field.[30]

- The study produced pressure curves from ruptured Vibe/Other OEM Inflators that match pressure curves generated by ruptures in inflators returned from the field.[31]

- The study produced no ruptures in the GMT900 Inflators, which is consistent with field data and ballistic testing data from GMT900 Inflators recovered from the field (see section III.B).

As it did after the 30-year testing process completed in the summer of 2017, GM retained Massachusetts Institute of Technology Professor Arnie Barnett to assess these results from a statistical perspective. With respect to the comparative performance differences between the GMT900 Inflators and the Vibe/Other OEM Inflators in the study, Professor Barnett concluded that these differences were no accident:

> Given this consistent evidence from three different sources of relevant information, the idea that the GMT900 has just been "lucky" in faring better than the benchmark vehicles is preposterous. The null hypothesis of no difference got a fair hearing, and it has been discredited to an extent that is remarkable in my experience.[32]

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[27] GM's June 2017 PAB Testing Update to NHTSA at 12-22 (Dkt No. 42).

[28] *See, e.g.*, EXPONENT REPORT at 17-20.

[29] GM June 8, 2018 GMT900 Takata Airbag Inflator Investigation Presentation at 62-68 (Dkt No 163).

[30] *Id.* at 59 (tank testing summary) (Dkt No 163).

[31] *Id.* at 87 (Dkt No 163).

[32] *Id.* at 23 (Dkt No 163).

Several public comments have raised objections to the aging study's design. GM does not believe that these objections—which are self-refuting, falsely premised, and largely addressed by the materials that GM has already submitted to the Agency—merit a comprehensive response.

A few points regarding the study's design, however, should be emphasized. Product-validation testing like USCAR testing is conducted at a range of hypothetical (and in some cases extreme) vehicle operating conditions because it is intended to uncover unknown failure modes in a product or system. The Northrop Grumman aging-study was intended to do something completely different: induce a specific known failure mode (propellant degradation) under laboratory conditions that approximated or slightly exceeded known conditions in the GMT900 Vehicles in the highest-risk climate region. In designing the experiment, Northrop Grumman had the benefit of existing research regarding the failure mode, and detailed data regarding observed moisture levels inside field-returned inflators and temperature measurements collected from vehicles in the field. The study's inflators were built with precisely measured amounts of moisture, which avoided the variability that would be introduced by relying on natural-moisture ingestion, and deployed at ambient temperatures, which permitted benchmarking against the MEAF dataset's hundreds of thousands of ambient deployments of recovered field inflators.

This last point is crucial. If the commenters' methodological objections were correct, the Northrop Grumman experiment should have failed to produce data aligned with prior research and the MEAF's real-world data. But it did not: As described above, the study produced data that is strikingly consistent with the MEAF data and accepted scientific principles regarding the chemical and ballistic mechanisms that can cause degradation-induced ruptures in PSAN inflators. The study's results are validated by this consistency, which shows up again and again in the data, from the Vibe/Other OEM Inflator results, to the GMT900 Inflator results, to the rate of propellant

growth, and a host of other factors. Reliable data available across the automotive industry and all OEMs affected by the Takata recalls wholly supports Northrop Grumman's analysis.

D. Northrop Grumman's predictive-aging model predicts that GMT900 Inflators will not reach a threshold-risk level within 30 years of worst-case environmental field exposure in Miami

Using MEAF data and data generated through lab-aging processes, Northrop Grumman developed a predictive model that, unlike previous service-life estimation techniques, accounts for variables such as inflator-design and vehicle-integration factors, and predicts inflator service life with a higher degree of accuracy than prior models.[33] Northrop Grumman began this project as part of its work for the Independent Testing Coalition and, at GM's request, used the model to generate predictions for the GMT900 Inflators.

The model's predictions are consistent with the results from the long-term aging study, field data, and ballistic testing data. The model predicts that the GMT900 Inflators will not reach a threshold risk level within 30 years of worst case environmental field exposure in Miami, Florida—well beyond the expected or reasonable service life of the GMT900 Vehicles. By contrast, the model predicts that the Vibe/Other OEM Inflators will reach a threshold risk level in less than ten years of field exposure if installed in a small vehicle.

IV. Conclusion and request for relief

For the reasons described above, GM respectfully requests that NHTSA grant the Petitions. The best available empirical evidence and predictive science—ballistic testing, field deployments, lab aging, modelling—unanimously points in the same direction: that the GMT900 Inflators are not at risk of rupture and that recalling these vehicles would unnecessarily expose the owners of four million vehicles to the risk of an improper repair.

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[33] Northrop Grumman Presentation to NHTSA dated June 7, 2018 (submitted by Northrop Grumman to NHTSA on or about June 7, 2018).

GM is, moreover, continuing to monitor the performance of the GMT900 Inflators in the field, thereby mitigating any risk that the Northrop long-term aging study and model may have failed to capture some critical variable that might cause the GMT900 Inflators to unexpectedly become dangerous in the future. While the details of the testing program are still being finalized, GM plans to provide Northrop Grumman with GMT900 Inflators collected from GMT900 Vehicles in the Zone A climate region every six months for further testing and analysis, and to keep NHTSA apprised of the results. If this testing at some point in time were to indicate that some or all of the GMT900 Inflators may be at risk, GM will take appropriate action to protect consumers.

Respectfully submitted,

GENERAL MOTORS LLC

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