BMW Comments
To
Docket NHTSA-2023-0038
NHTSA Initial Decision re EA16-003
December 18, 2023

INTRODUCTION

BMW of North America, LLC, on behalf of BMW AG, Munich, Germany ("BMW"), appreciates the opportunity to provide comments in response to the National Highway Traffic Safety Administration's (NHTSA) September 5, 2023 Initial Decision concerning certain driver and passenger front air bag inflators manufactured by ARC Automotive Inc.

BMW understands that since it is not the manufacturer of the equipment at issue, it is not presently the primary focus of EA16-003 nor of NHTSA's Initial Decision. However, it may be affected by subsequent decisions or actions by the agency.

BMW has extensively reviewed available information regarding NHTSA's Initial Decision, and we wish to provide our thoughts and analyses on this important topic. At the BMW Group, safety is a top priority, and we believe that our analyses, and the comments herein, may provide some potentially valuable and useful insights on this matter. We are offering our comments on this topic in the hopes that the agency will consider them as it further deliberates on this matter.

As will become apparent below, we respectfully do not agree with the agency's Initial Decision, particularly because it does not fully consider highly relevant differences among the inflators and their applications. Nevertheless, we look forward to continuing a constructive dialogue with the agency on this matter in pursuit of conclusions that are in the best interests of our customers and other members of the motoring public.

Our analyses were performed by a dedicated team of experts at the BMW Group. The analyses were conducted primarily on the basis of information that was made available in the data pool published by NHTSA after the Initial Decision.

SUMMARY

Before we provide details of our analyses, we believe it would be useful to offer an overview of our results, because it may be helpful to understand these points as the more detailed information is discussed and reviewed below.

First, as we are not aware of any rupture events within the BMW Group (BMW, MINI and Rolls-Royce Motor Cars) vehicle population, we do not believe it is fair to conclude that such events will occur in BMW Group vehicles in the future and, therefore, that a field action regarding those vehicles is required. As will be discussed below, additional statistical analyses we performed, using the automotive industry's field experience in the US, support our position.

Second, there are important differences in the ARC inflator population at issue. Based upon the Initial Decision, it appears that NHTSA's view is that the potential for ruptures of the ARC inflators at issue – and the ramifications thereof – are uniform among all such inflators and all vehicle applications in which they were installed. In our opinion that view cannot be reconciled with the available data. In other words, we do not believe there is a basis for assuming that if a rupture event occurred in one make or model of vehicle equipped:

a. with a specific air bag type (e.g., driver vs. passenger),
b. using a specific inflator variant,

c. produced on a specific inflator production line,
d. at a specific period of time,

then the same propensity for such an occurrence would necessarily exist for any or all other ARC hybrid toroidal inflators, just because they use a similar design.

Our view is that, even though all ARC toroidal hybrid inflators are indeed built on the same design principle, there are significant differences, both regarding the inflators themselves and their varying applications and installations, that should be considered. Consequently, we believe that it is not appropriate to treat all air bags with these inflators alike and for NHTSA to potentially demand that all of them be recalled without regard for important differences.

More precisely, we have identified four relevant variables not contemplated by the Initial Decision that we believe should be considered:

a. differences in the deployment frequency between driver and passenger air bags based on passenger seat occupancy,
b. differences in failure mode between driver and passenger air bags in the vehicle,
c. design differences between driver and passenger air bag inflators, and within these types – differences that are, in our opinion, relevant to the possibility of rupture,
d. possible differences of rupture incidence between inflators produced at different ARC plants, from different production lines and during different production periods.

In the analysis, we focused on potential ruptures caused by this specific failure mode — that is, the blockage of the exit orifice by weld flash particles from inside the Center Support of the inflator — which is the failure mode upon which NHTSA's analysis and decision focuses and which apparently is unique to this inflator design.

We will now provide a discussion of our detailed analyses. These analyses considered three specific and, as noted, important areas, which we believe are critical on this matter, as follows:

1. statistics,
2. failure mode of the inflator itself, and in connection with its application in the vehicle, and
3. inflator design.

Furthermore, we suggest deeper analysis on potential differences in rupture incidence in inflators from different ARC production plants, lines, and periods.

STATISTICAL ANALYSES

We are not aware of any field rupture in a BMW Group vehicle. To support our assessment that there is no indication for a field action, we calculated the expected number of ruptures in our vehicles, by using the US field experience data for the whole industry, and applying this information to the BMW Group vehicle population.

Without accepting that NHTSA's approach is appropriate and accurate, we used the agency's calculation for the rupture rate per deployment (*see* Initial Decision at 18-19), but differentiated between driver and passenger air bags by using the volume distribution between driver and passenger air bags in the US population indicated in in the data pool initially provided by the agency. According to our consolidation of those data, out of the approximately 52 million air bags at issue, there were approximately 36 million driver air bags and approximately 16 million passenger air bags. With the incidence of six (6) events reported among the driver air bags, and one (1) event reported among the passenger air bags in the US population, the data suggest that for driver air bags, 1 out of approximately 300,000 deployments results in a rupture. For the passenger air bags, the data suggest that 1 out of approximately 800,000 deployments results in a rupture. hanged if these different production figures are used.[1]

This number was then applied to the BMW Group US vehicle population, considering the years 2024 to 2043 for the calculation. For the passenger air bags, the passenger seat occupancy rate according to the NASS-CDS data (26.9%) was additionally considered. This resulted in an expected number of ruptures over the next 20 years at near-zero levels for both driver and passenger air bags. Statistics at this level or threshold would normally not be deemed to warrant a field action. We believe that this calculation supports our view that we <u>expect</u> no ruptures in the future in the BMW Group US vehicle population and, therefore, no recall is indicated by such statistics.

FAILURE MODE

We analyzed the apparent failure mode that may occur in the unlikely event of a rupture due to exit orifice blockage, presumably by detached weld flash particles. This type of rupture occurs in an oriented way alongside the inflator's main axis that is constituted by the Center Support. The Center Support is elongated, eventually tearing apart in the area of the through holes. The two Center Support fragments are then ejected from the inflator structure in opposite directions. The ejection of the upper Center Support segment results in a round hole in the upper inflator vessel followed by penetration of the manifold. The manifold is torn open in a rather clean and reproducible manner without particles of the manifold separating from the inflator. The upper vessel, apart from the hole left by the Center Support, remains intact. On the lower vessel side, there is usually more extensive damage due to the ignitor openings and the resulting weaker structure, the vessel being comprehensively torn open during rupture. The lower segment of the Center Support and loose internal components of the inflator are ejected through this opening in an axial, less focused direction. The analysis can be confirmed by reviewing pictures of ruptured inflators which we found in the data pool. All of them show the described damage pattern.

With the described failure mode, especially the axial ejection of fragments into two main directions, we are convinced that there are significant differences in the failure modes between driver and passenger air bags. For driver air bags, in the unlikely event of a rupture due to exit orifice blockage, the upper fragment of the Center Support potentially could be ejected towards the head, neck, or torso of the driver. The fragments ejected through the lower pressure vessel could potentially be reflected by the steering wheel hub into the passenger compartment in a less focused direction. By contrast, in the unlikely event of a passenger air bag rupture, with the passenger air bag installed vertically and the inflator at the bottom of the module, the upper segment of the Center Support can be expected to be ejected vertically through the windshield, as can be clearly seen in the pictures of the only passenger air bag field rupture case reported in the US. The fragments ejected through the lower vessel will first affect the lower parts of the

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[1] We acknowledge that the spreadsheet recently released by the agency explaining its calculation of the 2.6 million deployments of the subject airbags (*described in NHTSA's correspondence posted December 1, 2023)* suggests that the production volumes are approximately 41 million driver airbags and approximately 12 million passenger airbags. We were not able to reconcile those data in the few working days available, but in any event, our conclusion that the apparent rupture rates for driver vs. passenger airbags differ substantially is not affected by the changed production figures in the newly-released agency document. If the amended figures are used, the calculation would indicate that for driver airbags, 1 out of approximately 335,000 deployments results in a rupture, and for passenger airbags, ruptures occur in 1 out of approximately 585,000 deployments.

instrument-panel, where the glove box, the cross beam and the knee air bag module are located. Fragments that pass these components can enter the footwell. Therefore, in the unlikely event of a rupture, there are important differences between the initial flight path of ejected fragments from a driver and passenger air bag inflator.

In BMW Group vehicles that use ARC toroidal hybrid inflators, the mounting angles of passenger air bag modules are between approximately 1-degree and 23-degrees, measured from vertical. Ruptures due to exit orifice blockage primarily happen during the early phase of the air bag deployment, as the pressure in the inflator reduces quickly after the initial peak.

We compared the forward displacement of the passenger at the time of rupture, with the expected trajectory of inflator fragments, using worst-case assumptions including:

- mounting angle,
- rupture time after ignition,
- trigger delay for belted, and unbelted, load cases, and,
- crash pulse deceleration.

We concluded that even with all these worst-case assumptions combined, the upper segment of the Center Support can be expected to be ejected vertically through the windshield, and the fragments ejected through the lower vessel will first affect the lower parts of the instrument-panel, where the glove box, the cross beam and the knee air bag module are located, and then potentially enter the footwell. Thus, the Initial Decision's assertion that ***all*** of the subject inflators "may explosively rupture[], propelling metal fragments at a high velocity . . . ***into the [vehicle] occupants themselves"*** (Initial Decision at 17), to the extent it implies that that all ruptures in driver and passenger air bags result in the same initial flight path of inflator fragments, may be too generic and need further differentiation, depending on the installation of the airbag and the inflator in the vehicle.

INFLATOR DESIGN

We reviewed inflator design differences between driver and passenger air bag applications and subgroups of the inflators that may influence the potential for rupture due to exit orifice blockage.

The Initial Decision describes the "likely cause" of the ruptures at issue as follows:

> The manufacturer of the subject inflators included a friction welding process that in some inflators produces weld slag. Upon normal deployment of an air bag in a crash, any debris, ***if larger than the 5-millimeter diameter of the exit orifice*** of the inflator center support, can become lodged in that exit orifice and block the air required to fill the air bag cushion. The inability of the air to exit the inflator due to the blocked exit orifice can lead to over pressurization [and potentially a rupture] of the air bag inflator.

(Initial Decision at 15-16 (emphasis added).) Respectfully, a substantial flaw in this "likely cause" description is the apparent assumption that the diameter of the exit orifices in the subject inflators was uniformly 5 millimeters. According to our information, several different diameters were used.

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[CONFIDENTIAL INFORMATION RECATED]

BMW Group US driver air bags all have inflators with 4.8mm output nozzles. For the passenger air bags, the diameters used are bigger.

[CONFIDENTIAL INFORMATION RECATED]

BMW Group vehicles all use the biggest 5.8mm diameter, except for the applicable BMW X5 / X6 SAVs and certain Rolls-Royce derivatives that use a 5.3mm nozzle, the corresponding flow areas being 22.0mm² and 26.4mm². As the portion of the Initial Decision quoted above implicitly (and correctly) acknowledges, smaller nozzle flow area is an important contributor to the possibility of the output orifice being blocked by weld flash particles, as larger particles are required to block the larger nozzles. The flow area of the larger passenger air bag inflator nozzle is **[CONFIDENTIAL INFORMATION RECATED]** larger compared to the smallest of driver air bag variants. We are convinced that the possibility of a blockage is considerably influenced by the size of the nozzle, being significantly reduced for passenger air bag inflators with larger nozzles compared to driver air bag inflators, and, within the passenger and driver families, being lower for the variants with the larger nozzles.

The second design difference between passenger air bag inflators and driver air bag inflators relates to the Center Support dimensions. The larger Center Support dimensions of passenger air bag inflators allow for more generous zones with a wider bore at the ends of the Center Support that can accommodate weld flash more protected from the main gas flow area. This zone is almost nonexistent in driver air bag inflators after friction welding due to the axial space constraints.

Third, the longer Center Support keeps weld flash at a distance from the Center Support through-holes, avoiding weld flash to be subjected to lateral gas flow and thus forces that could potentially detach loose weld flash particles.

In summary, independent of the fact that it is an extremely remote possibility, we are convinced that due to the larger dimension, the possibility of a blockage of the exit orifice is significantly lower for passenger air bag inflators versus driver air bag inflators, and within these basic types, lower for the variants with larger output nozzles.

INFLATOR PRODUCTION PLANTS AND LINES

[CONFIDENTIAL INFORMATION RECATED]

In order to get more tangible results on this analysis dimension, we suggest conducting further evaluation on this point. Specifically, we suggest compiling a list of all field and test ruptures from all data sources available, then allocating each rupture to a failure mode, excluding ruptures due to blockage from other failure modes (e.g., insufficient weld bond or propellant issues). We also suggest excluding R&D-tests and process validation tests as they did not necessarily use inflators from series production, and the inflators often underwent artificial aging treatment, which could cause damage to the propellant if not done properly, as was actually suggested in some documents in the data pool. Then we suggest allocating each blockage rupture to an ARC production plant, line, and inflator production date, and analyzing the data for potential accumulations of cases for certain plants, lines, or production periods, and for plants, lines, or periods without incidents.

CONCLUSIONS

In summary, as we noted prior to our detailed discussion and comments regarding the three areas of analyses and the suggestions regarding the fourth area of analysis, we come to the following conclusions:

We believe that it is not appropriate to treat all air bags with ARC toroidal hybrid inflators alike, as there are important differences in the population that should be considered.

With the available information, we were able to identify the following differences:

1. Between inflator types due to their specific design features, mainly driver air bag vs. passenger air bag, and within these basic types among variants with different output nozzle sizes,
2. Regarding the use and installation of the air bag and the inflator in the vehicle (that is, between driver air bag vs. passenger air bag), and for the passenger air bags potentially between different mounting angles in the vehicle,
3. In the deployment frequency between driver air bags and passenger air bags.

We furthermore believe that there are differences between different ARC production plants, lines, and production periods, which warrant further analysis.

As noted at the outset, based on currently available information, we do not believe that a field action is appropriate as to the air bag inflators on any BMW Group vehicles. However, if the agency ultimately determines to issue a recall order, we urge that careful attention be given to the differentiations outlined above, lest the order be directed at an overly broad vehicle population. As is always the case, including in a recall order population, vehicles that may not contain defective components can only delay achieving corrective action in vehicles that may warrant more immediate attention, all in derogation of the agency's safety objectives.

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