August 22, 2022

Robert Bosch LLC
38000 Hills Tech Dr.
Farmington Hills, MI 48331
www.bosch.us

The Honorable Dr. Steven S. Cliff
Administrator
National Highway Traffic Safety Administration
US Department of Transportation
1200 New Jersey Avenue S.E.
Washington, D.C. 20590

Re: Docket No. NHTSA-2022-0021
Event Data Recorders

Dear Administrator Cliff,

Introduction

Robert Bosch LLC and Bosch Automotive Service Solutions (individually and collectively, "Bosch") appreciate the opportunity to provide input to this notice of proposed rulemaking (NPRM) whereby the National Highway Traffic Safety Administration (NHTSA) is proposing to amend its regulations regarding Event Data Recorders (EDRs) to extend the EDR recording period for timed data metrics from 5 seconds of pre-crash data at a frequency of 2 Hz to 20 seconds of pre-crash data at a frequency of 10 Hz. Bosch is neutral on whether NHTSA should proceed with this rulemaking. However, if NHTSA does decide to proceed, then Bosch offers several key points for the Agency's consideration. These will be discussed in further detail throughout this document. Bosch wishes to note that the NPRM, if implemented, will require considerable changes to the vehicle and will not be achieved through only a software update.

Bosch provides valuable tools and services in relation to EDRs in passenger vehicles, as well as other segments of the vehicle market. Bosch is one of the leading manufacturers of air bag control units. The airbag electronic control unit (AB ECU) is the component of the vehicle's occupant protection system that processes acceleration and other dynamic inputs and determines whether the conditions exist for the triggering of safety devices such as

airbags and seat belt pretensioners. The AB ECU also houses the EDR functionality. Bosch supplies approximately 20 million AB ECUs worldwide, thereof approximately four million AB ECUs in the United States per annum. When a vehicle is equipped with an EDR, to Bosch's knowledge, it is always implemented in the AB ECU.

Bosch also fulfills a key role in assisting with the retrieval of EDR data after a crash or incident. Bosch sells Crash Data Retrieval (CDR) tools to the marketplace. The CDR tool has been used by various organizations such as government, law enforcement, accident reconstruction, and insurance markets since 2000. The Bosch CDR tool is designed to meet each vehicle manufacturer's specifications for the readout, translation and presentation of EDR data from many vehicle models sold in the US and Canada. Today, the Bosch CDR tool supports EDR readout from a high percentage of vehicle manufacturers.

In August 2006, NHTSA established 49 CFR Part 563[1], which required that each vehicle manufacturer ensure, by licensing agreement or other means, the commercial availability of retrieval tool(s) for downloading or imaging the required EDR data. Bosch's CDR tool assists vehicle manufacturers to meet this requirement.

Lead Time Considerations

In the NPRM, NHTSA has proposed a one-year lead time for implementation of the new requirements.

Based on its experience with vehicle design differentiation, vehicle life cycles and the associated hardware and software changes, as well as overall vehicle integration, Bosch believes that NHTSA's proposed lead time underestimates the effort needed to implement this regulatory change.

Bosch wishes to emphasize that such a change must account for the diversity of applications present in the market. A one-size-fits-all solution is neither practical nor achievable. As it pertains to the AB ECU, each vehicle original equipment manufacturer (OEM) has unique design requirements. This differentiation is heightened when one accounts for application models or trim levels. This diversity alone drives much of the complexity in the AB ECU product area. Bosch notes that several OEMs also have different implementations of the AB ECU and the EDR. For example, some OEMs

[1] Part 563 – Event Data Recorders - https://www.ecfr.gov/current/title-49/subtitle-B/chapter-V/part-563

have two or more variants depending on the particular make and model of the specific vehicle. The different variants are related to the features and content requirements for each respective vehicle model, so there is not just one software or hardware for an OEM. The differentiation of requirements drive the multiple hardware and software variants that a supplier, such as Bosch, must provide.

Bosch recommends that NHTSA consider exempting older generation vehicle models from any updates to Part 563, particularly those that are coming to the end of their manufacturing cycle / being phased out (e.g., those with one to two years left in production), so that they would not be subject to the new requirements in the proposed rule. If NHTSA were to include such vehicles in the final regulation, then the associated software and potential hardware development costs would be considerable. The challenge would be exacerbated under a one-year implementation period as the necessary modifications would need to be covered in an extremely shortened time frame compared to the overall production life cycle of the vehicle.

The range of vehicles which are in production today are based on platforms which were finalized approximately three to four years ago. Midcycle actions are vehicle changes that are generally implemented only if the vehicle production is expected to carry on for at least three to four more years. Midcycle actions are typically utilized to incorporate various changes but depending on the complexity of the change required for the respective vehicle, these can also pose considerable challenges for the industry.

For new vehicle models, Bosch recommends a lead time of four to five years from publication of a final rule for the industry to comply with the new requirements. This would provide a realistic time frame in which the software and hardware adaptations as well as calibration, vehicle integration and component / system validation could be realized within the development cycle of a new vehicle. It is traditional for OEMs to require that AB ECU development be finalized one and a half years before the start of vehicle production in order to ensure sufficient time for calibration, testing and vehicle release.

Furthermore, Bosch CDR tools support EDR readout from a large percentage of the OEMs that are active in the U.S. market. Bosch notes that the changes set forth in the NPRM would not only drive modifications to the AB ECU, but also changes to the CDR tool. The tool is customized for each OEM customer and for the particular application in question; therefore, sufficient time and resources would be necessary to accommodate the

relevant changes at the end of the chain with respect to the read out of the EDR data.

If the entire vehicle fleet affected by 49 CFR 563 is expected to make the required changes in a similar timeframe, Bosch anticipates that there would be a very high spike in demand for engineering support to tailor the CDR tool to suit the amended specifications. Based upon the requirements proposed in the agency's NPRM, Bosch estimates that enabling the transition of the CDR tools for all of the supported OEMs that currently install EDRs in their vehicles would require approximately one to two calendar years to complete. Thus, Bosch asks NHTSA to please also consider the impact of the final rule for the maintenance and update of the CDR tool, which is essential to the key intent of 49 CFR Part 563.

Finally, the NHTSA EDR final rule from 2006 provided three years and 10 months for the industry to realize the mandated changes. NHTSA subsequently provided an additional two years of lead-time in recognition of the complexity of the transition. Bosch suggests that NHTSA consider adopting a similar time frame for this proposed rule and to only impose the updated requirements on vehicle models that have not yet entered the market or started production or have at least four years left in their production cycle.

Justification of Need to Increase the Pre-Crash Recording Duration

NHTSA expressed in the NPRM that "Based on these findings [of Phase One], the EDR Duration Study[2] concluded that in many cases, the 5-second recording duration may not be sufficient to determine the factors that led to the crash or the precrash actions taken by the driver to avoid the collision, meaning that EDRs currently would not always provide investigators crash-related information that could assist in the determination of crash causation."

NHTSA states that this proposed change "offers an opportunity to use EDR data to assist in the determination of crash causation and better understand driver pre-crash behavior. EDRs can provide a comprehensive snapshot of the driver inputs in the seconds prior to a crash (e.g., acceleration, brake application and steering inputs)."

Bosch believes that, in general, the information collected prior to a crash-event is highly beneficial with respect to the reconstruction of a crash

[2] DOT HS 813 082B - https://rosap.ntl.bts.gov/view/dot/60878

event (either single or multiple events) and pre-collision vehicle state information supports the root cause analysis.

As defined in 49 part 563, the purpose of the EDR is to "record, in a readily usable manner, data valuable for effective crash investigations and for analysis of safety equipment performance." Bosch Corporate Research, which encompasses an accident research team that conducts statistical analysis and simulation of real-world crash data, reviewed the NPRM and offered the following insights for inclusion in this document. In the experience of Bosch Corporate Research, data such as speed, braking and steering information cannot determine complete driver behavior nor can it interpret driver faults e.g., such as running a red light. Bosch would like to point out that if the objective is to understand the control of the vehicle prior to a crash, there are other recorders, such as the Data Storage System for Automated Driving (DSSAD) recommended by the United Nations Economic Commission for Europe (UN ECE) or the Society of Automotive Engineers (SAE) Automated Driving Systems (ADS) data logger (SAE J3197), which are designed to record other information such as driver state and automated driving system (ADS) state.

Bosch believes that driver impairments or errors cannot be captured by EDR signals alone, especially those such as braking, steering or acceleration signals. Special attention must be paid to the extra data which would be generated to ensure that data is not misinterpreted in determining the vehicle state prior to crash. Bosch believes that mistakes could occur if investigators or regulators rely only on EDR protocol data without considering traces and evidence at the crash site. In other words, EDR data is limited in their interpretation of crash causation without further information gathered either from the police or an on-spot crash investigator. Bosch believes that an extension to 20 seconds is less beneficial than considering a revised and harmonized EDR protocol which could capture information from other new vehicle technologies i.e., Automatic Emergency Braking.

Bosch concurs that additional consideration should be given to incidents involving Vulnerable Road Users (VRUs). However, Bosch does not envision notable benefits from this enhanced EDR requirement if it does not provide more information about the surroundings of the vehicle during the crash. EDR requirements are currently limited to the vehicles in which they are mounted and do not account for any inputs of data outside of the vehicle. Tools such as the SAE ADS data logger (SAE J3197) are better suited to tasks which involve collecting data outside of the vehicle.

The UN ECE is considering standards for the installation and deployment of EDRs in commercial vehicles. Bosch believes this could be beneficial for determining vehicle state and safety system performance for this category of vehicles. A harmonized specification between US and European regulators would be positive as vehicle platforms and technologies are shared across regions and such an alignment would reduce complexity. Bosch encourages NHTSA to collaborate in the UN ECE WP.29 informal working group (IWG) on this topic.

Practicability of Increasing the Pre-Crash Recording Duration

Bosch concurs, that with significant adaptations, it is possible to record information 20 seconds prior to a crash. However, Bosch believes that this change will likely require comprehensive changes to the hardware as well as to the software of the vehicle. Bosch expects that varying degrees of hardware changes would be necessary across the OEMs and across different vehicle models. Some OEM applications might be able to accommodate the proposed changes by utilizing existing hardware but others would be expected to require significant hardware changes. One such example could be the need to incorporate larger or more memory components to fulfill the data recording requirements. The proposed requirements would also create additional power demands, which drive the need for more or larger capacitors to supply the power in autarky mode when the primary battery has been cut off as a consequence of a crash. Figure 1 below depicts how the increase of capacitors from two to six can have major effects on hardware design.

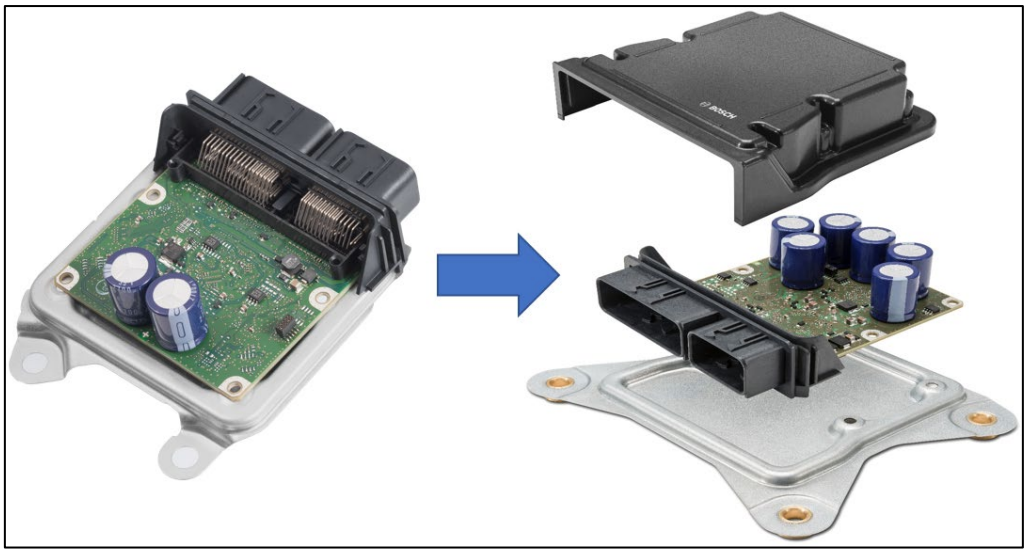

Figure 1 – AB ECU with two versus six capacitors (blue).

Source: Bosch Chassis Systems Control

Where hardware changes are required, there will be significant repercussions in terms of cost, timing and complexity. The flash memory (which consists of a semiconductor chip) must also be enlarged if the memory capacity of the one currently employed is not sufficient. The lead time in terms of the semiconductor supply chain could be significant and production of the AB ECUs could be affected if the chips are not available.

Need and Practicability of Increasing the Sampling Rate

The current Table I in 49 CFR Part 563 requires an EDR to capture pre-crash data at a sample rate of 2 samples per second (Hz). The same sample rate applies to Table II elements.

NHTSA stated in the NPRM that it believes that increasing the EDR sampling frequency to 10 Hz would:

- "Provide the agency with a more detailed representation of pre-crash actions because in some crash circumstances, 2Hz may be insufficient to identify crash causation factors and lead to misinterpretation of the data. For example, NHTSA is concerned that it is possible for rapid vehicle control inputs (e.g., brake application and release or rapid reversals in steering input of less than 0.5 seconds,) to be completely missed by an EDR that records data at 2 Hz." And that,
- "An improved data sampling rate is also needed because of how fast the sequence of events leading to crashes can happen and how fast the vehicle's systems need to activate, such as the activations of crash avoidance technologies (e.g., Antilock Braking System, and Electronic Stability Control). The current sampling rate is well below the timing necessary to understand the performance and effectiveness of such systems."

Bosch Corporate Research believes that a higher sampling rate can be beneficial when it comes to the analysis of crash causation and pre-crash behavior. An increase of the sampling rate to 10 Hz may enable additional events such as braking interventions, lane change maneuvers or steering maneuvers to be captured. Furthermore, during the crash phase, more information could be captured as the average crash duration for a single event is approximately 100ms, excluding rollover events. A 2Hz sampling rate may not capture all data when a multi-impact crash sequence happens. For example, such a crash sequence could consist of a crash initiated by a vehicle departing the road and then hitting a small tree, a barrier, and then another

wall or a tree in immediate succession. This example details multiple events which could occur very close in time to each other. However, Bosch wishes to emphasize that increasing the sampling rate could also require significant software and hardware changes as previously discussed in the previous section pertaining to the extension of the recording time.

Cost and Memory Capacity

NHTSA notes that the EDR Technologies Study reported that "a typical recorded event requires about 2 kilobytes (Kb) of memory depending on the manufacturer." NHTSA also stated in the NPRM that, "The pre-crash duration-only increase requires 0.21 Kb [1.14 Kb–0.93 Kb] of additional memory (a factor of 1.23 increase from the baseline). An increase in pre-crash recording duration from 5 seconds to 20 seconds with an increase in recording frequency from 2Hz to 10 Hz would require 1.33 Kb of additional memory (a factor of 2.43 increase from the baseline). NHTSA further added that, "Given how slight the proposed increase in memory would be, the agency believes that memory changes needed to accommodate the added EDR data storage can be incorporated into the existing or planned memory design in vehicles."

The actual cost of the proposed requirement will depend on the extent of the hardware and software changes required for each OEM and for each specific vehicle application. In cases where hardware changes will be needed, such as an increase in the size and/or quantity of the capacitors and the memory, the resulting cost impact will be considerable. Bosch is concerned that NHTSA's cost estimate in the NPRM focuses solely on the potential costs associated with additional memory. Bosch contends that there will be additional and considerable costs associated with increased capacitance for providing power to the AB ECU as well as the printed circuit board (PCB) hardware changes necessary to incorporate the changes.

Bosch also highlights the need to consider additional costs associated with testing, validation and certification of the redesigned airbag ECU. Further, as noted above, the necessary redesign of the relevant CDR tools will also command resources and should be considered in the overall estimate of cost to the industry.

It is important to understand that other features are also supported by the memory and the capacitors in the airbag ECU. The EDR Technologies

Study[3] mentions total flash memory available in airbag modules and argues that the EDR represents a small portion of it and, thus, an increase in memory by the EDR can be easily accommodated. In some situations, the memory capacity is already fully utilized and is already at the limit from a safety perspective. Increasing the amount of EDR data stored in the current flash memory semiconductors might lead to a breach of the capacity limits and may result in lost data.

One of the suggestions articulated in the NPRM, in lieu of utilizing a larger memory chip, was to reduce the number of Table II elements being recorded. Bosch is concerned that this proposed alternative would be counterproductive to the stated objective of the NPRM. Completely removing optional data from Table II would limit crash analysis capabilities.

Additional Processor Speed or Backup Power Need

In the NPRM, NHTSA does not anticipate there being any additional processor speed or backup power needs associated with the proposed greater recording duration and frequency increase. The Agency further requested comments on the potential impact on the air bag control module (ACM) processor and associated cost.

At present, Bosch does not envision any technical concerns with the "processor," which is more aptly labeled as a controller due to its nature and function. However, Bosch does anticipate that the proposed new requirements will necessitate an increase in backup power and, thereby, the costs associated with the overall upgrade of the relevant components and hardware.

EDR Reader / CDR Tool Considerations

As noted in the NPRM: "[49 CFR] Part 563 further requires that manufacturers of vehicles with EDRs that are subject to Part 563 make commercially available a tool for the purpose of imaging the data collected by the EDR."

Bosch enjoys a unique position in that it supplies not only the AB ECU to the OEMs but is also a market leader in providing the EDR retrieval tool used to obtain the data.

[3] DOT HS 812 929 – https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/14733_edrtechnologiesupdate_060420_v3-tag.pdf

When considering the changes being proposed by NHTSA for the EDR, attention must be given to the EDR retrieval tool development. OEMs will require software and hardware changes to their EDR retrieval tools in order to access the data contained in their vehicles' AB ECUs. Each OEM has different diagnostic protocols and strategies for retrieving stored EDR data even though they may utilize the same AB ECU suppliers. This diversity is based on the OEM's diagnostic tool strategy and vehicle network architecture.

Regarding EDR readout software adaptations, three important items need consideration. The first point which Bosch wishes to acknowledge is the EDR Data Retrieval. Most of the OEMs employ unique strategies to read out EDR data. Bosch's experience is that most of the OEMs have different messaging structures which can vary in size and quantity depending on the amount of data being recorded and retrieved. Bosch expects that each OEM would change the messaging structures for each of their AB ECU systems in order to accommodate the additional sampling resolution of 10Hz for up to 20 seconds. Therefore, each OEM would be expected to provide amendments to the specifications for each of their vehicle architectures.

The next point concerns Data Element Translations. There are differing data element translation requirements between each OEM and, depending on the vehicle, data reported in each of the EDR messages may be different between each of the OEMs and their associated brands.

Finally, Bosch wishes to call attention to the EDR Data Presentation. On average, there are 10~12 pre-crash data elements and therefore the reporting and display of each of these data elements will need to change to accommodate the additional data.

As previously stated, Bosch expects that it will take one to two calendar years to implement and test changes to the multiple OEM EDR readout requirements based on the proposed rule change.

Conclusion

If NHTSA proceeds with this proposed rulemaking, Bosch respectfully recommends an implementation time of at least four to five years to accommodate the significant software and hardware changes necessary to realize this transition. Bosch appreciates NHTSA's consideration of this feedback and input. If you have any questions, please do not hesitate to contact Ana Meuwissen at (202) 815-7645 or at Ana.Meuwissen@us.bosch.com.

Yours sincerely,

pki, BOSCH, US, R, A, Rashmi.Tumkur
Digitally signed by pki, BOSCH, US, R, A, Rashmi.Tumkur
Date: 2022.08.22 20:32:09 -04'00'

Ms. Rashmi Tumkur
Director of Engineering
Chassis Systems Control
Robert Bosch LLC

pki, BOSCH, US, B, I, Bill.Rose
Digitally signed by pki, BOSCH, US, B, I, Bill.Rose
Date: 2022.08.22 17:18:16 -07'00'

Mr. Bill Rose
Sr. Product Manager
Bosch Automotive Service Solutions

pki, BOSCH, US, A, N, Ana.Meuwissen
Digitally signed by pki, BOSCH, US, A, N, Ana.Meuwissen
Date: 2022.08.22 20:40:13 -04'00'

Ms. Ana M. Meuwissen
Director, Federal Government Affairs
Robert Bosch LLC