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FMVSS Considerations for Vehicles With Automated Driving Systems: Volume 1

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16. Abstract

The portion of the research project included in this volume focused on 12 Federal Motor Vehicle Safety Standards (FMVSS). It provides research findings, including the performance requirements and the test procedures, in terms of options regarding technical translations based on potential regulatory barriers identified for compliance verification of innovative new vehicle designs that may appear in vehicles equipped with automated driving systems (ADSs). This report evaluates the regulatory text and Office of Vehicle Safety Compliance test procedures with the goal of identifying possible options to address unnecessary/unintended regulatory barriers for the compliance verification of ADS-dedicated vehicles (ADS-DVs) that lack manually operated driving controls. It describes activities focused on six crash avoidance standards (FMVSS Nos. 102, 108, 114, 118, 138, and 141) and six crashworthiness standards (FMVSS Nos. 201, 202a, 203, 204, 205, and 206).

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EXECUTIVE SUMMARY

This project provides research findings in terms of options regarding technical translations of Federal Motor Vehicle Safety Standards (FMVSS), including the performance requirements and the test procedures, and related Office of Vehicle Safety Compliance (OVSC) test procedures based on potential unnecessary/unintended regulatory barriers[1] identified for compliance verification of innovative new vehicle designs that may appear in vehicles equipped with automated driving systems (ADSs). This report evaluates the regulatory text and test procedures with the goal of identifying possible options to remove barriers for the compliance verification of ADS-dedicated vehicles (ADS-DVs) that lack manually operated driving controls. It also describes activities focused on 6 crash avoidance standards (FMVSS Nos. 102, 108, 114, 118, 138, and 141) and 6 crashworthiness standards (FMVSS Nos. 201, 202a, 203, 204, 205, and 206). This research includes feedback obtained from research team experts, stakeholders, and subject matter experts (SMEs).

A technical translation is a modification that would allow regulatory text and/or test procedures that are identified as potential regulatory barriers to be carried out with the same basic engineering performance without manual control-specific restrictions. This report documents the process carried out to develop technical translations and testing procedure options for the 12 FMVSS designated for near-term research in this project, such that the identified potential regulatory barriers could be removed for vehicles operated exclusively by an ADS that may not have the traditional controls used by human drivers.

Despite the systematic approach used in developing the technical translation options, the current report features a number of limitations that should be disclosed in the interest of transparency. First, the legality of the potential options discussed in this report has not yet been verified. Second, the potential options in this report do not include all possibilities for translation of the FMVSS or the OVSC test procedures. The options included are limited to those the authors of the report and stakeholders involved suggested and discussed as potentially feasible at the time the research was performed. Thus, there may be other options not included in this report. Third, it is important to disclose that the majority of the stakeholders involved in this project were representatives of industry, not public interest groups or others that the National Highway Traffic Safety Administration would also consider stakeholders to NHTSA's processes. Please see **Appendix G** for a complete listing of the stakeholder organizations involved in the development of this report and in the technical translations of each of the FMVSS included in this report.

[1] The use of the term "regulatory barrier" in this report always refers to "an unintended and unnecessary regulatory barrier" because the technical translation process does not remove, reduce, or otherwise alter performance standards of the FMVSS under consideration.

This research project builds upon previous work completed by the Volpe National Transportation Systems Center, titled *Review of Federal Motor Vehicle Safety Standards (FMVSS) for Automated Vehicles: Identifying Potential Barriers and Challenges for the Certification of Automated Vehicles Using Existing FMVSS* (Kim, Bogard, Perlman, & Harrington, 2016).[2]

SCOPE

The FMVSS technical translations effort is focused on a particular type of new vehicle design, the ADS-DV, which this report defines as a vehicle designed to be operated exclusively by an SAE International (SAE) level 4 or level 5 ADS (as defined in SAE Standard J3016_201806, Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles, 2018) for all trips, and which is not equipped with manually operated driving controls. Thus, technical translation options were not developed for regulatory text or test procedures that might pose a barrier to compliance verification of an ADS that operates with functionalities less than SAE level 4. Nor were technical translations developed for provisions in the FMVSS targeted toward vehicles equipped with a level 4 or level 5 ADS that are also equipped with manually operated driving controls (sometimes referred to as "dual-mode" vehicles). Some of the physical characteristics absent in this type of vehicle present an opportunity to explore alternative methods for compliance verification.

Technical translations for this effort present possible options for the regulatory text and OVSC test procedures when a regulatory barrier is present. Many of the FMVSS include both performance requirements and test procedure regulatory text. The OVSC test procedures are derived from the FMVSS regulatory text test procedures. The technical translation options focus mainly on the FMVSS performance requirements and test procedure regulatory text. Once the rulemaking procedure takes place, the OVSC test procedure changes will follow to reflect any changes needed. Examples of potential regulatory barriers could be a feature mentioned in the regulatory text that is not available in the ADS-DV (e.g., steering column, steering wheel), if the feature is required as a reference point (e.g., driver's seat), or if its presence is required (e.g., rearview mirror). Also, a portion of an OVSC test procedure that cannot be implemented as prescribed (e.g., measuring a steering wheel angle) might present uncertainty for self-certification for a manufacturer electing to base certification upon OVSC test procedures.

APPROACH

The approach taken in this study included: (1) scoping, (2) planning, (3) development, and (4) testing and evaluation. This near-term research is focused primarily on the 100-series (crash avoidance) and the 200-series (crashworthiness/occupant protection) FMVSS. The 30 FMVSS

[2] The Volpe Report outlined two reviews of the FMVSS: (1) a review to identify standards that include an explicit or implicit reference to a human driver, and (2) a review to identify standards that might pose a barrier for compliance verification of a wide range of concept vehicles that may be equipped with an ADS. The Volpe Report identifies those standards that reference a driver (in several different contexts) and specifies which standards apply to which concepts (Kim et al., 2016, pp. 14-19). The report also categorizes certain types of regulatory challenges for ADS-equipped vehicles and links them to corresponding standards and concepts (Kim et al., 2016, Appendix B). The Volpe Report identified several potential regulatory barriers, highlighting uncertainty about how vehicles with innovative designs could execute some FMVSS test procedures.

that are part of the near- and mid-term research are shown in Figure ES-1 below. The 12 FMVSS of focus for this report are emphasized.

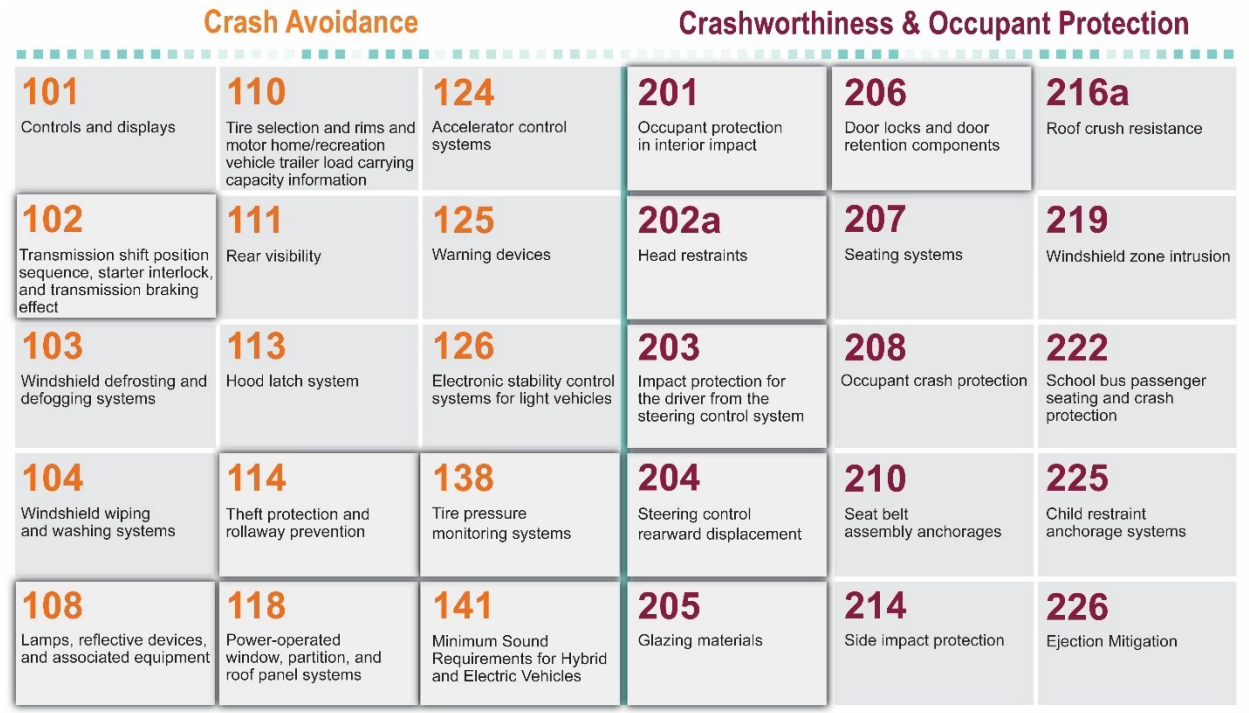

Figure ES-1. FMVSS of Focus for This Report

The knowledge gained and considerations made while evaluating the 30 FMVSS (12 of which are covered in this report) will be leveraged for the remaining portions of the FMVSS. This additional work will be addressed longer term and documented in a separate report.

During the translation process, potential regulatory barriers were analyzed from different sources: (1) FMVSS regulatory language, including performance requirements and test procedures, and (2) OVSC test procedures. Several parts of the regulatory language include standards that are incorporated by reference (e.g., American National Standards Institute [ANSI], ASTM, International Organization for Standardization [ISO], SAE). The standards incorporated by reference are part of the FMVSS regulatory language and were analyzed in the same way as the rest of the regulatory text.

Crash Avoidance Standards

Work on the 100-series crash avoidance standards focused on addressing some of the fundamental aspects that cut across many of that FMVSS series, such as definitions for driver and seating position, service brake application, and gear position/selection, as well as developing initial considerations for translating requirements for telltales—considering conventional and unconventional seating configurations—and addressing bidirectional vehicles. Vehicle functionalities (e.g., steering, transmission control, service brake application) that are explicitly referenced in FMVSS and OVSC test procedures were first identified (e.g., gear selection ignition start/stop). Subsequently, test method options were developed for potential alternatives

that could be used in compliance verification. These options were grouped into two categories based on whether the physical vehicle would be used to execute test procedures in the compliance verification process. Vehicle-based methods would employ the physical vehicle to execute the test procedures to verify compliance in a manner similar to the procedures used today. Non-vehicle- based methods would not execute the test with the physical vehicle being evaluated but would instead use detailed technical documentation about the vehicle design or simulation of vehicle operation and performance to assess compliance. To evaluate the vehicle-based methods, a standard production vehicle was modified to include actuators and control signals to allow the vehicle to have the ADS perform the functionality specified in the regulatory text or the associated OVSC test procedures. This test platform allowed for the execution of the developed test procedures.

Crashworthiness Standards

For the current portion of this effort, work on the 200-series FMVSS crashworthiness standards focused on occupant protection in ADS-DVs with conventional seating. This included ADS-DVs with forward-facing seating but without manually operated driving controls (e.g., steering wheel).[3] For ADS-DVs without manually operated driving controls, an option is to apply the test procedures that have been developed for the passenger seating positions to the left front outboard seating position, given that the main difference between the two front outboard seating positions in conventional vehicles is the presence or absence of these controls. However, subsequent research as part of this effort is planned to address knowledge gaps in several areas that could be beneficial such as passenger seating preferences (e.g., rear seat) as well as translation considerations for unconventional seating configurations.

STAKEHOLDERS AND SUBJECT MATTER EXPERTS

The involvement of stakeholders and SME reviewers was a part of the technical translation process. Several industry and research entities were engaged as collaborators on this project to obtain input and feedback, and produce prototype technology for testing and evaluation. Stakeholders include companies, organizations, and advocacy groups that were invited to be involved in this project in the proposal stage based on their experience with FMVSS and ADS-DVs. Additional stakeholder entities have since been added; in some cases, organizations have asked to be added and in other cases a need was identified for additional expert feedback, resulting in additional stakeholders being invited to participate (after obtaining NHTSA's approval).

SMEs were divided into working groups based on their expertise with a particular FMVSS and/or OVSC test procedure. The working group members assisted with the review process once technical translation options were developed. The SMEs also provided feedback on alternative methods evaluated for test procedures of interest. In addition, stakeholders participated in open project meetings and provided input regarding this project.

[3] Alternative seating configurations, such as rear-facing or side-facing seats were not considered during near-term research, but are planned to be part of the next steps of this research.

REPORT CONTENTS

This report includes the following information:

Chapter 1 – Introduction. This chapter provides an overview of the research project as well as relevant background information.

Chapter 2 – Technical Translation Process. This chapter introduces the process followed for the development of the technical translation options provided in this report. An overview describes the steps followed to analyze potential regulatory barriers for vehicles operated exclusively by an ADS in the references cited in 12 FMVSS (selected by NHTSA), the methods used to develop the technical translations, and the approach used for identifying and evaluating methods that NHTSA could potentially use to verify compliance. The steps followed for stakeholder and SME review and participation are also described in this chapter.

Chapter 3 – Crash Avoidance Standards. This chapter explains the results from the analysis performed for each of the six 100-series FMVSS covered in near-term research: FMVSS Nos. 102, 108, 114, 118, 138, and 141. An overview of the technical translations as well as the stakeholder and SME feedback on each technical translation is presented. Potential alternate means to verify compliance for an ADS-DV are also discussed, including equipment and/or methods researched to assist with the compliance verification process.

Chapter 4 – Crashworthiness and Occupant Protection Standards. This chapter explains the results from the analysis performed for each of the six 200-series FMVSS covered in near-term research: FMVSS Nos. 201, 202a, 203, 204, 205, and 206. The translation overview as well as the stakeholder and SME feedback on each translation are presented.

Chapter 5 – Summary of Research Findings. This chapter reviews the key findings and trends from the translation analyses performed in Chapters 3 and 4 and concludes the report for this phase of the research effort.

Appendices. Seven appendices are included to provide information regarding definitions, technical translation worksheets, the information communicated to occupants, a list of standards incorporated by reference for the FMVSS designated for near-term research, an example of the test procedure technical documentation method, other relevant aspects of the 6 alternate test methods considered for crash avoidance, and a list of stakeholders who were involved in the technical translation effort.

SUMMARY CONCLUSION

This study established an approach and a process for identifying and assessing the development of FMVSS translation options. The development of crosscutting analyses to drive consistency in the translation options and clarify when individual standards required unique options or approaches was a critical step in the FMVSS translation effort. Crosscutting analyses allowed development of a fuller range of potential options and recognition of where an option in one standard may have broader implications for other FMVSS. Another important aspect of the project was having a wide range of stakeholders and SME reviewers with different perspectives

and areas of expertise. The exchange of ideas and feedback by research team experts, stakeholders, and SME reviewers provided specialized input to the process.

This first phase of the project provided foundational work in determining the functionality options for FMVSS test procedures that could be used by NHTSA to verify the compliance of ADS-DVs without manually operated driving controls; this will be expanded upon during future research. Test procedures to verify FMVSS compliance for ADS-DVs without manually operated driving controls will also keep advancing throughout the next phases of this project. As the work on more complex standards progresses, technical translation approaches that were considered appropriate for the standards designated for near-term research might need to be revisited and potentially updated or characterized differently.

GLOSSARY OF ACRONYMS

ABS	anti-lock braking system
ADS	automated driving system
ADS-DV	automated driving system-dedicated vehicle
ANSI	American National Standards Institute
CIE	International Commission on Illumination
DDT	dynamic driving task
DSP	designated seating position
ECE	Economic Commission for Europe
ECU	electronic control unit
FMVSS	Federal Motor Vehicle Safety Standard(s)
GVWR	gross vehicle weight rating
IESNA	Illuminating Engineering Society of North America
ISO	International Organization for Standardization
ODD	operational design domain
OSHA	Occupational Safety and Health Administration
OVSC	Office of Vehicle Safety Compliance
SAE	SAE International
SME	subject matter expert
TPMS	tire pressure monitoring system
TREAD	Transportation Recall Enhancement, Accountability, and Documentation (Act)
VTTI	Virginia Tech Transportation Institute

CHAPTER 1. INTRODUCTION

This project provides research findings in terms of options regarding technical translations of Federal Motor Vehicle Safety Standards, including the performance requirements and the test procedures, and related Office of Vehicle Safety Compliance test procedures based on potential unnecessary/unintended regulatory barriers[1] identified for compliance verification of innovative new vehicle designs that may appear in vehicles equipped with automated driving systems. This report evaluates the regulatory text and test procedures with the goal of identifying possible options to remove barriers for compliance verification of ADS-dedicated vehicles that lack manually operated driving controls. It also describes activities focused on 6 crash avoidance standards (FMVSS Nos. 102, 108, 114, 118, 138, and 141) and 6 crashworthiness standards (FMVSS Nos. 201, 202a, 203, 204, 205, and 206). This research includes feedback obtained from research team experts, stakeholders, and subject matter experts (SMEs).

A technical translation is a modification that would allow regulatory text and/or test procedures that are identified as potential regulatory barriers to be carried out with the same basic engineering performance without manual control-specific restrictions. Technical translations for this effort present options for the regulatory text and OVSC test procedures when a potential regulatory barrier is present. This report documents the process carried out to develop technical translations and testing procedure options for the 12 FMVSS designated for near-term research in this project, such that the identified potential regulatory barriers could be removed for vehicles operated exclusively by an ADS that does not have the traditional controls used by human drivers.

BACKGROUND

A report prepared by the Volpe National Transportation Systems Center titled *Review of Federal Motor Vehicle Safety Standards (FMVSS) for Automated Vehicles: Identifying Potential Barriers and Challenges for the Certification of Automated Vehicles Using Existing FMVSS* (Kim, Bogard, Perlman, & Harrington, 2016; the "Volpe Report") included two reviews of the FMVSS: (1) a review to identify standards that include an explicit or implicit reference to a human driver, and (2) a review to identify standards that might pose a barrier for compliance verification of a wide range of concept vehicles that may be equipped with an ADS. From this review, 13 automated vehicle concepts were defined to reflect the identified barriers and potential future applications of automated vehicle technology. The 13 concepts differed in their design convention and speed classification. Design convention considered differences in the application of advanced features that take full advantage of automation (e.g., removing steering wheel). Speed classification regarded low-speed (e.g., speed restricted to 40 km/h [25 mph]) and high-speed (i.e., no speed restriction).

For the current project, the vehicles under consideration were assumed to be SAE level 4 or level 5 without manually operated driving controls. Throughout the current report, these vehicles are generally referred to as ADS-DVs (SAE International, 2018).

[1] The use of the term "regulatory barrier" in this report always refers to "an unintended and unnecessary regulatory barrier" because the technical translation process does not remove, reduce, or otherwise alter performance standards of the FMVSS under consideration.

The Volpe Report identifies those standards that reference a driver (in several different contexts) and specifies which standards apply to which concepts (Kim et al., 2016, pp. 14–19). The report also categorizes certain types of regulatory challenges for ADS-equipped vehicles and links them to corresponding standards and concepts (Kim et al., 2016; Appendix B of that report). The authors identified several potential regulatory barriers and challenges, highlighting uncertainty about how vehicles with innovative designs could execute some FMVSS test procedures.

Although the Volpe Report focuses on the 100-series (crash avoidance) and the 200-series (crashworthiness) FMVSS, some interrelated standards in the 300-series (post-crash) may also warrant consideration (e.g., fuel integrity standards incorporate elements of the crashworthiness standards). Based on the initial FMVSS review carried out by the project team and the technical SMEs, during subsequent analyses the potential technical translation options may be expanded to other standards not identified in the Volpe Report.

SCOPE

SAE International's definition of "ADS-DV" (provided in the Definitions section below) indicates that some ADS-DVs could contain driving controls; e.g., for braking, acceleration, steering (SAE International, 2018). However, this project's development of FMVSS technical translation options focused on ADS-DVs designed to be operated exclusively by an SAE level 4 or level 5 ADS for all trips, within the given operational design domain limitations (if any) and which are not equipped with user interfaces. As the current SAE definition for ADS-DV applies to driving automation levels 4 and 5 only, level 3 ADS-equipped vehicles (i.e., vehicles equipped with a user interface that permits operation by a human driver) are outside of the scope of this project.

Only existent FMVSS are covered as part of the scope of this effort. The development of future standards is considered outside of the project's scope. In addition, this project does not address vehicles equipped with a level 4 or level 5 ADS that are also equipped with manually operated driving controls (sometimes referred to as "dual-mode" vehicles).

Multiple factors were considered during the research scoping effort, including definitions, concept vehicles, and technical translation principles. The scoping process allowed the development of technical translation options appropriate to the vehicles of interest: ADS-DVs without manually operated driving controls. The approaches used for evaluating the translation options and test procedure implications for those standards designated for near-term research are presented in their respective chapters.

Conventional Seating Configuration

As part of Phase 1, the 200-series technical translation options only consider conventional seating configurations. Certain unconventional seating configurations may be considered as part of Phase 2.

Bidirectional Vehicles

The current standards do not define the front and rear of the vehicle. They have been well understood to date (hood, trunk, front doors, rear axles, headlamps, etc.); however, with a

bidirectional vehicle, it is possible that, depending on the vehicle's direction of travel, the hood becomes the trunk, the front doors become the rear doors, the front axles become the rear axles, the headlamps become the taillamps, and so on. While front and rear are referenced throughout the standards, they are not defined, so this can be unclear when discussing vehicles with bidirectional functionality. Bidirectional ADS-DVs were analyzed in the context of the crash avoidance standards (100-series) and potential bidirectional vehicle definition options and application approaches were provided; these are discussed further in the FMVSS Definition Translation Options section further below. For the crashworthiness (200-series) standards, bidirectional vehicles are not considered under near- or mid-term research. The implications of bidirectional vehicles for crashworthiness may be included as a part of long-term research.

APPROACH

A systematic approach was developed for identifying technical translation options that may be needed for an ADS-DV to be certified to the various FMVSS. The approach used in this study included (1) scoping, (2) planning, (3) development, and (4) testing and evaluation. The near-term research is focused primarily on the 100-series crash avoidance and the 200-series crashworthiness/occupant protection FMVSS.

The knowledge gained and considerations made during evaluation of the 12 FMVSS covered in this report will be leveraged for the remaining portions of the FMVSS. Long-term research will address design aspects, such as unconventional seating configurations, and other FMVSS series not covered in Phase 1 (e.g., 49 C.F.R § 571.500). This additional work will be addressed longer term and then documented in a separate report.

During the technical translation process, potential regulatory barriers were analyzed from two sources: (1) FMVSS regulatory language, including performance requirements and test procedures, and (2) OVSC test procedures. Several parts of the regulatory language include standards that are incorporated by reference (e.g., American National Standards Institute, ASTM, International Organization for Standardization, SAE). The standards incorporated by reference are part of the FMVSS regulatory language and were analyzed in the same way as the rest of the regulatory text. This first set of regulatory barrier analysis, technical translations, and test method evaluations provides a framework for the evaluation of the standards that are designated for mid-term research and beyond.

DEFINITIONS

FMVSS include definitions within standards (specific to the particular standard) as well as definitions that apply across the standards, as specified in FMVSS section 571.3. In some instances, definitions could be part of a standard incorporated by reference. Operational definitions helped the project team take a standardized approach to the development of the technical translation options. In some instances, technical translation options were developed for existent definitions, in other cases existent definitions that could potentially be incorporated by reference were identified, and in a few cases new definitions were developed. The definitions presented next provide clarifications to the technical translations and the associated new innovative designs being considered for this project.

Terms Defined by SAE International

Among the feedback received from SME reviewers and from attendees of the April 2018 FMVSS Stakeholder Meeting (VTTI, 2018a, 2018b, discussed in more detail in Chapter 2) was the notion that creating new definitions could add confusion. These stakeholders identified definitions from SAE's Recommended Practice J3016, *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* (SAE International, 2018) as a potential source of existing definitions. Consistent with that feedback, the definitions in this subsection are based on Section 3.3 of that Recommended Practice.

Automated Driving System

> The hardware and software that are collectively capable of performing the entire DDT [dynamic driving task] on a sustained basis, regardless of whether it is limited to a specific ODD; this term is used specifically to describe a level 3, 4, or 5 driving automation system. (SAE International, 2018, p. 3)

Operational Design Domain

> Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics. (SAE International, 2018, p. 14)

Dynamic Driving Task

> All of the real-time operational and tactical functions required to *operate* a *vehicle* in on-road traffic, excluding the strategic functions such as *trip* scheduling and selection of destinations and waypoints, and including without limitation:
>
> - Lateral vehicle motion control via steering (operational);
> - Longitudinal vehicle motion control via acceleration and deceleration (operational);
> - Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical);
> - Object and event response execution (operational and tactical);
> - Maneuver planning (tactical); and
> - Enhancing conspicuity via lighting, signaling and gesturing, etc. (tactical) (SAE International, 2018, p. 6).

While considering SAE International's DDT definition for FMVSS technical translations, it was noted that the definition seems to exclude transmission operation (e.g., Park or Reverse). The transmission state is an important driving function within the FMVSS (e.g., FMVSS Nos. 102 and 114). Refinement of the DDT to include transmission state consideration may help to further align potential FMVSS incorporation.

ADS-Dedicated Vehicle

Based on Section 3.3 of SAE International (2018) an ADS-DV is: "a vehicle designed to be operated exclusively by a level 4 or level 5 ADS during all trips within its given ODD limitations (if any)" and might lack user interfaces such as "braking, accelerating, steering, and transmission

gear selection input devices." Additional considerations identified by SAE International in its definition of ADS-DV include the following (SAE International, 2018, p. 4):

> ADS-DVs might be operated temporarily by a conventional or remote driver:
>
> 1. to manage transient deviations from the *ODD*,
> 2. to address a system failure, or
> 3. while in a marshalling yard before being dispatched.
>
> Example 1:
> A level 4 ADS-DV designed to operate exclusively within a corporate campus where it picks up and discharges passengers along a specific route specified by the ADS-DV dispatcher.
>
> Example 2:
> A level 4 ADS-DV designed to operate exclusively within a geographically prescribed central business district where it delivers supplies using roads (but not necessarily routes) specified by the ADS-DV dispatcher.
>
> Example 3:
> A level 5 ADS-DV capable of operating on all mapped roads in the US [United States] that are navigable by a human driver. The user simply inputs a destination, and the ADS-DV automatically navigates to that destination.

For the purposes of this project, the FMVSS technical translation options focused on ADS-DVs which are not equipped with manually operated driving controls.

FMVSS Definition Translation Options

The definitions below were developed as potential options to help support the ADS-DV technical translation options throughout this report. Developed iteratively in conjunction with the technical translation process, the definitions cut across many of the standards and were central to the technical translation approach used in this project. The selected options (or variations of those options) could potentially be included in 49 CFR § 571.3, or elsewhere in future regulatory text. As noted earlier, the terms ADS, ODD, DDT, and ADS-DV as defined by SAE International (2018) have been used. As explained below, definition options for additional terms, such as driver, seating positions, and driving controls, have also been developed. The driver definition options are meant to be interchangeable with the other potential definitions, whereas the seating positions and driving controls definition sets are meant to be used as a combined grouping. In addition to the following discussion, a table summarizing the definition translation options is included in **Appendix A**.

Driver

As currently specified in 49 CFR § 571.3, "Driver means the occupant of a motor vehicle seated immediately behind the steering control system." Two distinct options for defining "driver" have been developed to facilitate the technical translation of the FMVSS to ADS-DVs, as shown in Table 1 below.

Table 1. Potential Driver Definition Technical Translation Options

Potential Option 1	Potential Option 2
Driver means: (1) the occupant (human driver) of a motor vehicle seated immediately behind the manually operated driving controls, and (2) the ADS (ADS driver), for ADS-equipped vehicles when the ADS is engaged. When the ADS is not engaged, the definition in paragraph (1) applies.	*Driver* means the occupant of a motor vehicle seated immediately behind the manually operated driving controls.
Note: Under this Option, the ADS performing the driving for an ADS-DV would be considered the "driver."	*Note: Under this Option, the term "driver" always refers to a human driver. The ADS would operate on an ADS-DV and would be addressed in the translated standards independently from the "driver."*

When Option 1 is used in the translations, "driver" is used to refer to either a human driver or an ADS driver. The term "human driver" is used when only paragraph (1) applies, and the term "ADS driver" is used when only paragraph (2) applies. Conversely, Option 2 treats the human driver and the ADS driver independently. Under Option 2, the references to a "driver" always refer to a human driver. An ADS, as defined by SAE International (2018), would be the operator of an ADS-DV. Option 2 for driver was used throughout the 200-series standards technical translation options development in the few cases that "driver" was maintained in the regulatory text. One of these cases is in FMVSS No. 203 S1 which states "this standard specifies requirements for steering control systems that will minimize chest, neck, and facial injuries to the driver as a result of impact." However, driver Option 1 could also be used as follows "…human driver as a result of impact."

Both Option 1 and Option 2 definitions are associated with the definition of manually operated driving controls. The manually operated driving controls definition is discussed below and describes a system used by an occupant to manipulate the vehicle's heading and speed. This provides a similar context to the current "driver" definition, which uses the steering control system to define the human driver. To the extent that the "steering control system" is a manually operated driving control, it does not change the meaning of the current "driver" definition from its historical meaning; i.e., where the current 49 CFR §571.3 definition of driver currently uses the term "steering control system," the driver definition options use "manually operated driving control." The developed definition of "manually operated driving controls" provides further consistency with other translation options and clarifies that it is a manual control.

For the vehicles covered under the scope of this project, if there is an ADS, it will always be engaged, since there are no manually operated driving controls that a human driver could use. However, this optional definition of "driver" has been worded in this manner to address the possible application of the FMVSS translation options to vehicles in which an ADS is present but might not be engaged (e.g., vehicles equipped with level 3 ADS features and/or dual-mode vehicles with level 4 ADS features). Because Option 2 does not specify the entity that is

operating/controlling the vehicle, the translation options use language such as "for a vehicle operated by an ADS" or "for a vehicle operated by a driver." Although this terminology was sometimes used under other technical translation options, it was essential in the context of the Option 2 definition of "driver."

During the development of the technical translations, driver Option 1 and Option 2 were applied to driver references associated with the function of operating a vehicle. In some cases for the 100-series, the term "driver" was deleted from the technical translation where the deletion would not impact the technical understanding of the requirement. For example, the FMVSS No. 102 S3.1.3.1 requirement begins with the following language: "After the driver has activated the vehicle's propulsion system…." The technical translation option for this section removed the word "driver," since removing that word would not affect the technical meaning of the provision. There were also a few instances where a reference to an ADS-DV was used to clarify a requirement instead of referring to a driver. One of the technical translation cases that used ADS-DV to clarify the requirement was FMVSS No. 108, S9.4.1 semi-automatic headlamp beam switching device. The current requirement states, "As an alternative to S9.4, a vehicle may be equipped with a semi-automatic means of switching between lower and upper beams." The technical translation adds the following statement to this requirement, "Semi-automatic headlamps are not allowed in an ADS-DV." As discussed in the next section, in some cases "driver" was replaced by "driver's DSP" where the reference to driver was not associated with the operation of the vehicle but rather to a designated seating position (DSP).

Seating Positions and Driving Controls

Designated Seating Position

As specified in 49 CFR §571.3, for vehicles manufactured on or after September 1, 2011, DSP means a seat location that has a seating surface width, as described in section 571.10(c), of at least 330 mm (13 inches). Section 571.10 provides a method for calculating the number of DSPs based on the width of the seat.

In the context of the analysis conducted, there was no perceived need to translate the term "DSP." However, a key term found throughout the FMVSS 200-series is "driver's DSP," along with similar terms such as "driver's seat" and "driver's position," often in conjunction with references to driving controls. After considering several possible approaches, the use of the term "driver's designated seating position" seemed to greatly simplify the FMVSS translations. For example, it avoids the need to translate current language in the FMVSS referring to a driver's DSP or driver's seat.

In order to support this translation approach, two sets of definition options for seating positions and driving controls were evaluated. Each set includes a definition of (1) driver's DSP, (2) manually operated driving controls, (3) steering controls, and (4) passenger DSP. In the context of this report, either Set 1 or Set 2 should be used in its entirety for the approach to make sense, and the definitions within those sets are constructed as a set (i.e., are not intended to be chosen on an à la carte basis). The sets are structured as shown in Table 2 below.

Table 2. Potential Definition Options: Seating Positions and Driving Controls

Potential Set 1	Potential Set 2
Driver designated seating position (driver's seat or driver's seating position) means a DSP immediately behind the manually operated driving controls positioned such that an occupant can operate the manual driving controls, regardless of whether the occupant is in active control of the vehicle.	*Driver designated seating position (driver's seat or driver's seating position)* means a DSP providing immediate access to the manually operated driving controls.
Manually operated driving controls in Potential Set 1 means the system used by an occupant to manipulate the vehicle's lateral (steering) and/or longitudinal (acceleration and deceleration) motion in real time.	*Manually operated driving controls* in Potential Set 2 means (a) the system used by an occupant for real-time sustained manipulation of the motor vehicle's heading (steering) and/or speed (accelerator and brake), (b) positioned such that they can be used by an occupant, (c) regardless of whether an occupant is actively manipulating the vehicle's motion.

One component of both optional definitions of the term "manually operated driving controls" is the inclusion of a "real-time" requirement. This was included to differentiate between controls needed to perform the DDT on a continuous, second-by-second basis versus a one-time task, such as simply typing a location into a smartphone and handing control over to the ADS. Similar to the observation made regarding the definition of "DDT," there may be an opportunity to incorporate transmission controls into the definitions that address forward, reverse, and park operation. While transmission shifting is an important aspect of the driving function, this aspect was not addressed because the reference to longitudinal (speed) motion implicitly covers forward and reverse operation but does not address park.

It should be noted that in the Set 2 definition of "manually operated driving controls," clause (c) specifies that the heading and speed controls come within the definition "…regardless of whether an occupant is actively manipulating the vehicle's motion." This portion of the definition addresses the case of a vehicle designed for both driverless operation and operation by a human driver, which is outside the present scope of the project. One example would be a level 4 ADS-equipped dual-mode vehicle with a limited ODD, such as a college campus, which also has a steering wheel and other controls that would allow manual operation by a human driver outside of the ODD. In this type of dual-mode vehicle, the steering wheel might remain in place even when the vehicle is being operated by the ADS in the ODD. In a crash, the presence of a steering wheel could pose an impact injury risk to an occupant seated behind it, regardless of whether it was functional or not. Hence, a DSP behind a steering wheel would be considered a driver's DSP from an occupant crash protection perspective, even when there is no human driver operating the vehicle. That same concern is addressed in Set 1 within the definition of "driver's DSP."

The steering control and passenger DSP definitions (shown in Table 3 below) are the same for both Set 1 and Set 2. Two options were developed for the term "passenger DSP" (A and B), whereas the term "steering control (wheel)" has one definition that could be used in conjunction with either of the driver's DSP and manually operated driving controls sets.

Table 3. Potential Definition Options: Passenger DSP and Steering Control (Wheel)

Potential Option A (Set 1 and 2)	Potential Option B (Set 1 and 2)
Passenger DSP means any DSP other than the driver's DSP.	*Passenger DSP* means any DSP other than the driver's DSP. Specifically, a seating position with stowed manually operated driving controls in a passenger seating position.
Potential Option (Set 1 and 2)	
Steering control (wheel) means the manually operated driving control used to manipulate the vehicle's heading.	

If an ADS-equipped vehicle does not have a driver's DSP[2] then all DSPs would be considered passenger DSPs, and the FMVSS sections referring to passenger DSPs would apply to these seating positions. However, there may be instances where a requirement or provision may apply to or be relevant for the driver's seat and may be silent with respect to the passenger seat (e.g., a door closure warning system for hinged doors is required to be visible to the driver, *see* FMVSS No. 206, S4.1.2.3). In this example, even if all DSPs are considered passenger DSPs in an ADS-DV, this does not necessarily mean that the warning does not have to be visible to any occupant. Occupants may still be expected to be notified of an unlatched door. This is discussed further in Chapter 2 under Controls, Telltales, and Indicators.

As outlined in Chapter 4, the translation strategy for the 200-series standards was to use the definitions of driver's DSP and passenger DSP to translate the current requirements for ADS-DVs. In many instances, the FMVSS currently use a form of driver's DSP or passenger DSP. However, there are also references to these terms in some of the 100-series (crash avoidance) standards. For example, S5.1.3 of FMVSS No. 114 uses the term driver's DSP in the following: "Except as specified…an audible warning to the vehicle operator must be activated whenever the key is in the starting system and the door located closest to the driver's designated seating position is opened."

Vehicle Direction

As discussed in the Scope section, it was determined that the near-term 100-series research would consider bidirectional vehicles in the development of technical translation options. Initially, one of the key issues was determining how to address the references to front and rear of the vehicle that are used throughout the FMVSS. What constitutes the front and rear of the vehicle may be critical to the technical translation implementation of numerous provisions of FMVSS No. 108; e.g., the headlamps provide illumination forward of the vehicle and indicate the forward travel direction, and the taillamps illuminate the road to the rear of a vehicle and indicate when the vehicle is backing up or is about to back up. Looking at the near-term

[2] For the ADS-DVs covered under the scope of this project, if there is an ADS, there will not be a driver's DSP, since by definition there will not be any manually operated driving controls.

standards, this is pertinent not only to vehicle lighting, but also to FMVSS No. 141 sound requirements, which are likewise associated with both forward and reverse vehicle movement.

Options for defining the front and rear of a vehicle in the context of travel direction were initially analyzed, but such an approach raised a number of ambiguities and complexities for applications across the standards. There are situations where the direction of travel is not always defined. When a vehicle is driving out of a perpendicular parking space, which direction of travel would be considered pulling out (forward motion) and which direction would be considered reversing (rearward motion) from the parking space? Figure 1 shows an example of a downtown parking lot in Brighton, MI. The lot is part asphalt and part dirt with no travel lines defined and, without the travel lines as reference, the travel direction to define front and rear might not be clear.

Figure 1. Example of Parking Setting Without Clear Travel Direction Indication

The possibility was considered of addressing bidirectional vehicles within each of the potentially applicable standards by including the following statement in the "application" section of the standard: "For motor vehicles that are capable of bidirectional operation as defined in section 571.3, this standard applies in both directions of travel." However, after further review, and taking into consideration feedback received from SME reviewers and some attendees of the April 2018 FMVSS Stakeholder Meeting (VTTI, 2018a, 2018b), it was determined that the applicability of the FMVSS to bidirectional vehicles could be addressed generically in Subpart A of 49 CFR Part 571, potentially as a new subsection (g) of section 571.7 or as a new section 571.11, or as a separate FMVSS addressing bidirectional vehicles.

Under this approach, "bidirectional vehicle" could be defined in section 571.3 as shown in Table 4 below.

Table 4. Potential Definition Options: Bidirectional Vehicle

Potential Option 1	Potential Option 2
Bidirectional vehicle means an ADS-equipped vehicle without manually operated driving controls that can perform the DDT across an equivalent range of speed and heading control in two opposite directions.	*Bidirectional vehicle* means a motor vehicle that operates across an equivalent range of speed and heading control in two opposite directions.

In addition, a new subsection (g) of section 571.7, or a new section 571.11, could be added as follows:

Bidirectional Vehicles. Each applicable standard set forth in Subpart B of this Part shall apply to bidirectional vehicles in both directions of travel.

Under Option 1, bidirectional vehicles could be operated only by an ADS and not by a human driver; i.e., only ADS-DVs could be bidirectional vehicles (although additional language might be added to address dual-mode vehicles and/or vehicles with level 3 automation). Conversely, Option 2 would not impose such a limitation.

Therefore, the requirements imposed by the potential new subsection (g) of section 571.7, or a new section 571.11, would not apply. Thus, if NHTSA wishes to limit bidirectional capability to ADS-DVs, the agency may want to consider adding another provision that explicitly precludes the sale of vehicles that could function as bidirectional vehicles unless they are ADS-DVs.

Both options try to differentiate between a conventional vehicle, which can travel in reverse at relatively low speeds, and a true bidirectional vehicle. However, there may still be situations that require further analysis; for example, a vehicle may be able to be driven at 90 mph in one direction but only 75 mph in the other direction.

For the 100-series standards designated for near-term research, the definition and application approach outlined above eliminates the need to make separate technical translations for bidirectional vehicles on a standard-by-standard basis**.**

CONCEPT VEHICLES

As part of the scope and development steps for this research effort, the different vehicle features that could have an impact on determining if a potential regulatory barrier exists were examined. For example, ADS-DVs that lack manually operated driving controls do not have features such as an accelerator and brake pedal, shifter, or steering wheel. These features are mentioned in multiple sections of the FMVSS and are sometimes used when implementing a test procedure. When evaluating the potential for regulatory barriers, it is important to understand the vehicle features that are present or absent (e.g., steering wheel) or if the feature was replaced by a new feature (e.g., key replaced by user authentication). Other features were added for completeness even if no standards currently exist (e.g., minimal risk condition activation). This portion of the effort developed a comprehensive list of features and supplemented them by evaluating industry concepts. The goal was to develop a framework that would key in on important aspects of

concept vehicles as they relate to current FMVSS (e.g., key/theft protection) or ways in which they might assist with the explanation of how some aspects of the vehicle that are now regulated by FMVSS might change in the future due to new features of these innovative new vehicle designs (e.g., user authentication).

Feature Categories

Another component of this research effort was the development of a framework to describe ADS-DV features. This framework was intended to focus on concepts that are impacted by the technical translations, concepts that would help the research effort anticipate how an ADS may perform the entire DDT without user intervention, and any safety-related aspects of interest. The framework began with the concepts presented in the Volpe Report and was expanded through discussions with industry partners and other research organizations. A subsequent SME review was conducted and revisions to this document were made based on feedback from the reviewers. In addition to this information, concepts presented online by different vehicle manufacturers and technology companies were analyzed. The first steps taken in the development process were to compile the feature descriptions from specific concepts specified in the Volpe Report. These are referred to below as "Volpe Concepts." Verbatim excerpts from that report are included below. (Referenced page numbers indicate page locations in the Volpe Report.)

Highly Automated Vehicle with Advanced Design

> The Advanced Design concept is capable of truly "driverless" operation and does not provide manual controls that would permit human driver operation. Not only does the vehicle not come equipped with a steering wheel, shifter, or pedals, but the design omits driver aids such as rear-view mirrors and cameras. The front seats can rotate 180 degrees. The vehicle retains a conventional windshield, equipment to aid in visibility (e.g., windshield wipers, defog/defrost, and exterior lighting), and telltales allowing the occupants of the vehicle (specifically, the person seated in the front left position) to monitor vehicle systems. (Kim et al., p. 6)

Further concept details (Kim et al., p. 23):

- Operator provides destination inputs via smartphone.
- Vehicle has no steering wheel, no brake pedals, and no shifter, so that human occupants cannot drive the vehicle. There is a panic button that may be depressed in case of an emergency.
- Vehicle has no side view mirrors and no back-up camera display.
- Vehicle does have [a] windshield, windshield wipers, windows, and defog/defrost, though vision angles may not conform to FMVSS guidance.
- Vehicle does have headlights, tail lights, and turn signals. These indicators would be able to be interpreted by non-automated vehicles and human drivers.

- Vehicle does have telltales visible to the front left occupant when the occupant is facing forward.
- Seats are arranged in a conventional manner, but occupants can spin front seats to face rearward.

Highly Automated Vehicle with Novel Design

> The ultimate incarnation of a driverless passenger vehicle, this concept omits any equipment that would otherwise be provided to allow for manual control or visibility outside the vehicle (mirrors, sun visors, windshield, windshield wipers, defog/defrost, headlights). Instead, the design emphasizes passenger comfort and convenience, providing a flexible, unconventional seating arrangement (making the designation of a "driver's seat" ambiguous). (Kim et al., p. 6)

Further concept details (Kim et al., p. 23-24):

- Operator provides destination inputs via smartphone.
- Vehicle has no steering wheel, no brake pedals, and no shifter, so that human occupants cannot drive the vehicle. There is a panic button that may be depressed in case of an emergency.
- Vehicle has no park[ing] brake system.
- Vehicle has no side view mirrors and no back-up camera display.
- Vehicle has no sun visors.
- Vehicle does not have [a] windshield, windshield wipers, and defog/defrost.
- Vehicle has small side windows that may be raised and lowered via control from an authorized smartphone.
- Vehicle has large video display devices mounted on the interior where the windshield/rear window would be. These can display video of [the] outside captured via cameras, or video of other media.
- The vehicle does not have headlights, but the vehicle is illuminated while driving in the dark.
- Vehicle does not have telltales in the vehicle, but vehicle information is available via smartphone interface.
- Vehicle does not have tail lights or turn signals, but rather could wirelessly communicate braking and turn signal indications to other vehicles.
- Seats are arranged in a new manner; "driver's seat" designation is no longer clear.
- Vehicle has no hood. All service is done on modules that may be removed from a lifted car.
- Vehicle is all electric and has no fluid fuel system.
- Climate control systems are operated by authorized occupants via smartphone.

Low-Speed Highly Automated Vehicle with Advanced Design

This concept is equivalent to the highly automated vehicle with advanced design described above but is limited to 25 miles per hour (Kim et al., 2016, p. 6).

Further concept details (Kim et al., 2016, p. 25):

- Operator provides destination inputs via smartphone.
- Vehicle has no steering wheel, no brake pedals, and no shifter, so that human occupants cannot drive the vehicle. There is a panic button that may be depressed in case of an emergency.
- Vehicle has no side view mirrors and no back-up camera display.
- Vehicle does have [a] windshield, windshield wipers, windows, and defog/defrost, though vision angles may not conform to FMVSS guidance.
- Vehicle does have tail lights and turn signals.
- The vehicle does not have headlights, but the vehicle is illuminated while driving in the dark.
- Vehicle does have telltales visible to the front left occupant when the occupant is facing forward.
- Seats are arranged in a conventional manner, but occupants can spin front seats to face rearward.

After reviewing these Volpe Concepts, the next step was to take the vehicle features for each of the concepts and group them into cohesive categories in the framework development process. These categories identify the main areas where ADS-DV concept designs could potentially warrant very specific terminology and specifications relating to FMVSS regulatory barriers (i.e., technical translation options). This work included expanding the features of interest to include features not described in the Volpe Report that may be necessary for the implementation of advanced and novel designs.

Figure 2 presents the reconfigured framework, further details, and operational definitions for the features.

Entry/Egress	External Communication	Occupant Protection
• Doors • Key/Theft Protection • User Authentication	• Auditory Indicator • Exterior Illumination • Stop Lamps • Taillamps • Turn Signals • Wireless Intent Communication	• Child Restraints & Anchorage Systems • Head Impact Protection • Head Restraints • Inflatable Restraints • Roof Crush • Seat Belts • Seating Configuration • Upper and Lower Extremity Restraints
User Communication	**Vehicle Control**	**Visibility**
• Minimal Risk Condition Activation • Mounted Displays • Portable Device Destination Input • Portable Device User Communication • Portable Device Window/Comfort Input • Safety Relevant Occupant Communication	• Accelerator/Brake Pedals • Bidirectional Vehicle Motion • Parking Brake System • Shifter • Speed Limiter • Steering Wheel • Tires	• Headlamps • Hood/Trunk • Mirrors • Rear Visibility System • Sun Visor • Window • Window Defog/Defrost • Windshield • Windshield Wiper

Figure 2. Categories and Features of Interest

ADS-DV Vehicle Classifications

Four generic classifications were developed as a means to categorize ADS-DVs to assist in development of the technical translation options for the FMVSS and to overcome potential regulatory barriers to compliance verification as this technology comes closer to reality on public roadways. These generic concept classifications form a hierarchy, with each subsequent classification level adding unconventional or even radically different (described as "radical" below) features of interest. An unconventional feature is defined as a vehicle feature that could face challenges in, or regulatory barriers to, meeting current FMVSS. An unconventional feature could modify or remove a feature that is currently regulated under FMVSS (e.g., altering seating configurations, removing a steering wheel). In cases where an associated FMVSS feature (assumed, regulated or referenced) is removed, an ADS-controlled function is implemented to replace it (e.g., "steering wheel" is removed and replaced with "steering control" as this implies the implementation of steering as an ADS-controlled function). A radical feature could be a feature that does not exist on conventional vehicles (e.g., a minimal risk condition activation). Furthermore, it is anticipated that improvements in ADS technology will lead manufacturers to release new ADS-DV models that build upon prior ADS-DV technology, creating a systematic evolution of a higher-level concept ADS-DV. In some instances, this will include augmenting a vehicle feature of interest already identified by this document as "unconventional."

The definitions of unconventional and radical features were weighed against current FMVSS: unconventional features could face challenges complying with current regulations, whereas radical features exist outside the current bounds of the FMVSS.

The *First Generation* ADS-DV concept is the most similar to a current production vehicle when compared to the other concepts, but also has many unconventional vehicle features (Figure 3). The unconventional features found in the First Generation ADS-DV concept are within the user communication, vehicle control, and visibility categories. No radical features are found within this concept.

Figure 3. Renderings of First Generation ADS-DV Concept

The *Transitional* concept encompasses the same unconventional features as the First Generation concept, but starts to add unconventional external communication features as well as unconventional user communication, unconventional occupant protection systems, and unconventional visibility features (Figure 4). A limited number of radical features are found in this concept classification.

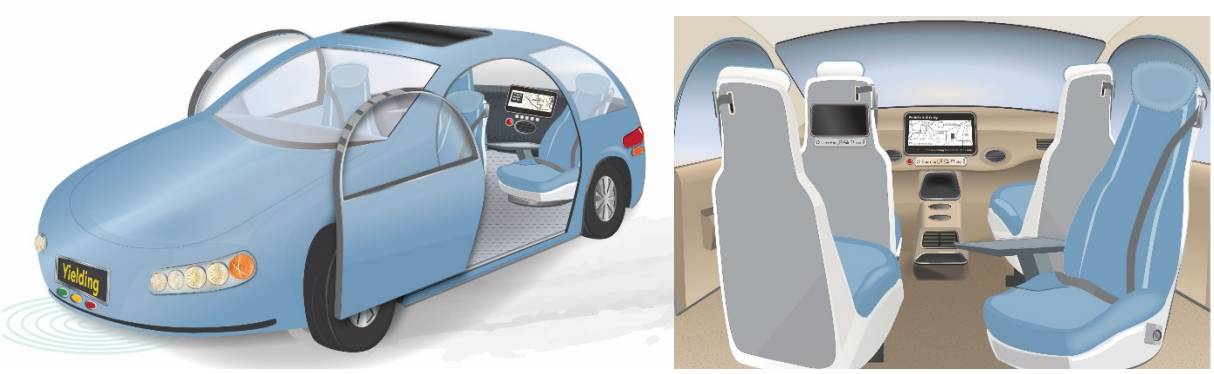

Figure 4. Renderings of Transitional ADS-DV Concept

For the *Revolutionary* ADS-DV concept, virtually all features of interest are at least unconventional, and several are deemed radical (Figure 5). In the Revolutionary ADS-DV concept, there are many innovative vehicle features, such as bidirectional vehicle motion,

reconfigurable seating, unconventional occupant protection systems, and particular features for sensor visibility.

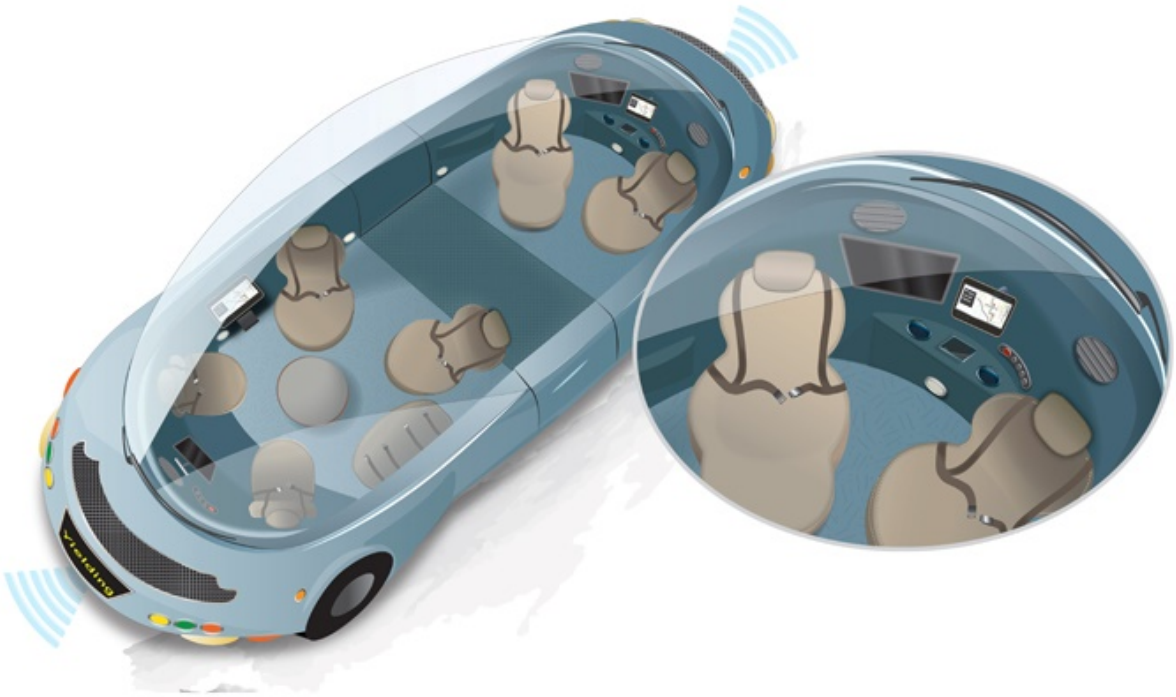

Figure 5. Rendering of Revolutionary ADS-DV Concept

The *Low-Speed* ADS-DV concept is most similar to the Revolutionary ADS-DV concept; however, this classification is limited to vehicles that have a maximum capable speed of 25 mph (40 km/h). The Low-Speed ADS-DV concept includes vehicles that could be used for mass transit in urban areas (Figure 6). It should be noted that this category of vehicles would not necessarily fall within the definition of a low-speed vehicle. For example, this vehicle may exceed the GVWR limit of 1,361 kg (3,000 pounds) that is currently specified in the definitions of "low-speed vehicle" in 49 C.F.R § Part 571.3.

Figure 6. Renderings of Low-Speed ADS-DV Concept

TECHNICAL TRANSLATION PRINCIPLES

The process developed for the technical translations resulted in a set of principles that were followed throughout this effort:

- Technical translations should not dictate or assume policy decisions; they should only provide options.
- Technical translation types and the reason for any inability to translate a specific provision should follow the taxonomy framework described in Chapter 2 of this report.
- If the standard's language works today, it should not be changed. Technical translations should be provided only if necessary to address ADS-DVs.
- Use straightforward technical translations where possible to minimize changes to the current regulatory language.
- Technical translation options should be considered as a whole to develop a consistent overarching approach, where suitable. The effort was to use common themes that cut across standards.
- Incorporated references by external organizations cited within the standards could present potential regulatory barriers. Thus, the incorporated by reference standards should be evaluated in the same manner as the regulatory text that appears in the CFR.
- To the extent possible, develop technical translations that will enable manufacturer certainty and allow NHTSA to verify compliance with FMVSS requirements, taking into consideration both near- and long-term implementation in order to alleviate regulatory barriers.

CHAPTER 2. TECHNICAL TRANSLATION PROCESS

PERFORMING TECHNICAL TRANSLATIONS

Following are the steps taken to conduct the technical translations. Potential ADS-DV barriers indicating a need for translations were analyzed at two levels: (1) regulatory language, including performance requirements and test procedures, and (2) implementation of test procedures. Several parts of the regulatory language include standards that are incorporated by reference (e.g., ANSI, ASTM, ISO, SAE). The standards incorporated by reference are part of the FMVSS regulatory language and were analyzed in the same way as the rest of the regulatory text.

Technical Translation Data Sources

In order to complete the technical translation exercise, several pieces of regulatory data and related information were obtained for the analysis. This included the language from each standard and supporting documents, including laboratory test procedures, which the expert leads for each of the standards reviewed as a starting point to the development of the technical translation options. An assessment of the regulatory barrier was made and considerations associated with the technical translation options were captured. In addition, members of the Core Team Expert Group reviewed and commented on the completeness of the translations.

Technical Translation Types and Inability to Translate Reasons

The following taxonomy was used to categorize the analysis performed for each FMVSS. This initial framework allows for the accommodation of options as they evolve or as information develops throughout the technical translation process. The regulation translation assessment code is a categorical variable ranging from 0 to 2. The code assigned to each standard's technical translation conveys the appropriate category (Table 5). Codes are used to categorize the considered translations throughout the technical translation development process. The technical translation type and assessment reason can be found in the individual standard translation worksheet. **Appendix B** includes the technical translation worksheets for each of the FMVSS of focus during near-term research.

Table 5. Technical Translation Taxonomy

Reason	Technical Translation Type Description
0 – Not performed	Translation evaluated but not performed.
1 – Translation is straightforward	The Translation performed is straightforward.
2 – Limited Research may be beneficial	Can translate standards or provisions of standards, maintaining current performance levels, with some limited amount of research for NHTSA to conduct compliance verification for both conventional vehicle designs and new vehicle designs associated with automated driving system – Dedicated Vehicles (ADS-DVs).

KEY CONSIDERATIONS

Crash Avoidance

Addressing an inherent assumption throughout 49 C.F.R § Part 571—that a human driver is operating the vehicle using manually operated driving controls—presents one of the biggest challenges to the translation of the 100-series standards. As depicted in the Concept Vehicles section, even the First Generation ADS-DV, which is the most similar to a current production vehicle, may have many unconventional vehicle features (e.g., removal of manually operated driving controls and visibility features which are specific to the human driver's safe performance of the DDT). The approach used to define "driver" and "ADS" was a key consideration for removing 100-series regulatory barriers to ADS-DVs. This was discussed in the Definitions section in Chapter 1 and additional details are provided in Chapter 3.

Standards that specify the manner in which a vehicle is controlled, such as driving the vehicle, activating the engine, gear selection, or service brake application, required careful review and a consistent translation approach. In general, these items were addressed by specifying a state rather than a specific action and/or using a generic method to achieve the action. As an example of the generic approach, FMVSS No. 102, S3.1.3.1 currently expresses that, "After the driver has activated the vehicle's propulsion system: (a) The engine may start and stop when the transmission shift position is in any forward drive gear." This could be translated to "After the vehicle's propulsion system has been activated: (a) The engine may start and stop when the transmission is in any forward drive gear."

The regulatory language was reviewed to determine if a translation may be needed to remove a barrier to compliance verification of an ADS-DV. For example, S6.2.3 (a) of FMVSS No. 114 states the following: "Drive the vehicle forward down a 10 percent grade and stop it with the service brakes." Upon initial review, one might consider translating this provision, as suggested in the FMVSS Scan Approach undertaken in the Volpe Report (Kim et al., 2016, p. 3), given that the text contains language referring to driving, stopping, and service brakes. However, the current language does not reference who is driving, stopping, or applying the brakes. Therefore, in accordance with the strategy of providing technical translation options only when it appears that there may be a regulatory barrier for an ADS-DV, this test condition was not translated.

In current vehicle designs, the flow of information from the vehicle to the human driver is dependent upon visibility, sound, and lighting of the environment. The delivery of the information is communicated using telltales, indicators, and auditory alerts and provides important safety information to the human driver and any passengers. Potential approaches to developing technical translation options for these concepts, such as the low tire pressure warning telltale required by FMVSS No. 138, elicited a range of SME reviewer feedback and was a central topic of discussion at the April 2018 FMVSS Stakeholder Meeting (VTTI, 2018a, 2018b). In order to aid in the development of the translations, an analysis of the information currently required to be communicated to the driver was completed. This analysis included reviewing what information is communicated, the delivery method, who it is intended for, and the expected response (**Appendix C**).

In most cases, it was determined that language in the 100-series standards could be addressed with straightforward clarification through potential rulemaking or interpretations, and therefore the regulatory language was assessed as a 0 (technical translation evaluated but not performed) or a 1 (technical translation is straightforward). However, many of the test procedures in the regulatory text were assessed as a 2 (limited research may be beneficial). Several of the items assessed as a 2 related to the potential compliance verification challenges. The development of methods that may allow NHTSA to perform the test procedure to verify the compliance of ADS-DVs is one of the aspects to removing regulatory barriers. Test procedures are discussed further below in the Test Procedure section.

Documents incorporated into the FMVSS by reference (see 49 CFR § 571.5) were evaluated using the same method as was used for the rest of the regulation. For example, FMVSS No. 108 refers to 17 different incorporated reference documents, although many of those documents may not pose a barrier and will not require technical translation (see **Appendix D**). Nonetheless, through rulemaking, NHTSA can change its incorporation by reference of those documents, and can decide to no longer incorporate them or to adopt them in part, or can incorporate a different document.

Several of the near-term standards are associated with Congressional mandates. These mandates were taken into consideration during the development of the technical translations to ensure that the options presented would retain the performance requirements associated with these mandates, but a full legal analysis was not conducted.

Crashworthiness and Occupant Protection

The aim of the 200-series standards is to reduce the risk of injury in the event of a crash. In a crash, the person seated in the driver's DSP experiences a risk of injury from the steering control system that is different from the risk experienced by the other occupants of the front seat (or occupants of the rear seats). The language of several of the 200-series FMVSS reflects this difference in injury risk by specifying requirements or test procedures that differ by seating location. Two examples are FMVSS Nos. 203 and 204, which specify requirements to minimize injury risk from the steering controls.

Many of the FMVSS in the 200-series use the terms "driver," "driver's seat," "driver's designated seating position," and similar terms, which might appear at first inspection to require translation. However, the occupant protection provisions of the 200-series are associated with the potential hazards to occupants at various seating positions rather than the role of the occupants seated at those locations. Additionally, the FMVSS require vehicles to comply with numerous requirements intended to protect persons in that driver's seat but most do not explicitly state that a vehicle must have a driver's seat. The one exception, S4.1 of FMVSS No. 207, which currently specifies, "Each vehicle shall have an occupant seat for the driver." This FMVSS is part of the standards that will be evaluated during mid-term research. At that point, potential barriers and options for technical translations will be provided, if appropriate.

The team believes that the clarification and use of the term "driver's DSP" and its associated definitions greatly simplifies the FMVSS technical translations. Language that refers to the driver's DSP or a similar term may not require technical translation. If a vehicle does not have a

driver's DSP, then all DSPs become passenger DSPs, and only the FMVSS sections referring to a passenger DSP would apply to these seating positions. This would be the case for an ADS-DV. (Of course, conventional vehicles all have a driver's DSP and, therefore, would be required to meet all FMVSS requirements associated with protection of occupants seated at that position.) For example, FMVSS Nos. 203 and 204 have requirements and test procedures associated with a steering control system and, therefore, their application to vehicles with manually operated driving controls is clear. No technical translation of these standards was performed for ADS-DVs, since no manually operated driving controls are present.

In some FMVSS, the terms "driver side" or "passenger side" are used to define vehicle landmarks. In some instances, technical translation options were provided to modify these terms to "left side" or "right side," respectively.

Identifying Crosscutting Themes

A common set of crosscutting themes was developed as part of the potential technical translations for the crash avoidance (100-series; Table 6) and crashworthiness (200-series; Table 7) standards. Identifying crosscutting themes assisted in maintaining consistent technical translation approaches and identifying the reasons for technical translation when they were unique. The crosscutting themes not only support the work taking place within the 100-series and 200-series but also provide a platform to work across the series and identify which technical translation concepts might need to be coordinated. These themes were also used to review the technical translation concepts during the April 2018 FMVSS Stakeholder Meeting (VTTI, 2018a, 2018b), which is summarized later in this chapter.

For the 100-series, 10 common themes that cut across the standards were identified and designated for near-term research (Table 6). The crosscutting themes not only supported consistency in options but allowed technical translation approaches to be grouped and further analyzed. These groupings were themes that directly influenced the technical translation approaches that were used across multiple standards (e.g., driver and controls, telltales, indicators and alerts). These themes were discussed in the previous Key Considerations section.

Table 6. Crash Avoidance Crosscutting Themes

Themes	102	108	114	118	138	141
Congressional Mandate			•	•	•	•
Controls, Telltales, Indicators, and Alerts	•	•	•		•	
Driver (Operator)	•	•	•		•	
Driver/Passenger Position/Presence	•	•	•	•		
Equipment May Not Be Applicable		•	•			
Front/Rear of Vehicle		•				•
Service Brake Application	•	•	•		•	•
Shift Position (Gear, Selects, Reverse)	•	•	•			•
Vehicle Loading Including Test Driver and Instrumentation			•		•	•
Visibility		•				

In developing technical translations for the 200-series standards designated for near-term research, the crosscutting themes shown in Table 7 were identified.

Table 7. Crashworthiness and Occupant Protection Crosscutting Themes

Themes	201	202a	203	204	205	206
Assumes Front Row is Preferred Seating Position	•	•	•	•		•
Controls, Telltales, Indicators, and Alerts						•
Driver (Operator)	•	•	•		•	•
Driver/Passenger Position/Presence	•	•				•
Dummy Positioning	•	•				
Equipment May Not Be Applicable			•	•		
Front/Rear of Vehicle	•	•				•

The differences between the crashworthiness protection offered to occupants of the front seats compared to occupants of the rear seats in many of the 200-series standards will be considered during mid-term research. If front and rear seat occupancy remains similar between conventional vehicles and ADS-DVs, this does not present a significant challenge for ADS-DVs with conventional, forward-facing seating, but will need to be addressed in the context of non-traditional seating configurations.

Controls, Telltales, and Indicators

Telltales, indicators, and audible alerts are designed to convey information to the driver and, sometimes, to other occupants of a vehicle. As mentioned in the Crosscutting Themes tables (above), a number of standards require controls, telltales and indicators and some of the standards specify performance requirements for those features. In addition to these standards, FMVSS No. 101, "Controls and Displays," contains the requirements for location, identification, color, and illumination of motor vehicle controls, telltales and indicators. For example, FMVSS No. 101 S5.1.2 specifies, "The telltales and indicators listed in Table 1 and Table 2 must be located so that, when activated, they are visible to a driver...." Although the FMVSS No. 101 standard will not be addressed in detail during the near-term research, certain aspects were considered, since several of the standards designated for near-term research include requirements for controls, telltales, and indicators.

In general, the performance requirements for controls, telltales, and indicators are contained within the individual standards and are designed to be used by, or convey information to, the driver of a vehicle and, in a few cases, to other occupants. Because the driver's action in response to a telltale is not currently regulated, providing an option that the ADS perform a certain action as a result of a telltale warning is beyond the scope of this project. Nevertheless, the premise of providing a driver a warning indicates the expectation that a response will be initiated based on that warning. Therefore, as a first step, in order to develop the different technical translation options, an analysis of the driver's expected response to telltales and alerts was conducted. When no FMVSS-related sources were found, a combination of language from owner's manuals and/or the researchers' collective knowledge was applied. The objective of this part of the research project was to: (1) identify standards that require controls, telltales, indicators, or alerts; (2) attempt to decipher the "expected response" of a driver and/or occupants to these features today; (3) present options for technical translations; and (4) identify the consideration associated with the options.

Table 8 outlines the four areas that were used in the analysis: (1) information communicated, (2) delivery method, (3) intended for, and (4) expected response.

Table 8. Analysis of Regulatory Information Communicated in Vehicles

Categories	Analysis Questions	Examples
Information Communicated	What is communicated? What type of communication?	Engaged, warning, malfunction, identification
Delivery Method	How is information delivered?	Illumination of a telltale, auditory alert, indicator
Intended For	Whom is the information for?	Driver, non-driving occupants, maintenance entity
Expected Response	What action is expected in response to information?	After a low tire pressure warning is activated, someone is expected to check the tire(s) and take appropriate action

Appendix C captures the results of the analysis, and a few examples of the expected responses are included below.

- Some FMVSS explicitly state who the information in question should be communicated to, and some specify the expected response. An example of the latter category is S4.5 (a) of FMVSS No. 138, which requires owner's manual language that describes the expected response: "when the low tire pressure telltale illuminates, you should stop and check your tires as soon as possible, and inflate them to the proper pressure."

- Other provisions do not explicitly specify an expected response. For example, FMVSS No. 108, S9.3.6 sets forth requirements to indicate to the driver a turn signal lamp failure, but there is nothing in the standard that specifies what the driver should do following such a malfunction indicator. However, such information may be included in vehicle owner's manuals. See, for example, the owner's manual for the model year 2018 Ford Fusion, at p. 92: "If the turn signal indicators stay on or flash faster, check for a burned out bulb" (Ford Motor Company, 2018) and the owner's manual for the 2018 Toyota Camry, at p. 211: "If the indicator flashes faster than usual, check that a light bulb in the front or rear turn signal lights has not burned out" (Toyota Motor Sales U.S.A., Inc., 2016).

From the analysis, 10 potential options for technical translation of provisions that specify where or to whom a telltale, indicator, or alert is directed in ADS-DVs were developed.

Communication information:

Potential Option 1. To the ADS only.
Example: In an ADS-DV, the information would be required to be communicated to the ADS. The standard would not have performance requirements to provide the information to the occupants.

Potential Option 2. To the ADS and provide to occupants per the current standard location.
Example: This option would require an ADS-DV to be equipped with telltales and indicators in the same manner as standards require for vehicles today, which would generally mean that

information would be provided to the left, front seating position, if one existed. However, there may be some information provided to other locations, such as the right, front seating position or associated with a particular seating-position-adjacent door opening.

Potential Option 3. To the ADS and all front DSPs.
Example: This option would require an ADS-DV to be equipped with telltales and indicators that would be provided to the front row seating positions. This option aligns with a few of the mid-term standards and was predominantly used in the crashworthiness standards.

Potential Option 4. To the ADS and DSPs as specified by the vehicle manufacturer.
Example: Similar to Option 2, the information would be communicated to the ADS but the location, identification, color, and illumination of information provided to the occupants would be specified by the vehicle manufacturer.

Potential Option 5. To the ADS and an occupant compartment maintenance screen or panel.
This option presents the idea of a maintenance message, as it is possible that none of the occupants of an ADS-DV would be responsible for, or have the ability to perform, maintenance; another person or entity may be responsible for the ADS-DV's maintenance. This may be an option to help ensure maintenance information is available to those who need it in a consistent location and manner. It should be noted that the responsible person/entity may not be present in the vehicle to receive the information in real-time.

Potential Option 6. To the ADS and all DSPs.
Example: Similar to the above options (1–4), the information would be communicated to the ADS but it would also require all safety-relevant information to be provided to all occupants.

Potential Option 7. To the occupants per the current standard location and not to the ADS.
Example: This option was not used in the near-term standards but may be considered for the mid-term research. For example, the passenger air bag deactivation light (i.e., S19.2.2 [e]) of FMVSS No. 208 provides that the telltale, "Shall be visible and recognizable to a driver and right front passenger during night and day when the occupants have adapted to the ambient light roadway conditions." An option that could be considered is to provide the passenger air bag deactivation light to just the left and right front seating positions.

Potential Option 8. To the occupants as specified by the vehicle manufacturer and not to the ADS.
Example: The information would be required in the occupant compartment; however, the manufacturer would determine the location, identification, color, and illumination. The standard would not require the information to be communicated to the ADS. This option was also not used during the near-term research but may be considered in the mid-term research.

Potential Option 9. To all DSPs and not to the ADS.
Example: This option would require all safety-relevant information to be provided to all occupants but would not require the information to be communicated to the ADS. Similar to Options 7 and 8, this option was also not used during the near-term research but may be considered in the mid-term research.

Potential Option 10. To no entity: not communicated to the ADS or occupants.
Example: This last option could cover telltales that provide information potentially relevant for human drivers but would not necessarily be needed for the ADS or the occupants of an ADS-DV. These are telltales that are designed to remind a human driver of some condition that they initiated, as opposed to a notification of a component or system failure. For example, a human driver may need to be reminded that the turn signal is still activated after a turn or a lane change is completed. An ADS controlling the turn signals presumably would know the status of these controls and would not "forget" they were activated, except in cases of malfunction. Therefore, it may not be necessary to require such information to be communicated to the ADS. The project team recognized that NHTSA's February 4, 2016, letter to Google stated, ". . . Similarly, telltales and indicators must also be 'visible' to the [ADS]. For purposes of both S5.1.1 and S5.1.2 [of FMVSS No. 101], we interpret the [ADS] to be the 'driver.'" However, NHTSA's interpretation was specific to Google's incoming letter, in which Google asked if the telltales would be "visible" to the ADS and did not consider other options.

As mentioned in the above outline of the 10 potential options for translation, not all of the options were used in the translation of each standard; selections were made based on the Technical Translation Principles discussed in the general considerations along with the results of the analysis of regulatory information communicated in vehicles. Using FMVSS No. 108 lamp failure as an example, the expected response is to check for a burned out bulb and replace it, if necessary (Ford Motor Company, 2018, p. 92; Toyota Motor Sales U.S.A., Inc., 2018, p. 211). In order for the responsible entity to know to check for a bulb failure, that entity would need to be provided the lamp failure information. Therefore, the above Options 2, 4, 5 and 6 were used to develop the potential turn signal lamp failure technical translation options that provide the telltale in a range of occupant compartment locations. These options also all communicate the bulb failure to the ADS.

At the time of this report submission, the analysis of the standards designated for mid-term is in progress and may impact the near-term research findings of regulatory information communicated in vehicles. Additionally, vehicles equipped with an ADS level 3 automation system may require further considerations outside the scope of this project. For example, some of the technical translation options have the telltales displayed only when a human driver is operating the vehicle. However, in a vehicle equipped with a level 3 ADS, there may be a reason to display the telltales when a human is seated behind the manually operated driving controls even when the ADS is operating the vehicle. In that case, the occupant behind the manually operated driving controls is considered the fallback ready user. Based on SAE International's Recommended Practice J3016, the driver "is able to operate the vehicle and is receptive to ADS-issued requests to intervene and to evident DDT performance-relevant system failures in the vehicle compelling him or her to perform the DDT fallback." In order to understand the DDT, information relevant to the task, such as a telltale, indicator, or alert, should be available. The length of time the information is available before the request to intervene has not been researched (e.g., continuously available, 1 minute before). Although this effort provided a foundation for translating the regulations, more research above and beyond current literature reviews may be needed to further evaluate the safety-relevant information for occupants.

One of the areas of discussion that surfaced during the analysis was related to FMVSS No. 138, S4.5, which requires that the following written instructions be included in the vehicle's owner's manual: "Please note that the TPMS [tire pressure monitoring system] is not a substitute for proper tire maintenance, and it is the driver's responsibility to maintain correct tire pressure, even if under-inflation has not reached the level to trigger illumination of the TPMS low tire pressure telltale." This statement could possibly be translated as follows (Option 1 in the FMVSS No 138 worksheet): "Please note that the TPMS is not a substitute for proper tire maintenance, and it is imperative that the vehicle's tires are maintained to the correct tire pressure."

The considered technical translation still provides the written instruction on the importance of maintaining proper tire pressure. However, the responsibility for ADS-DV maintenance, such as maintaining correct tire pressure, may no longer be the human driver's. Rather, it could be the vehicle's owner and/or a fleet management company that would need to have access to the owner's manual information. Today's vehicles are equipped with owner's manuals that are largely intended for the driver and cover a variety of topics, such as feature functionality, safety, vehicle operation, and maintenance. However, some information in today's owner's manuals, such as how to adjust the head restraints, is relevant to passenger occupants. Specifically, FMVSS No. 202a, S4.7 requires the owner's manual to provide clear instructions on how to position and use the head restraints. With an ADS-DV, the method of communicating the required regulatory written instructions—which is typically provided in the vehicle owner's manual—may change.

Test Procedures

As with controls, telltales, indicators, and alerts, standards from near-, mid-, and long-term research were considered during the development of the approach chosen for testing ADS-DVs. For example, in addition to the standards designated for near-term research, methods to test compliance for the requirements of FMVSS No. 126, Electronic Stability Control System (which is designated for mid-term research) were also considered, since that standard contains more demanding and complex test requirements. While not the focus of this report, where appropriate to aid in the discussion, this standard has been included to explain the overall approach used for the test procedure related research.

Crash Avoidance

At a high level, the goal was to identify the equipment and/or procedures that may help NHTSA perform compliance verification on ADS-DVs without manual controls. Due to the permutations of the generated FMVSS technical translation options and test methods that could allow NHTSA to verify compliance, it would be impractical to provide line-by-line language translations for each aspect of the test procedures. Instead, the focus was on developing and evaluating test methods to exercise the required vehicle functionalities.

Approach

The following outlines the approach being undertaken as part of the near-term crash avoidance research. These six steps will be discussed in further detail.

1. Classification of standards
2. Selection of standards for inclusion
3. Implementation and execution
4. Evaluation of test methods
5. Iteration of testing and evaluation of results as necessary
6. Validation of test platform and execution

As noted above, even though the approach being used is in the context of the standards designated for near-term research, it will be applied to all FMVSS. In addition, the initial classification and the subsequent selection of standards for this effort also took standards from mid- and long-term research into account. The implementation, execution, and evaluation of the testing was designed to first be applied to standards containing functionalities with less demanding requirements to verify the test platform and test methods. Subsequent testing will include standards that have unique requirements and more demanding test procedures, such as FMVSS No. 126, which has more exacting steering requirements. The expectation is that this approach will provide a sufficient set of test cases to allow the selection of an appropriate test method that could be applicable for any requirements and associated test procedures.

Before discussing the approach used in more detail, the five potential methods identified for verifying compliance are outlined below. These methods were grouped into two categories based on whether the physical vehicle would be used to execute test procedures in the compliance verification process. Vehicle-based methods would employ the physical vehicle to execute the test procedures to verify compliance in a manner similar to the procedures used today. Non-vehicle-based methods would not execute the test with the physical vehicle being evaluated but would instead use detailed technical documentation about the vehicle design or simulation of vehicle operation and performance to assess compliance. These five methods will be discussed in further detail in the Implementation section. These methods fall into two general categories.

Vehicle-based

Human control: Testing is performed using a controller console, connected either physically or through a wireless link (which could include teleoperation), to provide manual driving control.

Programmed control:

- Scripted control – A standard set of commands (e.g., “start engine,” “apply parking brake,” “speed = *x*”) is used to define the actions the ADS is required to take to execute the test.

- Pre-programmed routine – The steps for executing the test are predefined and compiled into a script that can be run but not modified in the field.

ADS normal operation: The normal operation of the ADS is used to perform some or all of the test procedure.

Non-vehicle-based

Simulation: Simulation, either solely software-based or including a hardware-in-the-loop solution, is used to execute the test procedure.

Technical design documentation: Vehicle-specific technical design and/or build documentation which provides sufficient information and detail to show the system in question was designed to be in compliance with part or all of a particular standard. It should be noted that this is different than the Test Specification Forms provided to NHTSA when a vehicle is selected for potential verification testing. Instead, it is technical design documentation used by the manufacturer in the design, construction, and validation of the vehicle. This could include items such as a wiring diagram, code segments, or performance test data.

Some of the above methods are believed to be more appropriate for some standards than for others. For example, normal ADS operation may be appropriate for executing the system calibration drive on the specified public roadway as the first step in testing the functionality of the TPMS under FMVSS No. 138, but may not be applicable for executing the rollaway prevention test procedures in FMVSS No. 114, which require a particular sequence for engaging and disengaging the service and parking brakes. An ADS-DV that was programmed to always engage the parking brake when the vehicle stops would not allow the test procedures outlined in FMVSS No. 114 for rollaway prevention (which requires the vehicle to be parked without the parking brake engaged) to be conducted with normal operation of that ADS. Given the variation in functionalities and requirements within the standards, a hybrid approach may be more effective, where a combination of methods is used for a given standard or portion of a standard. This may be relevant for the non-vehicle-based methods which could possibly use a physical test or set of tests to provide a reference with the production vehicle.

It should be noted that the non-vehicle-based test methods do not explicitly check the physical performance of the vehicle. Except for FMVSS No. 126, which uses a form of technical design documentation as part of compliance verification (TP126-02, Section 13.1), NHTSA does not use non-vehicle-based test methods to verify compliance. Instead, OVSC selects vehicles from dealerships to conduct physical testing to verify the vehicle meets the standard. Testing an actual vehicle ensures the manufacturer's quality control, manufacturing processes, and materials used to make the selected vehicle all "match" the design. Consequently, simulations or technical design documents may not be able to provide the level of certainty for compliance that is achieved through execution of a physical test with a vehicle.

Classification of Standards

Since the goal of the project was to investigate a representative subset of the standards, this subset needed to cover the spectrum of requirements within the current standards and associated test procedures. The following questions were considered when evaluating the functionalities

required to execute the test procedures used by NHTSA to verify compliance with the FMVSS requirements, as well as in determining test procedure complexity and applicable test methods.

- Does the standard include regulatory language for test set-up and execution?
- Does the standard have an associated OVSC test procedure?
- Are there specific sequences or requirements for vehicle functionality?
- Are there specific requirements for driver controls relating to the relevant DDTs?
- How many functionalities are needed to execute the test procedure or demonstrate compliance with the requirement?
- How many potential test methods are technically feasible (e.g., programmed control, simulation)?

The first step was to identify functionalities required by the FMVSS and any associated test procedures. For example, S5.3 of FMVSS No. 114, Theft Protection and Rollaway Prevention, requires application of the service brake prior to the transmission being shifted out of Park This is a specific vehicle functionality requirement. In contrast, the laboratory test procedure for backup cameras (TP-111V-01, Section 7) associated with 49 CFR § 571.111 Rear Visibility includes instructions to, "Start the vehicle, initiate and complete a backing event." The vehicle functionality needed to execute the test procedures associated with this FMVSS includes ignition, steering control, speed control, gear selection and service brake application. Note that this procedure was developed to assess compliance with the existing requirements. If those requirements are translated to apply to the sensor systems in ADS-DVs, a different technical translation could result in the need to develop a different test procedure. However, if a method or methods to exercise these functions is demonstrated, those same methods can possibly be applied to new or modified procedures supporting other FMVSS technical translations.

It should be noted that while the test procedures are not requirements, they do capture functionalities that are often implied by the regulatory text (e.g., to test the requirements of the backup camera, the vehicle will be started and backed up) and which NHTSA currently uses to verify compliance.

The crashworthiness standards include some of the same functionalities identified in the 100-series. For example, the telltales for air bags and seat belts are set forth in FMVSS No. 208 (which is part of mid-term research). The methods that are tested and evaluated for telltales in the 100-series standards (crash avoidance) should be directly applicable to the same functionalities in the 200-series.

Table 9 shows the Phase 1 crash avoidance FMVSS and the associated functionality requirements that are either specified in the FMVSS or that are necessary to execute the associated test procedures. These are organized into categories shown in the first column. The first four categories apply to vehicle operation and the last category (driver's environmental awareness) addresses items that allow the driver to perceive the environment outside the vehicle. Within the categories, the functionalities are grouped (e.g., vehicle position control, braking) and ordered by use and occurrence within the standards.

Table 9. Functionalities Identified in Near- and Mid-Term Standards and Test Procedures

Category	Functionality	101	102	103	104	108	110	111	113	114	118	124	125	126	138	141
Driving Tasks	Steering Control						●	●		●				●	●	●
	Speed control (vehicle/engine)			●	●		●	●		●		●		●	●	●
	Service brake application						●	●		●				●	●	●
	Parking brake							●		●						●
	Gear Selection		●	●	●		●	●		●				●	●	●
Vehicle Communications	Telltales/ warnings/indicators	●	●			●				●		●		●	●	
Key/Ignition Function	Key insertion/ removal									●						
	Ignition start/stop		●	●	●		●	●		●	●	●		●	●	
	Accessory mode									●	●					
Non-driving Tasks	Door open/close									●	●					
	Non-driving controls			●	●	●		●			●					
Environment Awareness	Visibility	●		●	●			●	●							

Identification of specific functionality is necessary, but is insufficient as the sole means of selecting FMVSS to obtain the desired research results. Since the goal is to provide an evaluation of the different compliance verification methods, it is also useful to consider which standards are candidates for demonstrating different methods, the complexity of the OVSC test procedures, the specific requirements for the functionality, and allowing for opportunities to include normal ADS functionality. This last item is not critical, but may allow for a straightforward execution and thus may be relevant in the future for evaluation of basic ADS operation.

The following provides a description of each column in Table 10.

- *FMVSS*: lists the standards
- *OVSC Test Procedure*: indicates if there is an associated OVSC test procedure
- *Specific Sequence*: indicates if the test procedures specify a unique sequence (e.g., S6.2.2 of FMVSS No. 114: stop with service brake, apply the parking brake, move gear selection to "Park," release the parking brake, release the service brake, remove the key)
- *DDT*: indicates whether the requirements or test procedures include driving task functionalities
- *Method*: indicates test methods that may be applicable

For those standards that have no OVSC test procedure, no testing is being performed during this phase of the project. However, the functionalities identified for these standards will be included in the final analysis linking the test methods with the functionalities identified in Table 9. Though part of the mid-term research, FMVSS No. 126 is also shown since it was included in

the classification and selection process. The assignment of a given method to a given standard is based on the functionalities contained in the regulation and an evaluation by the research team as to how well a given method may provide meaningful information regarding the operation of a given function. For example, FMVSS No. 138 addresses the TPMS. While a simulation could be used to show the electrical system associated with the TPMS, if used, it would likely be more effective as part of the technical design documentation method. Therefore, it was not included in the method list for FMVSS No. 138.

Table 10. Phase 1 Standards Classification Summary

FMVSS	OVSC Test Procedure	Specific Sequence	DDT	Method*
102	No	No	No	HC, P, D
108	Yes	No	No	n/a
114	Yes	Yes	Yes	HC, P, D
118	Yes	Yes	No	HC, D, ADS(?)
138	Yes	No	Yes	HC, P, ADS, D
141	Yes	Yes	Yes	HC, P, ADS, D
126	Yes	Yes	Yes	HC(?), P, S

** HC = human control; P = programmed; ADS = normal ADS operation; S = simulation; D = documentation, n/a = current verification method may be adequate; (?) = may be possible*

Selection of Standards for Inclusion

Table 11 provides a summary of the subset of Phase 1 standards selected for inclusion in the subsequent steps for evaluating test methods and developing generalized test procedures based on the identified functionalities. Test procedures from FMVSS Nos. 114 and 138 were selected for near-term testing as they capture many of the FMVSS functionalities (see Table 9). FMVSS Nos. 114 or 138 are necessary to demonstrate these functionalities but they are not sufficient to confirm the ability to execute the precise speed and lateral control required by some of the standards, such as FMVSS No. 141. Consequently, the higher precision requirements for these functionalities will be included in the generalized test procedures.

FMVSS No. 126 was also included in the selection. This standard was included because it provides a more complex test procedure and has unique and specific inputs to certain vehicle controls (i.e., the steering wheel) that do not exist in the functionalities associated with the standard in near-term research. FMVSS No. 110 was also assessed but is currently not included. However, S4.4.1(b) of that standard states, “In the event of rapid loss of inflation pressure with the vehicle traveling in a straight line at a speed of 97 kilometers per hour, [the rim shall] retain the deflated tire until the vehicle can be stopped with a controlled braking application.” This necessitates unique steering system control requirements that are not tested in the other standards (i.e., being able to steer the vehicle for normal driving conditions as required in FMVSS No. 138

does not ensure that the vehicle will be controllable in an emergency situation). As the test procedure work progresses, FMVSS No. 110 and its unique functionality requirements may be considered further.

Table 11. Status of Phase 1 Standards for Implementation

FMVSS No.	Implementation Status	Reasoning
102: Transmission shift position sequence, starter interlock, and transmission braking effect	Not Included	No test procedure and minimal functionalities
108: Lamps, reflective devices, and associated equipment	Not Included	Primarily component-level testing
114: Theft protection and rollaway prevention	Included	Many functional requirements with specific sequence requirements
118: Power-operated window, partition, and roof panel systems	Not Included	Non-driving controls which can be demonstrated with other driving-based controls
126: Electronic stability control systems for light vehicles	Included	Complex test procedure requirements with very specific input requirements
138: Tire pressure monitoring systems	Included	Good example of normal ADS test method
141: Minimum Sound Requirements for Hybrid and Electric Vehicles	Not Included	Requirements covered in FMVSS No. 114

Since the intent is to test specific functionalities, it was unnecessary to test FMVSS Nos. 114 and 138 in their entirety. Instead, key portions of the standards and associated test procedures were selected to assess the ability of ADS-DVs to be tested in order to demonstrate compliance with the rest of the requirements in those standards, in addition to the other FMVSS that were designated for near-term research.

Implementation and Execution

Following selection of the standards, it was necessary to develop a test platform that could execute the functionalities in a manner similar to an ADS-DV and to develop the hardware and software needed to perform the specific requirements identified in FMVSS Nos. 114 and 138.

Prepare Test Platform

A 2013 Cadillac SRX was selected for the test platform. The SRX was chosen because it had some automated functionality, which minimized both the cost and the development time required to prepare the vehicle for test execution. Table 12 provides a summary of the modifications made to the test platform to provide automated control of the functionalities identified in the FMVSS.

Table 12. Test Platform Modifications for ADS Functionality

Function	Control
Steering	Motor attached to steering shaft between steering wheel and steering gear
Accelerator	Tap into sensor signals
Service brake	Motor attached to brake pedal
Transmission	Linear actuator attached to shift mechanism
Parking brake	Tap into electrical signal
Ignition	Tap into electrical signal

Figure 7 shows a high-level vehicle architecture including two alternative ways a test platform could monitor and control the vehicle. In one, the test platform connects to the ADS electronic control unit where the ADS can modify the control commands based on the algorithms associated with the ADS. For example, the longitudinal and lateral accelerations may be limited by the ADS ECU to provide a safe and comfortable experience to occupants. Consequently, a requested steering input (either directly or implied by a path and target speed) may be altered or the vehicle speed decreased to stay within the bounds set forth within the ADS ECU. In contrast, the other Virginia Tech Transportation Institute test platform connects directly to the control components which allows for precise control of the vehicle.

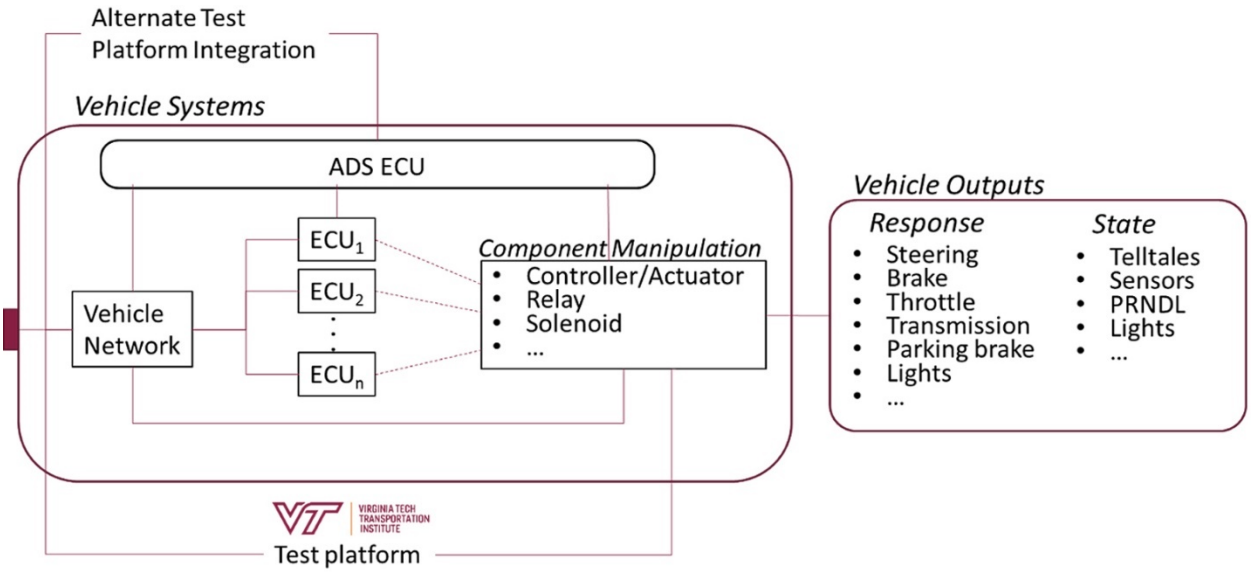

Figure 7. Basic Vehicle Architecture Showing Alternative ADS Test Platform Implementations

Figure 8 shows the sequence of basic driving tasks. The top braces show the responsibility of the human driver and the bottom braces show the responsibility for ADS operation. The last block encompasses the vehicle systems regulated by the FMVSS. Currently, the human driver is

responsible for determining the destination, identifying the best way to get there and providing control inputs to the vehicle systems. For vehicles equipped with an ADS, a human will likely only be responsible for selecting a destination. The ADS will determine the route and control the vehicle. Additionally, the ADS could also interact directly with or be integrated into some or all of the vehicle systems to affect the performance. Note that the perception of the environment is not explicitly identified here but is implicit in both the route planning and motion control.

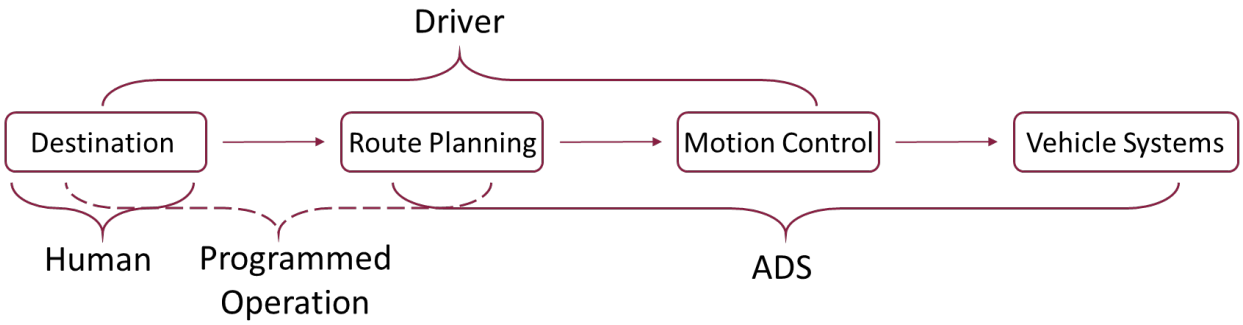

Figure 8. Basic Driving Tasks

In the case of the vehicle-based methods, the human control console keeps the responsibility of the first three driving tasks with the human. For the programmed control, because of how the test platform has been designed, the responsibility of the human includes both the destination as well as some of the route planning. This is accomplished through recording a series of GPS coordinates, or waypoints, along the course defined for a given set of test procedures. The programmed ADS functionality determines how to fill in the gaps between the waypoints to complete the route. This overlap is shown as a dotted brace between the first two blocks.

Collect Baseline Data

The test procedures were performed as they are today with the production vehicle, driving the test platform using the conventional controls. This provided a set of baseline data to compare the results of the test procedures run with the applicable vehicle-based test methods and to confirm the vehicle was capable of performing the required maneuvers.

Vehicle-Based Methods – General Considerations

The ADS features previously integrated into the SRX were augmented to include additional automated functionality, a human control console, programming functionality, and data logging capabilities to support the execution of the required functionalities to complete the test procedures and to collect and display vehicle data (Figure 9).

Figure 9. Test Platform to Execute FMVSS No. 114 via Human Control Method

Human Control Method

The human control console provides a set of manual controls consisting of a steering wheel, pedal assembly, and buttons for a human driver to operate the vehicle. The output from the human control goes to a central ECU that communicates with the different vehicle control elements. Because the human control module is a drive-by-wire system, it allows for many different interfaces with the vehicle, including wireless. Control via telepresence, or the remote operation of the vehicle, is being offered by some companies as a means to provide remote backup driving capabilities for ADSs, which demonstrates that is a viable means for human control. However, execution of the tests via telepresence could introduce additional variables (e.g., latency and skill of the test driver), which may influence the outcome of the results. Consequently, evaluation of telepresence was not included in near-term research but may be considered in future phases of the project. Building in the capability to remotely operate the vehicle also introduces additional considerations regarding security.

The following provides some of the considerations regarding human control, some of which have been identified through discussions with stakeholders.

- Allows for execution of the test procedures as currently defined.
- Operation of an ADS-DV via manual controls may require aspects of ADS be turned off, which could alter the way the vehicle behaves when operated by the ADS as the driver.
- Allowing for manual control may influence the design of the architecture to accommodate direct control of the actuators.
- While able to operate within the defined limits placed on the vehicle by the ADS, the actuators may not be capable of responding to the manual inputs, which could influence the performance and results.

- Being able to interface to the vehicle controls is a key consideration in being able to implement the human control method.
- There may be unique cybersecurity considerations raised by having an interface to the vehicle that is designed to allow control to be taken from the ADS-DV.
- Implementing a human control console in the near term may require that the console be provided by the OEM. It may be possible to implement a standardized human control for future applications, which may necessitate a standardized interface to the vehicle.
- Collaboration with the OEMs may facilitate the implementation of human control mode of operation.
- Some vehicles, such as dedicated delivery vehicles, may not be designed for occupants and therefore would not have a location to place controls or a driver.

Programmed-Control Method

The programmed-control method works by executing a predefined set of commands to control the functionalities of the vehicle. Knowledge of the vehicle's position and its surrounding environment is critical for proper ADS-DV operation. This is determined through a suite of sensors. While the equipment for controlling an ADS-DV is somewhat independent of the environment in which it is operated—there has to be a means to control lateral position—the ODD does influence the composition of the sensor suite and programming. Since the ODD is limited to closed test facilities for this project, the sensor system relies primarily on GPS to determine the location and path of the vehicle with cameras playing a secondary role. The route for a given test was defined by manually driving the course for a given test sequence and recording a breadcrumb trail of GPS coordinates, or waypoints, along the route. The path the vehicle took between the waypoints was determined by the ADS algorithm. To improve the accuracy of the positioning, differential GPS was used to improve position accuracy from meters to centimeters.

For areas with poor GPS coverage, a camera-based lane following system was used on the test platform to accurately determine the location of the vehicle relative to the lane lines. Localization, in this context, is how a vehicle equipped with an ADS determines where it is, both globally (i.e., "what road am I on") and locally (i.e., "where in the road am I"). Using GPS is a common localization technique that can provide both global and local positioning information, but it is dependent on GPS signal and map data to link those coordinates to roadways. Video-based systems such as the one used on the test platform are only capable of determining position relative to a roadway feature and are therefore dependent on having that particular feature they are designed to identify (e.g., lane lines). The ADS uses this information to determine subsequent controls inputs to the vehicle. A test facility that does not have map information, lane lines (Figure 10), or does not follow the lane lines present, poses a unique set of considerations for operating an ADS-DV that is expecting this information.

Figure 10. Vehicle on Test Track With No Lane Lines

In addition to the global and local position of the vehicle, the algorithm also has constraints on things such as acceleration and deceleration rates, steering rates, and speed. However, the team can set these to allow for the execution of any unique requirements that exist within the test that might not be required in normal driving (e.g., rollaway prevention stop sequence defined in S6.2.2 of FMVSS No. 114).

There are two operational concepts that have currently been identified for a programmed solution. The first is a pre-programmed script that could reside on the vehicle or on a dongle. In the latter, the dongle would need an interface to the vehicle from which it could run. The VTTI test platform uses a pre-programmed script that is integrated into the ADS functionality on the vehicle. Another possibility for implementing a programmed solution is to create a high-level scripting language that would allow a custom sequence of commands to design a program that would perform the step in a test procedure. This high-level language would provide the flexibility for the test operator to create a unique test procedure program. However, this flexibility to create a script to control the vehicle functions may also have additional cybersecurity considerations over having a program residing on the vehicle or having an interface port that allows for the control and monitoring commands necessary to execute the current test procedures.

The following provides some of the considerations regarding programmed control of the vehicle. Some of these are shared with the human control method. As with the human control considerations, some were identified through discussions with stakeholders.

- A deterministic program should be able to repeat the results of the human control at a level at least as good as human control.
- As with human control, the ability to override the ADS rules to allow execution of the programmed steps may be a consideration.
- Standardization and variations across OEMs may necessitate collaboration with OEMs.

- Particularly for pre-programmed execution, the question of who programs the test procedures (e.g., NHTSA, OEMs, or a third party) should be addressed.
- Collaboration with OEMs may be needed, especially in the near term to help in the programming or execution.
- As with the human control method, all of the ways that the programmed method could be implemented result in a means to control the vehicle outside of its mode of normal operation. There may be associated cybersecurity implications to consider.

True ADS operation may not be directly testable for the test platform since it is designed to have ADS functionality rather than be an actual ADS. For level 4 vehicles, a test facility may not be mapped for the vehicle or have adequate lane makings, making the test facility fall outside the ADS-DV's ODD. As discussed previously, the control of the vehicle by means other than ADS functionality may be outside of the vehicle's normal operating conditions. Related, some of the FMVSS require operation when there is a failure within a given system. For example, in FMVSS No. 135, several of the test conditions define minimum performance when there is a failure in the brake system. If an ADS is designed not to operate when there is a failure in the brake system, some additional action would be required. Similarly, the ADS may limit some of the inputs or may not execute some of the test procedures as currently defined. For example, the equivalent of the 0.7 Hz, 270-degree sine-with-dwell for FMVSS No. 126 may require steering rates and torque/force that exceed the performance of the actuators used to steer the vehicle.

Set Up Vehicle Test Platform
A subset of the test procedures (S6.2.2 of FMVSS No. 114 and section 13.2 of TP-138-03) were translated to allow the vehicle to be programmed so that it could automatically execute the steps in the above procedures. This, along with the human control console, allowed two of the vehicle-based methods to be tested.

Non-Vehicle-Based Methods
In addition to the vehicle-based methods described above, technical design documentation was included for FMVSS No. 138 (see **Appendix E**). In this context, technical design documentation includes documentation showing system design, architecture, wiring, etc., that could be used to demonstrate the link between the normal functions of the vehicle's systems to the ADS. For example, a manufacturer could provide wiring diagrams and/or hardware and software system architecture information to demonstrate that the sensor signals used by the TPMS to indicate a low tire pressure condition via illumination of a telltale in a conventional vehicle are designed to be communicated to the ADS. NHTSA could potentially use this information to verify compliance or as part of the verification process. This might not ensure that the ADS will act on the data communicated to it, but it would show that the relevant information is present for the ADS to act upon. This is consistent with the current regulation, which provides a low tire pressure warning to the human driver, but does not require the driver to take action to respond to such a warning in order to continue operations. Requiring an ADS to take appropriate action in response to information about vehicle conditions that could create safety problems, such as a low tire pressure warning, is not within the scope of this project.

Technical design documentation will continue to be developed during the current effort and will be reported on in further detail. The use of simulation is also being investigated in association

with FMVSS No. 126. Results from this research into these non-vehicle-based methods will be presented in subsequent reports.

It should be noted here that this approach does not check the performance of the vehicle as manufactured. Currently, NHTSA's OVSC purchases new vehicles from dealerships to ensure the vehicle meets the requirements as produced and as sold to the public. While documentation may be used to show intent, it does not provide a means to confirm operation of the end-to-end system, which includes variables associated with the manufacturing and assembly processes. However, it may explain how the ADS is designed to receive the information and include test data collected from the manufacturer to provide the system performance of the physical vehicle. (see **Appendix E**). It could also be used in conjunction with normal operation, human control and program test methods

Execution
The initial round of testing was performed based on FMVSS Nos. 114 and 138 at one of the project team's test facilities. Further testing of these initial test procedures is being conducted with another test platform at a second facility. Testing for FMVSS No. 126 is currently under development and, when complete, will provide a complete data set for the initial evaluation.

Evaluation of Test Methods
The goal of the evaluation is to assess whether the methods allow for execution and control of the identified functionalities. To accomplish this, an initial set of criteria have been identified by which to evaluate the efficacy of the methods. This portion of the evaluation will consider such items as short- and long term-practicability; effort in obtaining data, whether through physical testing, simulation, or compilation of information; and results of the methods. Volume 2 will provide a more complete evaluation following the completion of the next round of testing.

The initial testing did not implement and test all the functionalities identified. However, the near-term research deliverables did provide a means to assess the testing and evaluation process before implementing the remaining functionalities. One of the results of this initial testing was to motivate a revision of the test procedure steps to be functionality-based rather than explicitly following the steps defined in a given FMVSS or its associated OVSC test procedure. For example, the test procedures in **Appendix F** follow steps defined in FMVSS Nos. 114 and 138. However, it is not necessary to execute the procedures from S6.2.3 in addition to those in S6.2.2 since the steps are repeated, as are the functionalities. In addition, since the purpose of the project is to evaluate the methods rather than the compliance, the steps in S6.2.2.(d)–(h) (shown below) do not provide new or pertinent data for execution of functionalities. Similarly, the constraint of a 10 percent grade is not necessary to demonstrate the functions associated with driving the vehicle.

(a) Drive the vehicle forward up a 10 percent grade and stop it with the service brakes.
(b) Apply the parking brake (if present).
(c) Move the gear selection control to Park
(d) Note the vehicle position.
(e) Release the parking brake. Release the service brakes.
(f) Remove the key.
(g) Verify that the gear selection control or transmission is locked in Park

(h) Verify that the vehicle, at rest, has moved no more than 150 mm from the position noted prior to release of the brakes.

An initial review of the current test procedures relative to the additional test platform that will be used as part of the validation indicates that the test platform will not be able to execute the procedures as defined. Consequently, the final test definition will be developed as part of the next round of testing accounting for the additional test platform and this will be documented in a future report.

Consistent with the initial classification, the human control and programmed methods provided the most direct means to execute the driving functionalities with a well-defined sequence of commands that may not follow the same sequence that a driver or ADS-DV may follow. While the next round of testing will address some of the functionalities not tested during the near-term research (e.g., non-driving controls such as turn signal operating unit), the demonstration of other functionalities is adequate to show how they could be controlled by the test methods. For instance, the turn signal control is operated by an electrical signal in a similar manner to the parking brake on the test platform. Consequently, the ability to control the parking brake demonstrates how any similar switch (such as the turn signal) could be operated.

In addition to vehicle control, many of the FMVSS provide regulatory language regarding the vehicle state (e.g., telltale status, transmission state, door open/closed) and how that is communicated to the driver. Since an ADS-DV may not have a standard display, it may be necessary to provide a means to confirm the vehicle state information is communicated in such a way as to comply with the regulations. For any of the vehicle-based test methods, this will require some means to capture, display and/or record the vehicle state during compliance testing. There are several ways this could be accomplished: (1) the vehicle state data could be made available on the vehicle network; (2) the vehicle could record the data as part of a programmed test; (3) the vehicle data could be transmitted to and displayed on an external monitor; or (4) the vehicle could have a test mode that presents the data on an in-vehicle display in real time.

For FMVSS Nos. 114 and 138, each of the approaches above were demonstrated, with the exception of data presentation on the in-vehicle display, as it is analogous to the external monitor. It should be noted that while these provide examples of how to confirm the presence of vehicle state data on the network, they may not prove that the data is being communicated to the ADS (e.g., the ADS may not monitor all the network variables). As the test methods are further developed, the research team will develop options that address verifying the communication to the ADS. This may include a combination of methods, such as reading the vehicle state data on the network along with the manufacturer providing schematic drawings for NHTSA to verify that the network data is designed to be communicated to the ADS.

Technical design documentation may be used to demonstrate that given subsystems, such as the TPMS, are designed to communicate vehicle state information all the way to the ADS and/or to the occupant as required (e.g., a wiring diagram showing the connection between the TPMS electronic control unit and the ADS). However, documentation does not provide a physical confirmation of the final production offering. Another consideration is the potential need for the disclosure of proprietary information. Based on SME feedback, the use of technical design

documentation, as with any of the other methods, may require a collaborative effort between NHTSA and manufacturers, especially in the near term. This method may also be able to be extended to other areas, as noted by some SMEs. Investigation of this method will continue with the SME reviewers and other stakeholders during the validation activities and during mid- and long-term research to see how it may be applied to other functionalities.

The use of the normal ADS operation for production ADS-DVs would have to be limited to the ODD for which the vehicle was developed. If a test facility does not fall within that ODD, special design implementations may be required to allow the tests to be conducted. However, at that point, it could be argued that the vehicle is not in "normal" ADS operation. This could also be addressed by executing tests within a manufacturer's ODD or making the necessary addition to a test facility so that it could be included in a manufacturer's ODD. Normal ADS operation is a test mode that will continue to be evaluated during the validation work.

Simulation was not evaluated as part of the standards designated for near-term research but will be evaluated for FMVSS No. 126 in mid-term research. The SME review responses reached both ends of the spectrum regarding simulation. At one end, reviewers thought it was a more effective means for demonstrating compliance with FMVSS, as the vehicle-based methods may require the normal operation of the vehicle to be altered and may provide an additional cybersecurity risk by providing a physical port or programming commands for vehicle control that may not otherwise be there. Others see it as inappropriate at this time since there are still many questions regarding some of the technical considerations, such as the fidelity of the models and how they are validated, as well as logistical considerations, including what models are used, who supplies the models, and how or if proprietary algorithms may be supplied. Based on this feedback, SME reviewer and stakeholder engagement will continue to investigate the application of simulation.

Other Evaluation Considerations: Vehicle Cybersecurity Assessment
As mentioned previously, one of the considerations associated with the vehicle-based test methods is the possibility of introducing additional cybersecurity vulnerabilities. Including a means to physically manipulate the vehicle through software commands (programmed method) or by having a means to interface surrogate human controls to the vehicle, may introduce increased cybersecurity issues by providing additional attack vectors that would not exist in a production ADS-DV without these interfaces. While cybersecurity is being acknowledged in the evaluation of the test methods, it is outside the scope of this project to perform an analysis of cybersecurity concerns for ADS-DVs. However, NHTSA is supporting research into cybersecurity through other projects, both current and planned.

Iteration of Testing and Evaluation of Results as Necessary
Iterations in the test platform, execution of a given method, and evaluation of the results will continue in the mid-term and far-term research activities. It is expected that the evaluation task will result in several iterations to incorporate the feedback from those evaluating the results.

Validation of Test Platform and Execution
Currently, tests associated with Phase 1 Volume 1 have been implemented and performed on a single platform at a single location. The goal of the validation step is to perform the tests on additional platforms at additional locations with other operators. As mentioned previously, the process of replicating the test activity for some or all of the test modes identified is ongoing. In addition, work with industry stakeholders to try to identify opportunities to implement and execute some or all of the test methods on additional ADS platforms continues.

Crashworthiness and Occupant Protection

A translation option for the FMVSS 200-series is to apply the test procedures that have been developed for the passenger seating positions to the left front outboard seating position, given the main difference between the two front outboard seating positions in conventional vehicles is the presence or absence of these controls. There are common needs for the 100- and 200-series, such as the communication to the ADS and/or occupants under FMVSS No. 206 (telltale). The results presented in this report for those aspects of functionality in the 100-series will benefit the 200-series and other test procedures evaluated during mid- and long-term research. Activation of the ignition start/stop (required for checking the wheelchair lift door requirement in FMVSS No. 206) would similarly use the method of activating ADS functionalities for testing the 100-series.

ANALYSIS OF STANDARDS INCORPORATED BY REFERENCE

Many of the FMVSS make reference to external standards; these documents are incorporated by reference in the FMVSS and they appear in 49 CFR §571.5. With the goal of eliminating potential regulatory barriers to NHTSA's compliance verification, all aspects related to FMVSS were evaluated, including documents external to the CFR, yet incorporated by reference in the CFR. Each reference was evaluated and coded based on its potential to create a barrier for compliance verification. If it was a potential barrier, then technical translation options were provided. This was performed with criteria similar to those used for FMVSS, given standards incorporated by reference become part of the FMVSS regulatory language (Table 13).

Table 13. Taxonomy for Translation Needs: Analysis of Standards Incorporated by Reference

Reference Classification Scale	Description
0 – No barrier	The reference could be used as originally cited and intended. It does not present any regulatory barrier.
1 – Translation is straightforward	Translations were incorporated to ensure the reference does not present a regulatory barrier.
2 – Limited Research may be beneficial	Research may be beneficial in order to implement a translation in the reference or the regulatory text.

In order to perform a complete analysis, the first step was to identify and obtain all references cited as part of the FMVSS and classify them by FMVSS. A total of 33 standards by external organizations were incorporated by reference in the FMVSS and evaluated as part of this report. These standards represent multiple organizations external to NHTSA (e.g., ANSI, ASTM, ISO,

SAE). The total number of incorporated references within each FMVSS, as shown in **Appendix D**, was calculated per referenced document, not by the number of citations to references. Thus, while Figure 11 shows 39 citations, these refer to 33 standards from external organizations. FMVSS No. 141 contained 6 citations to different sections of one incorporated by reference document (e.g., S5.1 and S7.1.1 of SAE J2889-1) but was only counted once in the tables in **Appendix D**.

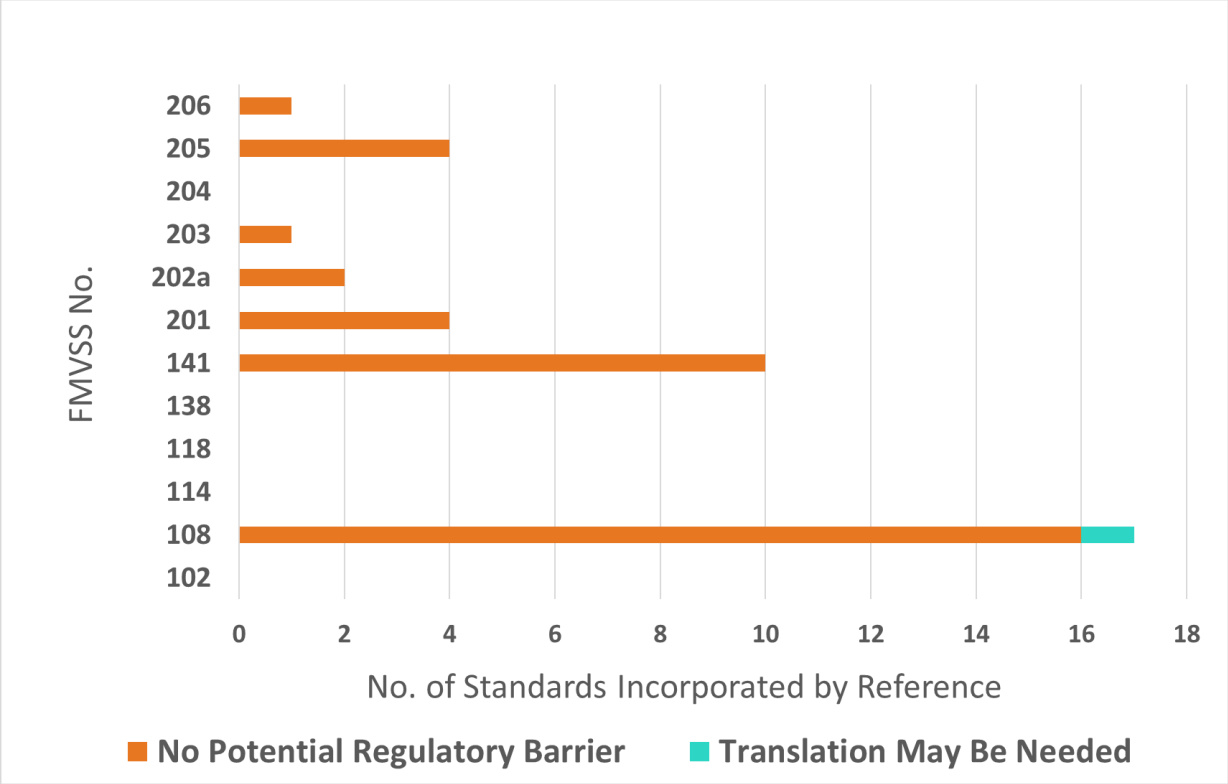

Figure 11. No. of Standards Incorporated by Reference Cited in the 12 FMVSS, Divided by Standard

References cited ranged in publication date from 1931 to 2004. It is important to note that newer references have been issued by external organizations for some of the standards but have not been incorporated by reference in FMVSS. While this was considered for the analysis performed, only the incorporated references cited within the standard were assessed. For situations where a potential regulatory barrier was found, a technical translation was suggested. The main reason for this was that a revision of the standard of interest (not the newest version) might not be in line with the version that would be used by the publishing organization during their next review cycle.

If the reference was categorized as a 1 or 2, the regulatory barriers presented by the reference was analyzed to determine what type of technical translation was needed. In order to categorize the reference, each line, or section, cited in FMVSS was reviewed in detail. The final results are presented by FMVSS as well as by external organizations in case there were some organization-based trends (Figure 12). Details about the analysis of standards incorporated by reference are provided for each FMVSS in its respective section (Chapters 3 and 4).

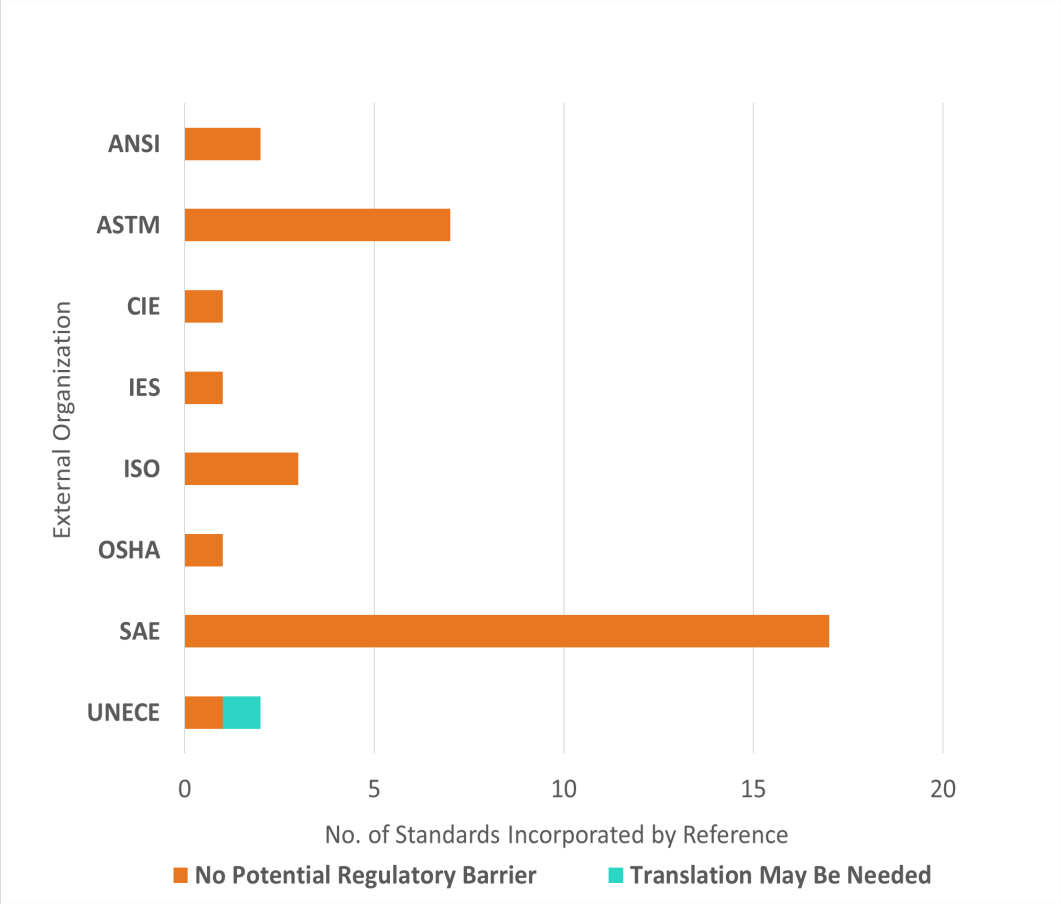

Figure 12. Standards Incorporated by Reference Cited in the 12 FMVSS, Divided by Publishing Organization

Overall, the potential barriers presented by these external standards incorporated by reference are believed to be minimal. For those that might be a barrier, a technical translation option is provided. The technical translations in the regulatory text analyzed were fairly straightforward. No need is seen for involving any of the identified organizations at this point given that the language used in the cited references would allow for successfully performing the technical translation.

STAKEHOLDER AND SUBJECT MATTER EXPERT REVIEW PROCESS

Overall Approach

During near-term research, multiple tasks benefited from input from SMEs and from stakeholders in general. Stakeholders for this project include companies, organizations, and advocacy groups that were invited to be involved during the proposal stage based on their experience with FMVSS and ADS-DVs. Additional stakeholder entities have since been added; in some cases, organizations have asked to be added and in other cases a need was identified for additional expert feedback, resulting in additional stakeholders being invited to participate (after obtaining NHTSA's approval). SME reviewers are a subset of the larger stakeholder group; these are individuals with demonstrated expertise in and knowledge of a particular FMVSS and/or

Laboratory Test Procedure and a comprehension of how potential FMVSS barriers to innovative vehicle designs may be addressed. The SME reviewers for each FMVSS of focus during near-term research have been involved in providing input to the developed technical translation options. The SMEs were provided opportunities to review the translation development work and provide feedback.

Worksheets were developed for each FMVSS to provide background information for developing the technical translation options (e.g., chronological regulatory history). The FMVSS project leads completed the initial technical translation exercise after reviewing and studying the background information. They then gathered input from multiple core team members and further refined the technical translation options. The updated worksheets were then provided to SME reviewers and their feedback was compiled and incorporated into the worksheets as deemed appropriate by the FMVSS project leads. All SME reviewer feedback was anonymized and maintained within the worksheet.

The results of this task were presented during an FMVSS Stakeholder Meeting (VTTI, 2018a, 2018b) held on April 3–4, 2018, at USDOT headquarters in Washington, DC. This meeting, which was open to the general public, enabled a larger group of stakeholders to provide input as desired. Details regarding this meeting are provided in the section below.

Stakeholder Meeting

Several industry and research entities were engaged as collaborators on this project in order to obtain input and feedback, and produce prototype technology for testing and evaluation. The meeting was held with the following objectives.

- Provide the research team with input related to FMVSS technical translations and test procedures.
- Identify potential barriers for compliance verification of innovative new vehicle designs precipitated by ADSs.

The meeting opened with introductory remarks by Dr. Cem Hatipoglu, director of NHTSA's Office of Vehicle Crash Avoidance and Electronic Controls Research, and by Ellen Lee of NHTSA's Human Injury Research Division, the Contracting Officer's Representative (Task Order) for this project. An overview of the project was then presented by Dr. Myra Blanco, director of the Center for Public Policy, Partnerships, and Outreach at VTTI and the project's principal investigator (Figure 13).

An expert panel followed, which included Michelle Chaka (program director at VTTI), George Soodoo (consultant, Lindsey Research Services), Kenneth Weinstein (Kenneth N. Weinstein LLC), Dr. Clay Gabler (Samuel Herrick Professor of Engineering, and chair, Biomedical Engineering Graduate Program, Virginia Tech), and Dr. William Thomas Hollowell (WTH Consulting, LLC).

Figure 13. Dr. Myra Blanco and the Expert Panel

The 100- and 200-series standards, the initial focus of this project, which were discussed at the April 2018 FMVSS Stakeholder Meeting (VTTI, 2018a, 2018b), are provided in Figure 14.

101 Controls and displays	102 Transmission shift position sequence, starter interlock, and transmission braking effect	103 Windshield defrosting and defogging systems	104 Windshield wiping and washing systems
108 Lamps, reflective devices, and associated equipment	111 Rear visibility	113 Hood latch system	114 Theft protection and rollaway prevention
118 Power-operated window, partition, and roof panel systems	138 Tire pressure monitoring systems	141 Minimum Sound Requirements for Hybrid and Electric Vehicles	201 Occupant protection in interior impact
203 Impact protection for the driver from the steering control system	204 Steering control rearward displacement	206 Door locks and door retention components	208 Occupant crash protection

Figure 14. FMVSS of Focus for Stakeholder Meeting 1

Breakout sessions for the standards listed above were then held: Four panel sessions were held for the 100-series (Figure 15) and four were held for the 200-series (Figure 16) standards. Each breakout session included project team members, a group of regulatory expert panelists, and the meeting attendees. Each panel discussion was chaired by the researcher responsible for leading

the technical translation for the standard. The panelists were project stakeholders who had provided feedback to the technical translation options. The panelists represented a range of perspectives and backgrounds: the stakeholder group included a large number of manufacturers, suppliers, tech companies, private industry-related organizations, and consumer groups.

Figure 15. A Panel Discussing Standards in the 100-series

Figure 16. A Panel Discussing Standards in the 200-series

On the second day, a plenary session was held in which the breakout session discussions were summarized by Michelle Chaka and Dr. Gabler. In addition, Loren Stowe (senior research associate at VTTI) presented an overview of the approach that is being taken for assessing methods that could be considered by NHTSA for use in compliance verification. Closing remarks were then provided by Dr. Blanco and Dr. Hatipoglu.

CHAPTER 3. CRASH AVOIDANCE STANDARDS

OVERVIEW

This chapter summarizes the technical translations of the crash avoidance standards designated for near-term research: FMVSS Nos. 102, 108, 114, 118, 138, and 141. These standards cover a range of performance requirements that help prevent motor vehicle crashes or injuries. The goal of this effort was to provide options for translating the language of each standard to accommodate ADS-DVs while maintaining the current performance standards. In addition to the FMVSS, the associated laboratory test procedures used by NHTSA to verify compliance were reviewed (discussed further in the Test Procedure Section below). Technical translation assessments were completed to identify the potential regulatory barriers. Additionally, possible overlapping requirements from the near-term standards with FMVSS No. 500, Low-speed vehicles, were considered during the technical translation options development. The low-speed vehicle requirements may be covered further in the long-term research.

Technical Translations

In translating the FMVSS 100-series near-term research standards, the following crosscutting themes were repeatedly encountered:

- Driver (operator)
- Service brake application
- Shift position
- Controls, telltales, and indicators

Determining how to treat the "driver" references in a way that worked across the standards was central to the development of technical translation options for the 100-series. As discussed in the Definition and Key Considerations sections, the potential "driver" definition (Option 1) treats the ADS performing the driving for an ADS-DV as the "driver" and the human driver as the "driver," whereas, the term "driver" in Option 2 always refers to a human driver. For Option 2, the ADS operating an ADS-DV was addressed in the standard's technical translation options independently from the "driver." Because the latter option does not specify the entity that is operating/controlling the vehicle, the technical translation options use language such as "for a vehicle operated by an ADS" or "for a vehicle operated by a driver."

An example of the "driver" definition to support the technical translation options for FMVSS No. 138 is demonstrated using S1., Purpose and Scope, which currently states "This standard specifies performance requirements for tire pressure monitoring systems (TPMSs) to warn drivers of significant under-inflation of tires and the resulting safety problems."

Applying Option 1, the "driver," terminology would remain the same (e.g., "driver" is both the human and ADS driver in this case). With the use of Option 2, the technical translation would be modified as follows, *"...to warn drivers and ADSs of significant under-inflation of tires and the resulting safety problems*." A third option was also provided that remove the reference to driver altogether, "*"...to warn of significant under-inflation of tires and the resulting safety problems*."

Option 1 keeps the current language for this occurrence; however, this was not true in all cases. In some occurrences, it was deemed more straightforward to separate the requirements. For example, FMVSS No. 108 S6.6.2 Associated Equipment, currently states, "All vehicles to which this standard applies except trailers and motorcycles must be equipped with a vehicular hazard warning operating unit, a vehicular hazard warning signal flasher, and a vehicular hazard warning signal pilot indicator meeting the requirements of S9." The potential technical translation using "driver" definition Option 1 with the changes in red text is shown below:

> All vehicles that can be operated by a human driver to which this standard applies, except trailers and motorcycles must be equipped with a human driver controlled vehicular hazard warning operating unit, a vehicular hazard warning signal flasher, and a vehicular hazard warning signal pilot indicator meeting the requirements of S9. All vehicles that can be operated by an ADS driver to which this standard applies except trailers and motorcycles must be equipped with the capability of the ADS driver activating the vehicular hazard warning signal flashers and the ability for all DSPs to activate the hazard light system. A pilot indicator visible by all DSPs must also be included.

There are other technical translations which clarify the requirement for a human driver. In these cases, Option 2 provides fewer language modifications. With the use of Option 2, the "driver," the human driver, is independent from the ADS, which provides a consistent manner to treat "driver" or "ADS." In contrast, Option 1 uses potentially three terms, driver (both driver and ADS), ADS driver (only ADS) and human driver (only human).

There were a few cases where the reference to an ADS-DV also provided a straightforward option. This is shown in one of the options applied for FMVSS No. 108 turn signal operating unit self-canceling by steering wheel rotation requirement, "…The turn signal function on an ADS-DV must cancel after completion of the turn or lane change." The use of ADS-DV does limit the applicability of the technical translations but aligns with the project scope.

The references to service brake application and shift position assume a specific human functionality. Where possible, the technical translation approach was to use a generic function, specifying a state and/or using the considered driver and ADS definitions. FMVSS No. 102 Starter Interlock requirements uses the following language in S3.1.3.1(c)(1): "When the engine is automatically stopped in a forward drive shift position and the driver selects Reverse, the engine restarts immediately whenever the service brake is applied." This could be translated to generic functions using terminology such as *"…stopped in a forward drive state"* and *"…transmission is placed in Reverse."*

The final crosscutting theme, controls, telltales, indicators, and alerts, cuts across FMVSS Nos. 108, 114 and 138. This area was previously discussed in detail in the Controls, Telltales and Indicators section and additional standard specific information are captured in the individual standard discussion.

Potential Considerations

There are several inherent assumptions in the 100-series that are addressed by the 100-series technical translation options: A human driver is operating the vehicle; the lateral control of a vehicle is manipulated through a steering wheel; the application of an accelerator pedal is used to accelerate a vehicle; the application of a brake pedal is used to stop a vehicle; a human driver is seated in the left, front DSP with established visibility sightlines; illumination of telltales is needed to communicate vehicle conditions to a human "driver;" and a human driver is present to supervise such things as power window operation. While the crosscutting themes helped to provide consistent technical translation approaches across the near-term standards, each standard addresses a unique crash avoidance safety area and may result in some differences in the technical translations. The technical translation summary and considerations for each of the near-term crash avoidance standards are provided in this chapter.

Test Procedures

As stated above, the ability to execute the test procedures associated with conformance verification with a dedicated ADS is one of the key considerations for the 100-series standards. This section provides an overview of specific considerations for the 6 FMVSS discussed in this chapter.

Chapter 2 describes the approach used regarding the test procedure research. For those portions of FMVSS Nos. 114, 118, 138, and 141 that were assessed as requiring limited additional research (i.e., a "2" in the translation worksheets), the functionalities were identified and used in the test procedures developed during the near-term implementation and evaluation. Of the two remaining standards that were part of the near-term research, FMVSS No. 102 does not have a specified test procedure and its functionalities are captured in the other standards selected for test procedure efforts. Lastly, FMVSS No. 108 is an equipment-based standard, and technical translations of its test procedures appeared to be either unnecessary for ADS-DVs or straightforward.

For the vehicle-based methods, the programmed and human control test methods were used to implement and test the functionalities. For FMVSS No. 138, programmed execution of the relevant portions can provide insight into the possible efficacy of normal ADS operation. For the non-vehicle-based methods, possible approaches for technical design documentation were investigated during the near-term research. Of the 6 FMVSS being considered for the near-term, none provide as good an opportunity to assess simulation as a method for compliance verification as FMVSS No. 126. Consequently, simulation was not applied during the near-term research.

As the standards and potential test procedure methods are evaluated, near-term implementation is a key consideration. Technical design documentation, ADS normal operation, and a manufacturer-supplied human control interface may have a shorter implementation cycle compared to the other methods being evaluated. A standardized human control console that could apply to multiple platforms or full programmed execution of test procedures may take longer to put into practice. As mentioned in the previous chapter, a hybrid approach—the use of more than one method to leverage the relative benefits of one method for a particular

functionality or test condition—is another possibility to address the potential barriers for ADS-DVs.

Stakeholder and SME Review Input

Many of the SME reviewers mentioned that NHTSA could consider adding a new category/class of vehicles (i.e., vehicles certified as being capable of being operated by an ADS without manually operated controls) instead of making changes to the current standards applicable to conventional vehicles. Using the SAE J3016 standard, 2018 terms and definitions (e.g., ADS, DDT, ODD) were provided multiple times as feedback. Several reviewers mentioned updates that were outside of the scope of the project, such as deleting or updating outdated requirements in the FMVSS and new requirements associated with an ADS response to the regulatory information presented.

Standards Incorporated by Reference

As noted above in Chapter 2, as part of the technical translation effort, documents incorporated by reference were reviewed. Only two of the near-term research 100-series standards refer to documents created by an external organization. FMVSS No. 108 has 17 such references and FMVSS No. 141 has 5 such references. Each of these documents were assessed as a 0 (i.e., no barrier) or 1 (i.e., translation is straightforward). These assessments are discussed further in the sections relating to FMVSS Nos. 108 and 141.

FMVSS No. 102: TRANSMISSION SHIFT POSITION SEQUENCE, STARTER INTERLOCK, AND TRANSMISSION BRAKING EFFECT

As currently specified in FMVSS No. 102 S1, Purpose and Scope,

> This standard specifies the requirements for the transmission shift position sequence, a starter interlock, and for a braking effect of automatic transmissions, which are intended to reduce the likelihood of shifting errors, to prevent starter engagement by the driver when the transmission is in any drive position, and to provide supplemental braking at speeds below 40 km/h (25 mph).

Technical Translations

The overall technical translation approach used was to try to eliminate dependency upon a human driver or a specific control implementation, while maintaining what the team believes the safety intent to be for both conventional vehicles and ADS-DVs.

One of the ways FMVSS No. 102 reduces the likelihood of shifting errors is by specifying that a neutral position shall be located between forward drive and reverse drive positions. The technical translation considered a range of options. The first two options add additional language specific to ADS-DV potential application "…unless other means exist to ensure transmission cannot inadvertently be shifted directly between forward and reverse positions" or "While the ADS is engaged, the transmission cannot be inadvertently shifted directly between forward and reverse

positions." The second two options provide variations on clarifying that the neutral position location may only pertain to vehicles operated by a human driver.

FMVSS No. 102 includes requirements for the automatic transmission control position, Park (P), Reverse (R), Neutral (N), and Drive (D). The letters are considered separate identifiers for the individual gear positions. The locations in the vehicle and with respect to each are specified in FMVSS No. 102. Based on the analysis of regulatory information communicated in vehicles, the automatic transmission control status indicator could be translated to not communicate the information to either the occupants or the ADS, or to communicate the information only to the ADS. These may be further assessed in the mid-term research FMVSS No. 101 technical translation work.

Potential Considerations

Since the focus of FMVSS No. 102 involves driver interaction and the vehicle's transmission, changing the language to not explicitly refer to the driver, and to refer to the action or state of the transmission rather than the manipulation of the control addresses most of the technical translation considerations. The primary challenge will be verification of the requirements set forth in FMVSS No. 102 for a vehicle without manual controls.

Test Procedures

While there are no specific test procedures identified in FMVSS No. 102, the functionality of transmission control and transmission state monitoring are captured in other standards such as FMVSS No. 114. Therefore, FMVSS No. 102 was not selected for evaluation.

Potential Considerations

As stated, test procedures or a method may need to be defined for NHTSA to be able to verify compliance for vehicles without manual controls.

Stakeholder and SME Review Input

Stakeholders generally supported the approaches that had been taken with the technical translations. Some stakeholders questioned the applicability of portions of the standard to ADS-DVs that do not need to display information to the driver or have to contend with driver error or inadvertent shifting actions. If driver shifting errors are eliminated, the safety purpose of a neutral position between forward drive and reverse drive, as is currently required in S3.1.1, was also questioned.

FMVSS No. 102 was not selected for the methods evaluation. Therefore, there was no specific stakeholder and SME review input for the test procedures.

Standards Incorporated by Reference

No incorporated references.

FMVSS No. 108: LAMPS, REFLECTIVE DEVICES, AND ASSOCIATED EQUIPMENT

FMVSS No. 108 "specifies requirements for all original and replacement lamps, reflective devices, and associated equipment" (S1). It includes requirements for the position, performance and properties of these devices and includes a wide scope of requirements, including color, size, and physical durability. In addition, the standard also specifies requirements for lighting controls, including switches, power supplies, and flashers.

Technical Translations

FMVSS No. 108 is an equipment standard and may require limited technical translations to remove the identified regulatory barriers. The primary focus area of the technical translations for FMVSS No. 108 was to maintain the requirements for lighting functionality as applied to ADS-DVs. Options for the treatment of the telltales and indicators specified in the standard and the applicability of the standard to bidirectional vehicles were also considered.

The initial challenge of this standard with respect to bidirectional vehicles relates to the location of various components on the vehicle. As discussed in Chapter 1, the applicability of the FMVSS to bidirectional vehicles could be addressed generically by defining such vehicles in 49 C.F.R. § 571.3 and by specifying the applicability of the standards to such vehicles in a new section 571.11. With this approach to bidirectional vehicles, technical translations to address references to the front and the rear are not believed to be necessary.

Several of the telltales and indicators specified in FMVSS No. 108 are "human reminder" type telltales, which serve to remind a human driver of some condition that they initiated, as opposed to a notification of a component or system failure. As an example, the upper beam headlamp indicator in a conventional vehicle is a telltale used to remind a human driver that the upper beams are activated, since it is possible that a human driver might not recall that they had activated them. In an ADS-DV, the ADS would have turned on the upper beams, and thus, in theory and if working properly, the ADS would "know"—and would not "forget"—that they are activated. For these type of telltales, two potential options were developed: one that did not require communication to the ADS and one that did.

The technical translations of the provisions addressing turn signal lamp failure would require the communication of the information about the failure to both the ADS and inside the occupant compartment. The options for the location of the telltales in the occupant compartment range from at least one DSP to all DSPs, as discussed in the section on Controls, Telltales, and Indicators in Chapter 2.

Technical translations were provided for the provisions governing the ADS's activation and operation of the vehicular hazard warning operating unit, the vehicular hazard warning signal flasher, and the vehicular hazard warning signal pilot indicator in an ADS-DV. In recognition that there might be occasions when an occupant of an ADS-DV would want or need to activate the hazard warning flashers, technical translation options in which capability would be required were also included. Under these options, if an occupant did activate the system, the ADS would need to be made aware of that fact. There were multiple options developed to specify the location of the controls to activate those flashers.

Since the switching between upper and lower beams in an ADS-DV would be fully controlled by the ADS (i.e., it would be fully automatic), a technical translation was included under which the option of using a "semi-automatic headlamp beam switching device," as described in S9.4.1, would not be applicable to ADS-DVs. However, the technical translation retains current language for a vehicle operated by a human driver, which allows a semi-automatic means of switching between lower and upper beams and requires a manual override switch.

Potential Considerations

Participants at the April 2018 FMVSS Stakeholder Meeting (VTTI, 2018a, 2018b) raised the issue of whether there should be a requirement for a turn signal pilot indicator in the occupant compartment of an ADS-DV in order to provide occupants with information regarding the intended path of the vehicle so they would be prepared when the vehicle makes a turn. If so, this would raise the issue of whether such an indicator would need to be visible to occupants located at all DSPs or just at some specified DSPs.

Some SMEs who reviewed the technical translation options believed that some of the equipment currently specified in S6.6.1 of FMVSS No. 108 may not be needed to achieve turn signal performance—specifically the turn signal operating unit and the turn signal flasher. Options presented maintain turn signal functionality under which the ADS would activate and cancel those signals.

There may be opportunities to research system performance requirements that are specific to ADS-DV sensor capabilities. For example, many SMEs noted that ADS-DVs may not need upper beam headlamps to perform the DDT, and that additional research in this area may be appropriate. Such research might include developing a performance metric to determine whether an ADS can "see" adequately without upper beam headlamps.

As discussed earlier, one of the principles of the technical translations was if the standard's language works today, it should not be changed. Technical translations should be provided only if necessary to address ADS-DVs. FMVSS No. 108 S4 defines the overall width as

> the nominal design dimension of the widest part of the vehicle, exclusive of signal lamps, marker lamps, outside rearview mirrors, flexible fender extensions, mud flaps, and outside door handles determined with doors and windows closed, and the wheels in the straight-ahead position. Running boards may also be excluded from the determination of overall width if they do not extend beyond the width as determined by the other items excluded by this definition.

The mounting of ADS sensor systems could impact the overall width definition. However, this is not necessarily an ADS-DV regulatory barrier.

Test Procedures

Only a few of the test procedures in FMVSS No. 108 required technical translation, since they relate to the testing of components. The few technical translations consisted of applying the

technical translations from the S4 definitions in the laboratory test procedure. There are some full vehicle tests for mounting and positioning of lamps and other devices, but these would not be dependent on whether the vehicle is being operated by a human or an ADS.

Potential Considerations

None.

Challenges

None.

Stakeholder and SME Review Input

There was general agreement among the attendees at the April 2018 FMVSS Stakeholder Meeting (VTTI, 2018a, 2018b) that in a mixed-fleet environment, FMVSS No. 108 must continue to assure conspicuity, identification of vehicle direction, turn intent, and signalization. Most stakeholders agreed that retaining the hazard warning indicator and control inside the vehicle was reasonable. Some commenters noted that the hazard warning control would then potentially be accessible to occupants without licenses who do not understand how to appropriately use it. Additionally, stakeholders agreed that malfunctions must be communicated to the ADS.

During the SME review process, minor changes and modifications were suggested to some of the draft technical translations. Two primary concerns presented by SME reviewers related to auxiliary lighting and test voltage. These issues were deemed to be out of the scope of this project, but are noted as observations below:

- Allowances for auxiliary lighting, such as lighting that will allow an ADS-DV to communicate the vehicle's state and intention to pedestrians or other roadway users. These lighting systems will likely need to be standardized to ensure that the communications are understandable by the public. As such, more research may be required in this area.

- Some of the test criteria, including headlamps, daytime running lamps, and turn signal/hazard operating unit/flashers, are based on a nominal 12.8-volt power supply. As some vehicles may be moving to a higher voltage supply (48 volts), these requirements may need to change. Additional information may be needed to ensure that the tests can be accomplished, and the requirements be satisfied, at this higher voltage.

In addition, many of the SME reviewers were of the opinion that upper beam headlamps may not be required in an ADS-DV.

FMVSS No. 108 was not selected for the methods evaluation. Therefore, there was no specific stakeholder and SME review input for the test procedures

Standards Incorporated by Reference

FMVSS No. 108 has 17 incorporated references in all. During the technical translation development, options that may reduce the need to translate the documents referenced within the regulatory text were considered. An analysis of the list of referenced documents concluded that most references, when considered in conjunction with the translation options, do not contain regulatory barriers for ADS-DVs. Several references have language that do not create a barrier for ADS-DVs (e.g., they use the term "operator") and/or provide alternative requirements (e.g., Concealable lamps in paragraph 5.14 of United Nations Economic Commission for Europe [UNECE] Regulation). Other references required technical translation approaches to address potential regulatory barriers. An example of this is SAE J941b (1969), Motor Vehicle Driver's Eye Range, which describes the procedure for establishing eyellipse, a statistical representation of driver eye locations. SAE J941b was addressed by maintaining the reference for vehicles that can be operated by a human driver and applying a generic method for ADS-DVs (e.g., indicator must be visible). This was based on the assumption that the criticality for visibility of a human driver might be different for an occupant in an ADS-DV, who is not completing the DDT. However, if the technical translation options are applied differently, the reference may pose a barrier and therefore require translation. Similar eyellipse-based calculations are used in the mid-term research regulations—such as in the FMVSS No. 104 reference to SAE J941 (1965)—and require further review in the contexts of these regulations. Table 15 summarizing this information can be found in **Appendix D**.

FMVSS NO. 114: THEFT PROTECTION AND ROLLAWAY PREVENTION

This standard "specifies vehicle performance requirements intended to reduce the incidence of crashes resulting from theft and accidental rollaway of motor vehicles" (S1). "The purpose of this standard is to decrease the likelihood that a vehicle is stolen, or accidentally set in motion" (S2). The standard also includes the requirement for the brake transmission shift interlock, which is one of the requirements in the Cameron Gulbransen Kids Transportation Safety Act of 2007 (the "K.T. Safety Act of 2007").

Technical Translations

The overall technical translation approach used for FMVSS No. 114 was to keep the intent of the regulation while using more generic language that does not imply a particular design (e.g., changed "move the gear selection control" to "change the transmission state"), action (e.g., changed "requires the service brake to be depressed" to "requires the service brake to be activated") or execution by a particular entity (e.g., changed "the user can remove the key" to "the key can be removed").

Potential Considerations

FMVSS No. 114 has several different requirements that refer to specific driver and vehicle actions. While generic language can be used to remove the dependency on a human or the implication of human control, some of the requirements are intended to address unintended consequences due to driver action or inaction, such as failure to set the parking brake when

parking on a hill or failure to remove the keys when leaving the vehicle. These may or may not be relevant for an ADS-DV.

During review of FMVSS No. 114, the key and vehicle propulsion system were evaluated to determine if there were regulatory barriers with the language specific to ADS-DVs. As defined in FMVSS No. 114, a key "means a physical device or an electronic code which, when inserted into the starting system (by physical or electronic means), enables the vehicle operator to activate the engine or motor." The implementation of the key may be different based on the use model. For example, an ADS-DV rideshare may handle the key differently than a private vehicle. Today, many vehicles use a key fob, which transmits an electronic code to "enable the vehicle operator to activate the engine or motor" (S4 of FMVSS No. 114). Although keyless ignition controls are not unique to ADS-DVs, the behaviors of the vehicle that are dependent on the functions associated with the key (i.e., accessory mode and engine/motor on/off) may vary depending on the use model. While it is expected that an ADS-DV will not have a traditional key system—there will be no physical key which is inserted into a starting system—the way that the key will be controlled by the operator is not known and any discussion at this time would be purely speculative. Therefore, the project did not provide technical translations for "key" references.

Although the literature review completed for this project suggests that most ADS-DV concepts and potential future deployments will use an electric motor, this cannot be assumed for all future ADS-DVs or conventional vehicles. FMVSS No. 114 refers to "engine or motor," where some other standards, such as FMVSS No. 141, refer to the vehicle's "propulsion system." However, this issue is not unique to ADS-DVs, as there are many vehicles currently on the road with plug-in electric or hybrid motors. There seems to be a common-sense approach to this issue, and the varying terminology in the FMVSS has not created any regulatory barriers, so no need was found for a technical translation to accommodate ADS-DVs.

S5.1.3 of FMVSS No. 114 generally requires an audible warning whenever the key is in the starting system and the door located closest to the driver's DSP is opened. The intent of the warning is for theft protection (i.e., to alert a driver who is leaving the vehicle that they may have inadvertently forgotten to take the key), which may not be applicable to an ADS-DV. For example, if the ADS-DV is not owned by any of the occupants, the key may purposely be left in the vehicle after the occupants leave. Similarly, in a rideshare ADS-DV use model, this audible warning may serve no purpose, as the occupants presumably would not be able to remove the key even if they wanted to. Another challenge is what seating locations should trigger the audible warning, as it is not known where the preferred seating location will be in an ADS-DV, and even if the preferred location is known, there is no certainty that the occupant in that seat will have the vehicle's key.

Test Procedures

FMVSS No. 114 is one of the two standards under near-term research from which portions are being used to demonstrate the identified functionalities. The test procedures specified in S6.2.2, which provides the current methodology to assess compliance with the rollaway prevention requirement in S5.2.5, were used to evaluate the human control and programmed-control methods. This regulation provides a unique case for ADS-DVs since the regulation requires a

specific order of service brake application/release, parking brake application/release and transmission control that will likely not be how an ADS will be programmed to operate. This highlights the possibility that in order to test an ADS-DV to verify compliance, its normal operation may need to be overridden and special commands given to execute the test procedures.

Since FMVSS No. 114 covers several seemingly unrelated items (e.g., theft protection, rollaway prevention, and shifting the gear out of park without the service brake applied), it serves as a good example of where it may make sense to use a combination of methods to verify compliance for a given standard. By way of example, technical design documentation may be used to demonstrate the intended performance of the audible alert (S5.1.3) and proper operation of the brake transmission interlock (S5.3), whereas a vehicle-based method may be more applicable for testing rollaway prevention (S5.2.5 and S6.2.2).

Conceivably, technical design documentation could also be used to show that the software for an ADS-DV keeps the brakes applied when the vehicle comes to a stop, thus demonstrating that the vehicle, as designed, is as safe as or safer than required for rollaway prevention (S5.2.5).

Potential Considerations

The final test procedures are dependent on the method used to test the requirements put forth in the standard. If the human control method is used, the test procedures could largely remain unchanged; if a programmed test method is used, the test procedures would focus more on the execution of the program rather than on the specific steps. This will be evaluated further as testing of the general test procedures continues.

Standards Incorporated by Reference

No incorporated references.

Challenges

None.

Stakeholder and SME Review Input

Several stakeholders provided feedback on the regulation text technical translation. In general, they agreed with the technical translations presented. There were some comments on the fact that the driver and vehicle operator may not be the same (e.g., the vehicle operator may be responsible for setting the destinations and interacting with the vehicle but not the DDT). In addition, there was general acknowledgement that the test procedures would likely need to be modified to allow the system states to be monitored for an ADS-DV since physical observation or manipulation of the vehicle state will not be possible.

Some SME reviewers provided input on the initial evaluation of the test methods based on the execution of the test procedures identified above. Two of the three SMEs were aligned with the evaluation results. One individual expressed the position that technical design documentation and simulation were much better methods for NHTSA to verify compliance, but did not elaborate on why or how.

Though not part of the test execution, with regards to the audible alarm associated with S5.1.3, the same reviewer questioned the relevance of telltales, warnings, and indicators for ADS-DVs.

Standards Incorporated by Reference

No incorporated references.

FMVSS NO. 118: POWER-OPERATED WINDOW, PARTITION, AND ROOF PANEL SYSTEMS

This standard specifies requirements for power-operated window, partition, and roof panel systems to minimize the likelihood of death or injury from their accidental operation. Some elements of this standard were prescribed in response to the aforementioned Cameron Gulbransen Kids Transportation Safety Act of 2007.

Technical Translations

While the technical translation language of FMVSS No. 118 is straightforward, the application and implementation may be more complex. The current regulation assumes that a human driver will be present to supervise the operation of the power windows, partitions, and roof panels. Indirect measures, such as door opening and key position, are used to determine whether a human driver is present. Providing manual pull-up window switches was not assessed to be a barrier to ADS-DVs and no feedback from SMEs indicated otherwise.

The aspect of unsupervised window operation was addressed in the technical translation options, either by specifying that ADS-DVs should comply with the S5 automatic reversal systems requirements (since driver presence may not be able to be assumed or applied) or by the notion that occupants riding in an ADS-DV are capable of safe window operation based on the level of maturity that would be needed to arrange a ride in an ADS-DV. In the latter approach, modifications were made to translate S4(e) from front doors to any door for an ADS-DV.

Potential Considerations

One approach could be to use seat belt buckling as a method to ensure safe operation of the windows. This would require the ADS-DV knowing that all occupants are seated and belted. This alternative may not necessarily prevent a child or other occupant from being belted and still operating the windows and potentially trapping either their own or another occupant's arm, hand, or fingers. However, it may protect from other more severe window-closure injuries and fatalities, as the head, neck, and upper body of a seated occupant would be positioned such that they are not at risk of entrapment. Additional research that is outside the scope of this project could be required to evaluate and potentially implement this option.

FMVSS No. 118 assumes that, when the power windows are operational, a human driver who is in control of the ignition key is present to supervise window operation. For example, S4(a) assumes that express-up windows will always be operated with some degree of supervision because the key must be in the "Accessory," "On," or "Start" position in order for the windows to close (optionally, the windows may comply with S5 Automatic Reversal System

requirements.) However, in an ADS-DV, the vehicle could be in the accessory, on, or start position without a suitable adult to supervise the operation of the windows by a child.

Another issue is determining whether to apply the provisions of S4(e) to the operation of ADS-DVs' power windows and sunroofs during the interval between engine shut-off and the opening of either of the vehicle's front doors. The challenge here is identifying whether additional ADS-DV doors should be included. The current standard assumes that a human driver would always be in the front seat, and therefore requires the power windows to be non-operational after the driver opens a front door in preparation for leaving the vehicle. But the "responsible adult" might not be seated in the front row of an ADS-DV, so it might be necessary to identify additional doors to achieve the same safety intent. Option 1 removes S4 (e) as an available choice for ADS-DVs, where Option 2 and Option 3 maintain this provision and specify that all vehicle doors are subject to the requirement.

Test Procedures

There are three potential methods being researched: human control, ADS normal operation, and technical design documentation. The human control method technical translation is not straightforward. The following functionalities were identified for the human control method: "Ignition Start/Stop," "Accessory Mode," and "Door Open/Close." The human control method development and considerations were discussed in the Test Procedures Section of Chapter 2. The programmed method was not applied to FMVSS No. 118 because there are no specific functionalities required outside of having power and being able to open the doors.

Potential Considerations

FMVSS No. 118 has the potential to be tested in the ADS-DV's normal domain (e.g., a parking lot) or using technical design documentation. Both of these are possibilities for near-term implementation. However, as discussed in the test procedure section, technical design documentation relies on information submitted by the manufacturer as compared to independent verification through testing. FMVSS No. 138 was used as an example for the technical design documentation method, and additional work may be needed to apply that method to other standards, such as FMVSS No. 118.

Stakeholder and SME Review Input

The majority of the SME reviewers believed that any changes to the S4 exceptions to S5 would expand the need for automatic reversal systems. One reviewer mentioned that an audible warning to occupants could be considered. At the April 2018 FMVSS Stakeholder Meeting (VTTI, 2018a, 2018b), SMEs expressed mixed opinions. Some believed that there are no regulatory barriers to ADS-DVs in FMVSS No. 118 while others believed technical translations were required. Some commented that translating the exception in S4(e) so that it would apply to the opening of any door, as opposed to just the front doors, would not be equivalent to the current standard and would instead be more restrictive. Others went even further and stated that when everyone is a passenger, automatic reversal systems should be required. However, many SMEs asserted that the performance requirements for automatic reversal systems in S5 are difficult

and/or costly to meet, and reducing or limiting the current alternatives allowed for in S5 could create an additional regulatory burden.

Standards Incorporated by Reference

No incorporated references.

FMVSS No. 138: TIRE PRESSURE MONITORING SYSTEMS

The Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act mandated that motor vehicles be equipped with TPMS. FMVSS No.138 addresses this Congressional mandate and specifies performance requirements to warn drivers of significant under-inflation of tires.

Technical Translations

There were three main aspects to developing technical translations options for FMVSS No. 138:

1. How to communicate the detection of a low tire pressure state and TPMS malfunction to the ADS under the same circumstances that currently initiates a telltale illumination to a human driver. This was addressed by altering the language specific to the telltale to allow for the incorporation of communication to the ADS. For example, the current use of "illuminate" was translated to "indicate" and a "low tire pressure warning telltale" was translated to a "low tire pressure warning state."

2. How the low tire pressure state and TPMS malfunction may be presented in an ADS-DV. As discussed in Chapter 1, Controls, Telltale and Indicators, Options 1–5 from the Analysis of Regulatory Information in Vehicles were used in the technical translation of FMVSS No. 138 to communicate the information to the ADS and provide a range of options for providing telltales in the occupant compartment and one option for not including the telltale. Because FMVSS No. 138 S1 states that its purpose and scope "is to warn drivers of significant under-inflation of tires and the resulting safety problems," the information is thought to be relevant for the ADS, and therefore options that did not include the ADS receiving the information were not employed.

3. Alternatives for the required written instructions that retain the warnings of significant under-inflation of tires and the resulting safety problems.

Potential Considerations

If the information is only provided to the ADS in an ADS-DV, this approach may clarify that the ADS is responsible for taking some action to address a low tire pressure state or a TPMS malfunction. However, having the information inside the occupant compartment provides important information to the occupants and entity responsible for maintenance. If the information is provided to both the occupants and the ADS, NHTSA may want to consider amending the required owner's manual language to clarify responsibility for taking action. Another option is a possible alternative for a maintenance message that would provide the information in a

consistent matter. Although this message may not be visible to all DSPs (e.g., accessible using a vehicle screen), it could be information occupants might check prior to riding in the ADS-DV.

The low tire pressure and malfunction warnings are currently presented to a human driver, and the delivery method used to communicate those warnings is through the illumination of a telltale. Telltales are one of the crosscutting technical translation themes; therefore, these issues were reviewed not just within the context of FMVSS No. 138 but within the larger crosscutting analysis. The options outlined above provide the high-level technical translations for addressing the telltale. The specific requirements for location, identification, color, and illumination of the telltale are covered in FMVSS No. 101, Controls and Displays, which will be examined during this project's mid-term research.

Test Procedures

The technical translation of the test procedures requires limited research and is not straightforward. FMVSS No. 138 requires general driving control functionalities (e.g., operating the ADS-DV on a public road course). In addition to general driving control, the following are also needed for NHTSA to verify compliance: service brake application, steering control, speed control, ignition start/stop, application of the parking brake, and communication of the low tire pressure state functionalities. A range of methods, including human control, programmed, normal ADS operation, and technical design documentation are being researched for testing. FMVSS No. 138 was used to evaluate technical design documentation and can found in **Appendix E**. Listed below is a paraphrased portion of section 13.3 of the OVSC test procedures for FMVSS No. 138 (TP-138-03; p.14) that were implemented.

J. If not running, start engine (assumes preprogrammed start command; e.g., brake must be applied and transmission must be in park)
    - Shift into drive (assumes preprogrammed gear change command; e.g., brake must be applied prior to shifting into drive)
    - Release brake
    - Drive pre-defined route at a target speed range of 75 + 25 km/h until 10–15 min of cumulative driving time in this range is complete. (Note: the particulars of this step are dependent on vehicle design; e.g., waypoint follower vs lane line follower)
    - Return to starting point and stop
    - Log/record cumulative driving time

K. Repeat the previous steps, traveling in opposite direction for 5–10 min cumulative driving time

L. Execute stop vehicle command (assumes preprogrammed stop command; e.g., apply brake, put transmission in park, turn off engine)
    - Immediately measure and record tire pressures and sidewall and roadway temperatures

M. Execute tire deflation as defined
    - Log TPMS state
    - If state changes to indicate low tire pressure, skip step O

O. Repeat step J for 15–17 min or until TPMS state changes
P. Log/record cumulative driving time

(Note: Step N. has been intentionally left out of this section.)

While the procedures are sufficient for a human driver to execute the test, additional details need to be defined for a vehicle to execute the test in a preprogrammed manner. The full set of instructions used to define the sequence of commands for the vehicle to operate in preprogrammed mode can be found in Table 24 (in **Appendix F**).

Potential Considerations

FMVSS No. 138 regulates a system that operates independently of the driver. By way of comparison, the theft protection and rollaway prevention requirements in FMVSS No. 114 involve driver action or inaction; e.g., the "driver" leaves the key in the vehicle (theft risk) or fails to ensure that the vehicle is locked in Park (rollaway risk). FMVSS No. 138 provides the opportunity to evaluate the use of normal ADS operation and technical design documentation.

While FMVSS No. 138 provides an opportunity to evaluate the normal ADS operation test method, successful demonstration of this method does not guarantee that it would be applicable for all ADS-DVs and therefore may require further investigation. For example, FMVSS No. 138 states that compliance testing is conducted on any portion of the Southern Loop of the Treadwear Test Course. This area may not be within a particular ADS-DV's ODD. Another potential challenge is accommodating the different ways that ADS-DVs may be programmed to deal with low tire pressure (e.g., stop the vehicle, drive to the nearest service station, or go to the next destination in limp-home mode).

Technical design documentation also presents challenges that are not unique to FMVSS No. 138 and, as discussed in the Chapter 2 Test Procedures documentation, can show intent but may not provide a means to confirm operation of the end-to-end system. However, it may explain how the ADS is designed to receive the information and include test data collected from the manufacturer to provide the system performance of the physical vehicle.

Stakeholder and SME Review Input

As reviewers provided feedback on the FMVSS No. 138 technical translation work, they provided several language revisions and comments that were captured in the final version of the worksheets. In general, the reviewers agreed with the technical translation approach. However, several of the reviewers did not agree with the options that would require a telltale in the occupant compartment of an ADS-DV. One of the reviewers commented, "This should be an 'OR' condition where it either illuminates the telltale or the manufacturer demonstrates ability to communicate the low tire pressure condition and the strategy to stop operating the vehicle in a low tire pressure condition if an occupant is not expected to react." Another SME reviewer commented that the technical translation was overreaching. Further input provided by one of the reviewers stated that FMVSS No. 138 is intended to incentivize human drivers to promptly address a low tire pressure condition and should not apply to ADS-DVs.

During the discussion regarding FMVSS Nos. 101 and 138 at the April 2018 FMVSS Stakeholder Meeting (VTTI, 2018a, 2018b), specifically the Controls and Displays panel session, the technical translation option requiring the TPMS information to be communicated to the ADS was generally accepted as an appropriate approach. The low tire pressure warning telltale options received mixed reactions, however. From the group comments, there seemed to be consensus that telltales in general needed to be considered when needed for safety reasons critical to the non-driving occupant. Additionally, the discussions considered that the written instruction for the TPMS is currently interpreted as a printed document, whereas this method may not be suitable for communicating safety information to a non-driving occupant, particularly in a ride-share market application.

Some participants noted that human drivers are presumed to take action when they receive a warning, and questioned what, if anything, the ADS would do with the information required to be conveyed to a human driver. Others noted that the ADS would be responsible for taking action and that there might not be anyone in the occupant compartment who would be able to react appropriately to the telltale.

There were three SME reviewers who provided input on the test procedures evaluation. Two of the reviewers generally agreed with the evaluation results, though there was some discussion on the amount of time it might take to execute the different testing methods. One reviewer's comments focused on the overall applicability of FMVSS No. 138 to an ADS-DV since the purpose of the standard is to warn the driver (human) of a potentially unsafe condition. Final test procedure evaluation will be done in the full context of the near-term and mid-term testing, which will be captured in the final mid-term report.

Standards Incorporated by Reference

No incorporated external references.

FMVSS No. 141: MINIMUM SOUND REQUIREMENTS FOR HYBRID AND ELECTRIC VEHICLES

This standard establishes performance requirements for pedestrian alert sounds for motor vehicles (S1). The purpose of this standard is to reduce the number of injuries that result from electric and hybrid vehicle crashes with pedestrians by providing a sound level and sound characteristics necessary for these vehicles to be detected and recognized by pedestrians (S2). This regulation was in response to the Pedestrians Safety Enhancement Act.

Technical Translations

In line with the larger effort, the overall technical translation approach used for FMVSS No. 141 was to maintain the safety purpose and scope while minimizing changes to the existing language. The considered technical translation options were typically straightforward, and generally were limited to either minor text changes or clarifications.

The most common technical translation was to replace references to a vehicle's "gear selector" with "transmission." The term "transmission" applies regardless of driver type, whereas a "gear selector" is a manually operated driving control that would not be present in an ADS-DV.

With respect to vehicle test weight, a simple addition of "if any" following the references to test driver allows for the inclusion of a driver only if one is necessary to conduct the prescribed testing. An alternative could be to change "driver" to "occupants." Another change considered was to remove references to "driver's side" and "passenger side" from the regulatory language. Two technical translation options were provided, one including references to the left and right sides of the vehicle, and another specifying that acoustic sound files were required for "both sides of the vehicle."

Potential Considerations

The original technical translation approach used accounted for bidirectional vehicles and, in the case of FMVSS 141, considered a greater variety of modifications throughout the regulatory language. However, as discussed previously in this report, after further analysis, it was deemed appropriate to address bidirectional vehicles in the context of translating Part 571.3, Definitions. This makes the FMVSS No. 141 technical translation more straightforward.

The technical translation of "gear selector" to "transmission" works for the types of ADS vehicles that are currently envisioned today, but may not be applicable to future technology.

Test Procedures

Technical translations to the test procedure were not required from a language perspective. However, methods for NHTSA to verify compliance may not be straightforward, as the procedure requires general driving control, speed control, gear selection, vehicle positioning, and use of a parking brake. The test procedure development and evaluation undertaken for FMVSS Nos. 114 and 138 encapsulates the FMVSS No. 141 test procedure needs.

Stakeholder and SME Review Input

Feedback offered by SME reviewers indicated general agreement with the considered changes, with reviewers offering alternate technical translation options at times. Understandably, feedback attempted to minimize the number of technical translations, agreeing with options or considered changes only when the reviewers felt modifying was unavoidable. The primary topic of disagreement or uncertainty related to whether there was a need to directly address bidirectional capabilities. In the end, the approach used for addressing such vehicles in Subpart A of Part 571 should satisfy concerns on both sides of this argument. Finally, comments that did not justify a translation (e.g., the comments were out of scope) but which may provide useful feedback were included as general observations; this also applied to feedback related to the test procedures.

For the test procedures, FMVSS No. 141 was not selected for the methods evaluation. Therefore, there was no specific stakeholder or SME review input.

Standards Incorporated by Reference

There are five incorporated references in FMVSS No. 141 (three of which are different versions of the same ISO standard). The referenced documents are ANSI S1.11-2004, ISO 10844:1994, ISO 10844:2011, ISO 10844:2014, and SAE J2889-1. These were reviewed and assessed as 0 (no barrier).

CHAPTER 4. CRASHWORTHINESS AND OCCUPANT PROTECTION STANDARDS

OVERVIEW

This chapter describes the strategy used for translating the FMVSS for crashworthiness and occupant protection designated for near-term research. The standards considered were FMVSS Nos. 201, 202a, 203, 204, 205, and 206. The goal of this effort was to translate the language of each standard and any associated test procedures to accommodate ADS-DVs while maintaining the requirements for conventional (i.e., non-ADS-equipped) vehicles.

This effort focused on occupant protection for ADS-DVs with conventional seating. This includes ADS-DVs with forward-facing seating but no steering wheel. Alternative seating configurations, such as rear-facing or side-facing seats were not considered.

Technical Translations

In providing technical translations for the FMVSS 200-series standards of focus during near-term research, the following crosscutting themes were repeatedly encountered.

1. References to the driver and driver's DSP, often in the form of "driver's seat" (FMVSS Nos. 201, 202a, 203, 206)
2. How to translate telltales, such as door closure reminders, to apply to ADS-DVs (FMVSS No. 206)
3. Dummy seating position landmarks, such as the steering wheel, which may no longer exist (FMVSS Nos. 201, 202a, 203, 206)
4. The apparent front seat bias of many of the FMVSS

The FMVSS do not require that a vehicle has a driver's DSP. However, if the vehicle has a driver's seat, then the FMVSS require that the vehicle meet several standards intended to protect a person in that seat. In a crash, the person seated in the driver's DSP experiences a different risk of injury from the steering control system than other front-seated occupants. Several of the FMVSS 200-series reflect this difference in injury risk. The occupant protection provisions of the FMVSS 200-series are associated with the potential hazards of individual occupant seating positions rather than the role of the occupants seated at those locations. An assessment of the potential hazards included the exposure of occupants to the harm addressed by the standard. Since occupancy rates are higher for front seats in conventional vehicles than for rear seats (i.e., there is always a driver in a front seat), some FMVSS only apply to front seats, and not to rear seats.

The overall technical translation strategy was to reframe the regulatory language in terms of DSPs rather than occupant roles, such as a "driver" or "passenger." Two distinct options for defining "driver" were developed to facilitate the technical translation of the FMVSS to ADS-DVs. Option 2 to define "driver" as stated in Chapter 1 is similar to the current definition of "driver" in 49 CFR § 571.3, meaning a vehicle occupant seated immediately behind the manually

operated driving controls. The technical translation included the development of carefully worded definitions of the following terms for incorporation into Section 571.3.

- Driver's DSP (driver's seat or driver's seating position)
- Manually Operated Driving Controls
- Steering Control
- Passenger DSP (passenger seat or passenger seating position)

Potential Considerations

The clarification and use of the term "driver's DSP" and its associated definitions greatly simplify the FMVSS technical translations. Any language that currently refers to a driver's DSP would not require technical translation. If a vehicle does not have a driver's DSP, as is the case for ADS-DVs, then all DSPs would be passenger DSPs, and only the FMVSS sections referring to passenger DSPs or passenger seats would apply to these seating positions. However, if a vehicle *does* have a driver's DSP, as is the case for conventional vehicles, it would be required to meet all FMVSS requirements associated with protection of an occupant seated in this position. As noted earlier, there may be cases where an FMVSS requirement or provision applies to or references the driver's seat and is silent with respect to the passenger seat (e.g., a door closure warning system for hinged doors is required to be visible to the driver, *see* FMVSS No. 206, S4.1.2.3). In this example, if all DSPs are considered passenger seats, it does not necessarily mean the warning does not have to visible to some occupant. Occupants may still be expected to be notified of an unlatched door. (This was discussed in Chapter 2 under Controls, Telltales, and Indicators.)

In some cases, the technical translation options modify the definitions or requirements for conventional vehicles and ADS-equipped vehicles. One example of this is the definition of "A-Pillar" in FMVSS No. 201, Occupant Protection in Interior Impact. Currently, the standard defines the A-Pillar as "any pillar that is entirely forward of a transverse vertical plane passing through the seating reference point of the driver's seat." One option is to translate this to "…passing through the seating reference point of any front passenger seat." This technical translation might have little effect on how automakers comply with this standard. However, the change would affect both conventional vehicles and ADS-DVs.

The technical translation of requirements for telltales of the FMVSS 200-series requires careful consideration. FMVSS No. 206, for example, specifies a requirement that the driver be notified if a limited number of specified doors (side doors with rear-mounted hinges and certain sliding side doors) are unlatched. If there is no human driver, the question arises as to who or what should be notified if one of the doors covered by this requirement is not properly latched. The issue of what actions should be taken by the ADS in an ADS-DV in response to such a warning is beyond the scope of this project.

The apparent front seat bias of certain FMVSS (e.g., air bags are required for front outboard DSPs, but not for the rear seats) will be considered during mid-term research. Assuming front and rear seat occupancy rates remain similar between vehicles with and without ADSs, the translation of front/rear references is straightforward for ADS-equipped vehicles with conventional, forward-facing seating, but may need to be revisited for technical translations of

the FMVSS 200-series to rear- or side-facing seating configurations. If front and rear seat occupancy rates are found to be substantially changing with the advent of ADS-DVs, this issue may need to be revisited for various seating configurations.

Test Procedures

The current technical translation of the FMVSS 200-series involves mirroring the passenger/right side testing to the left side when there are no controls, and therefore does not require any additional test procedure development for translation.

Stakeholder and SME Review Input

The comments from stakeholders were in general agreement with the generated technical translations. The consensus was that technical translations for conventional seating configurations should be considered first. The definition options for "driver designated seating position" were well-received. The sentiment among the stakeholders was that simple technical translations were better. The manufacturers in the stakeholders group felt the first priority should be removing regulatory barriers to ADS-DVs in the short-term. The panelists who participated in the 200-series sessions at the April 2018 FMVSS Stakeholder Meeting (VTTI, 2018a, 2018b) suggested that research should then begin in parallel with follow-on technical translations in the following timeframes:

- Near-term research: conventional seating (possibly extending existing FMVSS front seat requirements to the rear seats)
- Mid-term research: carriage seating (non-conventional seating arrangement with both forward and rearward facing seats)
- Long-term research: side-facing seating (may take up to a decade)

Standards Incorporated by Reference

All incorporated references noted in the 200-series FMVSS were evaluated for potential regulatory barriers. FMVSS No. 201 has four such references; FMVSS No. 202a has two such references; FMVSS No. 203 has one such reference; FMVSS No. 205 has four such references; and FMVSS No. 206 has one such reference. As summarized in the following sections, none of these references pose a regulatory barrier to technical translation.

FMVSS NO. 201: OCCUPANT PROTECTION IN INTERIOR IMPACT

FMVSS No. 201, S1 states that this standard "specifies requirements to afford impact protection for occupants" in impacts with interior components of the occupant compartment. This standard prescribes three types of tests: (1) component tests of impacts into interior components (e.g., the instrument panel) and requirements for interior compartment doors, armrests, sun visors, and instrument panels and seat backs; (2) impacts of a free-motion head form into the upper interior components and supporting structures (e.g., the A-pillar, B-pillar, roof rails and header); and (3) a dynamic rigid pole side crash test, which is typically met through the installation of side curtain air bags. This pole test, however, has been superseded by the pole test enumerated in S9 of FMVSS No. 214 for most vehicles.

Technical Translations

Technical translations were made for vehicle landmarks from terms such as "driver" or "passenger" side. For example, in S3 "Definitions," all "pillar" definitions are prescribed in terms of the "seating reference point of the driver's seat." In this context, the motivation for using the seating reference point of the driver's seat is simply to identify the front left seating reference point as a location-based landmark. Therefore, one technical translation option is to translate "driver's seat" to "left front seat." There are alternative technical translations for the "left" specification, as pillars appear on both sides of a vehicle. Another option is to translate "driver's seat" to "any front seat." To avoid modifying the definition for both vehicle designations, another option would be to split the definition between ADS-equipped and non-ADS-equipped vehicles. The technical translation options in the spreadsheets are primarily different in language and are typically interchangeable.

Potential Considerations

Using the new definitions in Section 571.3 for driver's DSP and associated terms, the technical translations are greatly simplified. While the overall approach of minimizing changes to the regulation text was maintained, some technical translation options modify definitions for conventional vehicles as well as ADS-DVs.

Test Procedures

FMVSS No. 201 has three distinct test procedures: (1) the occupant compartment test procedure in S5, (2) the upper interior test procedure in S8-S10, and (3) the dynamic rigid pole side crash test procedure. In each case, the technical translation approach used was to reframe the regulatory language in terms of DSPs rather than occupant roles, such as a "driver" or "passenger." Specifically, the test procedure language was translated to use the new definitions for driver's DSP and associated terms. In addition, technical translation options were provided for vehicle landmarks from terms such as "driver's" or "passenger" side to "left" or "right" side, "left" or "right front outboard" or "any front outboard" position. The dummy positioning for FMVSS No. 201 dynamic pole test involves mirroring the passenger/right side testing to the left side when there are no controls, and therefore does not require any additional test procedure development for technical translation.

Potential Considerations

None

Stakeholder and SME Review Input

The consensus among the stakeholders was that conventional seating configurations should be considered first. The definition options for "driver's DSP" were well-received, and the feedback provided was that simpler technical translations were preferred.

Standards Incorporated by Reference

FMVSS No. 201 incorporates a total of four references. SAE Recommended Practice J921, June 1965 does not pose a regulatory barrier for ADS-DVs, as it would continue to apply to instrument panels in front of the front passenger seats, regardless of whether they are on the left or right side of the front row. The standard also refers to SAE Recommended Practice J977, November 1966. This recommended practice reference also poses no regulatory barrier, as it only prescribes instrumentation. The standard also incorporates Section 5 of SAE Recommended Practice J839b, May 1965 for sun visors. This does not present a regulatory barrier as sun visors would continue to be required pursuant to Section 5.4 of FMVSS No. 201. The standard also incorporates SAE Recommended Practice J211/1, March 1995, by reference; however, this recommended practice only refers to signal processing of test instrumentation and therefore does not need to be translated.

FMVSS No. 202A: HEAD RESTRAINTS

S1 of FMVSS No. 202a states that this standard "specifies requirements for head restraints to reduce the frequency and severity of neck injury in rear-end and other collisions." The standard prescribes the installation of head restraints, which limit the rearward displacement of a seated occupant's head with respect to the occupant's torso. The standard applies to each front and rear outboard DSP with a head restraint, and allows head restraints to be tested either dynamically or statically. School buses are exempted from this requirement (other than the driver's DSP).

Technical Translations

In this standard, S4.7.1 states, "The owner's manual for each vehicle must emphasize that all occupants, including the driver, should not operate a vehicle or sit in a vehicle's seat until the head restraints are placed in their proper positions in order to minimize the risk of neck injury in the event of a crash." In this case, the simplest technical translation option is to omit "including the driver," as this may be considered unneeded language, even in the context of conventional vehicles, since the driver is captured by the "all occupants" statement and might be irrelevant in the context of ADS-DVs.

Potential Considerations

None

Test Procedures

Technical translations of the test procedures are not necessary, since they do not distinguish between the two front outboard seating positions.

Potential Considerations

None

Stakeholder and SME Review Input

The consensus among the stakeholders was that near-term research (conventional seating only) should be considered first.

Standards Incorporated by Reference

FMVSS No. 202a incorporates SAE Standard J826, July 1995, by reference. No technical translations are required, as FMVSS No. 202a applies to both front outboard DSPs. The standard also incorporates SAE Recommended Practice J211/1, March 1995, by reference for a total of two references. However, this recommended practice only refers to signal processing of test instrumentation and would not pose a regulatory barrier to ADSs.

FMVSS No. 203: IMPACT PROTECTION FOR THE DRIVER FROM THE STEERING CONTROL SYSTEM

S1 of FMVSS No. 203 states that this standard "specifies requirements for steering control systems that will minimize chest, neck, and facial injuries to the driver as a result of impact." The standard specifies a test procedure in which the steering control system is impacted by a body block at a relative velocity of 24 km/h, and limits the resulting force from the body block transmitted to the steering control system. In general, vehicle designers meet this requirement by installation of a steering control system made of energy-absorbing material. The standard also specifies that the steering control system be constructed so that no components or attachments "can catch the driver's clothing or jewelry during normal driving maneuvers." The standard does not apply to vehicles that conform to frontal barrier crash requirements of FMVSS No. 208 by means other than seat belt assemblies.

Technical Translations

The overall technical translation approach used was not to rewrite the regulatory language. The FMVSS do not require a driver's DSP, but if there is a driver's DSP, the requirements of this standard would apply, as there would also be a steering control system by definition.

Potential Considerations

Even with respect to conventional vehicles, this standard has a very limited application, since it applies only to passenger cars and to multipurpose passenger vehicles, trucks and buses with a GVWR of 4,536 kg (10,000 pounds) or less, but not to vehicles that comply with the frontal barrier crash requirements of FMVSS No. 208 by means other than seat belt assemblies (see S2). Since all passenger cars and all multipurpose passenger vehicles, etc. with a GVWR of 8,500 pounds or less and an unloaded vehicle weight of 5,000 pounds or less must be equipped with air bags at both front outboard seating positions, only a very limited subset of multipurpose passenger vehicles, trucks, and buses are within the scope of this standard. Driver definition Option 2 was used for FMVSS No. 203 but Option 1 could also be used by translating "for the driver" and "to the driver" to "for the human driver" and "to the human driver."

Test Procedures

The test procedure for FMVSS No. 203 is incorporated in the standard itself. The test is conducted following the procedure documented in SAE Recommended Practice J944, June 1980, (incorporated by reference). No technical translation is required for the test procedure, assuming it is only applicable to vehicles with steering controls.

Potential Considerations

None

Stakeholder and SME Review Input

None

Standards Incorporated by Reference

The inspection of the one cited reference, SAE Recommended Practice J944, June 1980 revealed no need for technical translation. This recommended practice would continue to apply only to vehicles for which FMVSS No. 203 is applicable.

FMVSS No. 204: STEERING CONTROL REARWARD DISPLACEMENT

S1 of FMVSS No. 204 states that this standard "specifies requirements limiting the rearward displacement of the steering control into the passenger compartment to reduce the likelihood of chest, neck, or head injury." In a 48 km/h perpendicular impact into a fixed collision barrier, the standard sets limits on the maximum intrusion of "the steering column and shaft" into the occupant compartment.

Technical Translations

The standard does not refer to a "driver" or a "driver's DSP." There would be no "steering column" or "steering shaft" in an ADS-DV, so the test specified in the standard would not be performed. S2 of FMVSS No. 204 states, "This standard applies to passenger cars and to multipurpose passenger vehicles, trucks, and buses. However, it does not apply to walk-in vans." One option is to leave this as is since FMVSS do not require a vehicle to have a steering control system. This would not apply to ADS-DVs without a steering control system. A second option is to more explicitly exclude ADS-DVs without a steering control system by translating S2 to "does not apply to walk-in vans or vehicles without a manual steering control system."

Potential Considerations

None

Test Procedures

The test procedure for FMVSS No. 204 is incorporated in the standard itself. If the test is expected to only apply to vehicles with a steering column and shaft, no technical translation is required.

Potential Considerations

None

Stakeholder and SME Review Input

None

Standards Incorporated by Reference

No incorporated references.

FMVSS No. 205: GLAZING MATERIALS

The purpose of FMVSS No. 205 as elaborated in S2 is "to reduce injuries resulting from impact to glazing surfaces, to ensure a necessary degree of transparency in motor vehicle windows for driver visibility, and to minimize the possibility of occupants being thrown through the vehicle windows in collisions."

Technical Translations

The 100-series and 200-series FMVSS do not require that a vehicle have a windshield or other glazing surfaces. Vehicles in which a windshield or any other glazing surfaces are present must meet the requirements of FMVSS No. 205. This applies to ADS-DVs and non-ADS-DVs with glazing materials. For ADS-DVs with glazing, the impact requirements already in place should remain. For S2, an option was added to specify the degree of transparency is for "driver visibility when manually operated driving controls are present."

Potential Considerations

Future consideration may be given to transparency requirements for driver visibility, as this may no longer be necessary in ADS-DVs, even for concept vehicles in which the manufacturer chooses to replace conventional windshields or glazing surfaces with other systems (e.g., LED screens).

Test Procedures

No translation required.

Potential Considerations

None

Stakeholder and SME Review Input

None.

Standards Incorporated by Reference

FMVSS No. 205 contains four references: ANSI SAE Z26.1, 1996; SAE J100, June 1995; and SAE J673, April 1993. (Since Z26.1 would need to be approved by two external organizations—ANSI and SAE—it is counted as two references.) Within these references, requirements are specified to establish the needed degree of transparency in motor vehicle windows allowing for adequate driver visibility as well as durability and resistance to scratching, effects of extended exposure to high humidity or temperature, impact resistance, etc. If any sensors and cameras are behind glazing, the lenses of the cameras could be glazing "requisite for driving visibility," as are the windshield and windows in front of the B-Pillar in multipurpose passenger vehicles.

Depending on the design of an ADS-DV, including the location and type of sensors, many of the vehicle windows may not be "requisite for driving visibility." This development does not require technical translation of FMVSS No. 205, and it may not require technical translation of the ANSI standard, but may require a new interpretation applicable to ADS-DVs in the future. A general approach for the long term would be to incorporate and modify Table 1 of ANSI for new vehicle designs by listing which tests are applicable. This has two benefits: (1) NHTSA could state that the windshield impact requirements are applicable at other locations, or that the light stability tests (or other tests listed such as luminous transmittance, humidity, abrasion resistance, optical deviation and distortion, etc.) are not applicable to certain ADS glazing locations; and (2) ANSI would not have to be updated. ANSI SAE Z26.1 refers to the location of safety glazing materials in relation to the driver. It would continue to apply for the purposes of the human driver, and as such, does not require technical translation. However, the reference may require technical translations if the term "driver" by itself is chosen to be removed (e.g., in ANSI SAE Z26.1, translate "immediate left or right of the driver" to "immediate left or right of the driver designated seating position").

FMVSS No. 206: DOOR LOCKS AND DOOR RETENTION COMPONENTS

S1 of FMVSS No. 206 states that this standard "specifies requirements for vehicle door locks and door retention components, including latches, hinges, and other supporting means, to minimize the likelihood of occupants being ejected from a vehicle as a result of impact." FMVSS No. 206 also requires that the driver be notified if a limited number of specified doors (side doors with rear mounted hinges and certain sliding side doors) are unlatched.

Technical Translations

The overall technical translation approach used in this project was to reframe the regulatory language in terms of DSPs rather than occupant roles, such as a "driver" or "passenger." For FMVSS No. 206, this approach was used in one location of the technical translation options. The FMVSS do not require a driver's DSP, but if there is a driver's DSP, the requirements of this standard would apply to that position. In addition, technical translations were made for vehicle landmarks from terms such as "driver" or "passenger" side to "left" or "right" side, respectively. For example, in S3 "Definitions," the terms "side front door" and "side rear door" are defined in

relation to "the driver's seat back." In this context, the motivation for referring to the driver's seat is simply to identify the back of the left front seat as a location-based point of reference. Therefore, one technical translation option is to translate "driver's seat back" to "left front occupant's seat back." Another option is to translate "driver's seat back" to "any front outboard seat back." If this option is not descriptive enough, another option is to explicitly state the "left front side door" is in relation to the "left front outboard seat back" and vice versa for the "right front side door."

FMVSS No. 206 defines a "Door Closure Warning System" as "a system that will activate a visual signal when a door latch system is not in its fully latched position and the vehicle ignition is activated." Door latch warning systems in which the visual signal must be located where it can be clearly seen by the driver are only required in connection with a limited number of specified doors. See S4.1.2.3(b), which applies to "side doors with rear mounted hinges that can be operated independently of other doors," and S4.2.1(b), which applies to sliding side doors if the vehicle manufacturer has elected not to use a "primary door latch system." In addition, for buses with a wheelchair lift door, the last sentence of S4 specifies that the door "…must be linked to an alarm system consisting of either a flashing visible signal located in the driver's compartment or an alarm audible to the driver that is activated when the door is not fully closed and the vehicle ignition is activated." The following technical translation options for each of these telltales would apply to ADS-DVs:

1. Add language requiring the door closure warning be communicated to the ADS and require a telltale be displayed at all front passenger DSPs if no driver's DSP is occupied or present (Controls, Telltales and Indicators, Potential Option 3).
2. Add language requiring the door closure warning be communicated to the ADS and require a telltale be displayed at all DSPs if no driver's DSP is occupied or present (Controls, Telltales and Indicators, Potential Option 6).
3. Add language requiring the door closure warning be communicated to the ADS and require a telltale to be displayed at the left, front DSP (i.e., consistent with the current requirements in a vehicle with a human driver, Controls, Telltales and Indicators, Potential Option 2).
4. Add language requiring the door closure warning be communicated to the ADS (Controls, Telltales and Indicators, Potential Option 1).

For the four options listed above, "clearly seen by the driver" is translated to "clearly seen from the driver's DSP," and the current requirements for non-ADS-equipped vehicles are maintained. Potential Option 9 (to all DSPs and not to the ADS) and Potential Option 1 (only to occupants) in Controls, Telltales and Indicators were not used for the telltale in FMVSS No. 206 but may be options to consider once it is determined who/what should be notified of an unlatched door. Potential Options 7, 8, and 10 were not used since the review input was that the information should always be communicated to the ADS.

Potential Considerations

Some technical translation options could result in the modification of requirements for both conventional vehicles and ADS-DVs. There are also a number of considerations outside the scope of this project for each of the telltale translation options, which are presented in Table 14

below. As stated in S4.1.2.3(b) for side doors with rear mounted hinges that can be operated independently, "The door closure warning system shall be located where it can be clearly seen by the driver." In addition to a visual warning, audible/haptic warnings could be considered.

Table 14. FMVSS No. 206 Telltale Translation

Option	Translation	Considerations
1	**To the ADS and all front DSPs.** Provide the telltale at all front passenger DSPs if no driver's DSP is occupied or present. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	In an ADS-DV, there may not be anyone seated in the front row.
2	**To the ADS and all DSPs.** Provide the telltale at all DSPs if no driver's DSP is occupied or present. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Novel approaches may be required to notify all passengers on a bus that a wheelchair lift door is not fully closed.
3	**To the ADS and provide per the current standard location.** Provide the telltale at the left front DSP. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	In an ADS-DV, there may not be anyone seated in this position. Information may not be received by any occupant.
4	**To the ADS and provide per the current standard location.** Retain current language for non-ADS-equipped vehicles (e.g., clearly seen by the driver) and communicate the door closure warning system to the ADS in ADS-DVs.	In an ADS-DV, there may not be anyone seated in this position. Maintains preference for left front seating position for conventional vehicles.

Test Procedures

As with the telltales in the regulatory language, the approach used for translating the test procedures was to reframe the test procedure language in terms of DSPs rather than occupant roles, such as a "driver" or "passenger." The technical translation options for the telltales regarding the "door closure warning system" in the test procedure were the same as the options in the regulation text. In addition, vehicle landmarks technical translation options include translations from terms such as "driver's" or "passenger" side to "left" or "right" side. For example, the test procedure includes definitions for "side front door" and "side rear door" in relation to the "driver's seat back," as well as "driver's door sill" for measuring vehicle pitch, "driver side impact," and "driver's" and "passenger" door.

Potential Considerations

Using the test methods further developed for the FMVSS 100-series telltales, the project may develop options that address verifying the communication of information to the ADS about unlatched doors. Activation of the ignition start/stop would similarly use the method of activating ADS controls developed for the FMVSS 100-series.

Stakeholder and SME Review Input

There were strong differences of opinion on telltales in general, not only for FMVSS No. 206, both among the stakeholders and the SME reviewers. With regard to the question, "Are telltales just to make the driver aware, or is there the expectation of safety?" there were two positions with little agreement among the stakeholders.

- Position 1: Just make the driver aware of the issue (e.g., a door is unlatched).
- Position 2: There is a need to assure that someone or something takes action in response to the information conveyed by the telltale.

Comments from the stakeholders included the following.

- There may be a need for someone to be designated as the responsible occupant (i.e., the "operator").
- Part of the reason for telltales is the assumption that it is the human driver who is responsible for taking action/making decisions. Wouldn't the ADS also be responsible for taking action/making decisions?
- If an ADS-DV operated with doors open, would the ADS be considered negligent?

Standards Incorporated by Reference

FMVSS No. 206 incorporates paragraph 6 of SAE Recommended Practice J839, June 1991 by reference (one reference only, see **Appendix D**). This recommended practice would not present a regulatory barrier, however, as the vehicle door latch strength would continue to be tested following this procedure regardless of whether the door is adjacent to a driver's or passenger DSP. Note that in an ADS-DV, all DSPs would be passenger DSPs.

CHAPTER 5. SUMMARY OF RESEARCH FINDINGS

This project provides research findings in the form of technical translations options to potential regulatory barriers in the FMVSS and related OVSC test procedures identified for compliance verification of innovative new vehicle designs that may appear in vehicles equipped with ADSs. Test procedures (FMVSS and OVSC) are used by NHTSA to assess compliance with the safety performance requirements of the FMVSS, which are wide-ranging. The FMVSS technical translations effort is focused on a particular type of ADS-equipped vehicle, the ADS-DV, which for the purposes of this project is defined as vehicle designed to be operated exclusively by a level 4 or level 5 ADS for all trips without manually operated driving controls.

APPROACH AND PROCESS

The near-term research provided lessons learned that will be used by the project team moving forward with mid- and long-term FMVSS and OVSC test procedures research. As part of this effort, crosscutting analyses were developed to drive consistency in the technical translation options and clarify when individual standards required unique options or approaches. This allowed for the development of a potential range of options, and recognition of where an option in one standard could have broader implications.

During the translation process, potential regulatory barriers were analyzed from different sources: (1) FMVSS regulatory language, including performance requirements and test procedures, and (2) OVSC test procedures. Several parts of the regulatory language include standards that are incorporated by reference. This first set of technical translations and test procedures work provides a framework for the evaluation of the mid-term research standards and beyond.

Crash Avoidance Standards

The near-term research for this effort was focused on analyzing some of the fundamental aspects that cut across many of the 100-series FMVSS, such as driver, seating position, service brake application, and gear position/selection, as well as developing initial approaches to translating requirements for telltales, indicators, and alerts and addressing bidirectional vehicles. Work was done to identify the vehicle functionalities (e.g., steering, transmission control, service brake application) explicitly referenced in FMVSS and OVSC test procedures. Subsequently, options were developed for potential alternatives that could be used in compliance verification. To evaluate the vehicle-based methods, a standard production vehicle was modified to include actuators and control signals to allow the vehicle to have the ADS functionality specified in the regulatory text or the associated OVSC test procedures. This test platform allowed for the implementation and execution of the developed test procedures. An initial qualitative evaluation of the different test methods implemented was performed based on the execution of the developed test procedures and the corresponding FMVSS. Some of the project's next steps include: (1) continuing to work through the next set of technical translations of standards designated for mid-term research, (2) expanding test methods to include simulation and further testing to support the evaluation of the vehicle-based test methods, and (3) building on the functionalities to include standards that have unique requirements and more demanding test procedures (e.g., the steering inputs required to execute the FMVSS No. 126 test procedure).

Functionality-Based Testing and Alternate Methods for Crash Avoidance Compliance Verification

Alternatives were sought for how to effectively evaluate the functionality requirements that are either specified in the FMVSS or that are necessary to execute the associated OVSC test procedures. Even though this work was done in the context of the near-term research standards, this approach will be applied by the project team to all FMVSS designated for mid- and long-term research under this project. The initial classification and subsequent selection of standards took both mid- and long-term research standards into account. The implementation, execution, and evaluation of the testing were designed to be applied to standards containing functionalities with less demanding requirements first to verify the test platform and test methods. Subsequent testing will include standards that have unique requirements and more demanding test procedures (e.g., FMVSS No. 126). The expectation is that this approach will provide a sufficient set of test cases to allow the selection of an appropriate test method for any requirements and associated test procedures.

Five potential methods were identified for verifying compliance. These methods fall into two general categories.

Vehicle-based

Three types of vehicle-based testing were identified: (1) human controlled, (2) program controlled, and (3) ADS normal operation. In human controlled testing, tests are performed using a controller console, connected either physically or through a wireless link, to provide manual driving control. Programmed control can either rely on scripted control or a pre-programmed routine. In the former, a standard set of commands (e.g., "start engine," "apply parking brake," "speed = *x*") is used to define the actions the ADS is required to take to execute the test. In the latter, the steps for executing the test are predefined and compiled into a script that can be run but not modified in the field. Finally, the normal operation of the ADS could be used to perform some or all of the test procedure.

Non-vehicle-based

Two types of non-vehicle-based testing were evaluated. The first, simulation, is either solely software-based or includes a hardware-in-the-loop solution to execute the test procedure. The second, technical design documentation, involves vehicle-specific technical design and/or build documentation which provides sufficient information and detail (e.g., a wiring diagram showing that a sensor signal is connected to an ADS electronic control unit) to show the system in question was designed to comply with part or all of a particular standard. It should be noted that this is different than the Test Specification Forms that are provided to NHTSA when a vehicle is selected for potential verification testing. Instead, it is technical design documentation used by the manufacturer in the design, construction, and validation of the vehicle.

Crashworthiness and Occupant Protection Standards

For the current portion of this effort, work on the 200-series FMVSS crashworthiness standards focused on occupant protection for ADS-DVs with conventional seating. This included ADS-DVs with forward-facing seating, but without manually operated driving controls (e.g., steering

wheel). For ADS-DVs without manually operated driving controls, an option is to apply the test procedures that have been developed for the passenger seating positions to the left front outboard seating position, given that the main difference between the two front outboard seating positions in conventional vehicles is the presence or absence of these controls. However, subsequent research as part of this effort will address knowledge gaps in several areas that could be beneficial since passenger seating preferences (e.g., rear seat) as well as technical translation considerations for unconventional seating configurations may begin to vary with different concept vehicles.

BEYOND NEAR-TERM RESEARCH

Crash Avoidance Standards

The near-term research presented herein covered 6 FMVSS (Nos. 102, 108, 114, 118, 138, 141) and the mid-term research that is currently in progress covers nine additional FMVSS (Nos. 101, 103, 104, 110, 111, 113, 124, 125, 126). The remaining FMVSS that are part of the 100-series form part of the long-term research plan. They will be addressed with a similar approach to the other 100-series standards that have been covered thus far.

FMVSS No. 101, Controls and Displays, defines the "accessibility, visibility and recognition of the motor vehicle's controls, telltales, and indicators" and is central to the consideration of how information is communicated in conventional vehicles. This standard is part of the mid-term technical translation work (in-progress at the time of this report) and, when the analysis for this standard is completed, it may impact the current near-term research findings.

The Controls and Displays standard is relevant to crashworthiness standards such as FMVSS No. 206, Door Locks and Door Retention Components, and FMVSS No. 208, Occupant Crash Protection. FMVSS No. 206 is a good example of a near-term standard that delineates the impact of the different telltale options when information is presented. It describes considerations of the different options for presenting information about an unlatched door in an ADS-DV. The analysis of information communicated in an ADS-DV presents this scenario as well as other information that should be considered. This analysis will be expanded on during mid-term research. FMVSS No. 208 has telltales intended for passengers as well as drivers, and the analysis of the information communicated is based on available data. Therefore, more research and new data may be needed to fully evaluate relevance and methods of communication for occupants and people performing ADS-DV maintenance.

Additional research may include addressing equipment that may not be necessary for ADS to complete the DDT and developing potential performance requirements that allow this equipment to be optional. One example is the upper beams, which may not be needed for an ADS to detect objects. Requirements could be developed to determine that an ADS-DV is capable of "seeing" without upper beam headlamps.

This portion of the research provided foundational work in determining the functionality needs for FMVSS test procedures to verify ADS compliance with standards, work which will be expanded on during mid- and long-term research. Test procedures to verify FMVSS compliance for ADS-DVs without manually operated driving controls will also keep advancing throughout

the project. As the work on more complex standards progresses during mid- and long-term research (e.g., FMVSS No. 126), technical translation approaches that were considered appropriate for standards examined during near-term research will need to be revisited and potentially updated or characterized differently. One such approach that will be key for this progression is the human control console. The functionality needed to execute the test procedures covered under near-term research is less demanding of the human control console capabilities and fidelity compared to some of the requirements needed for the mid- and long-term research (e.g., FMVSS test procedure for 126). Aspects of interest in future phases include discussing minimum requirements of controllers and the considerations of using a human control console as an interface to a robotic controller (such as in FMVSS No. 126 in the mid-term and FMVSS Nos. 135 and 136 in the long-term). Another area that will be considered further is the potential application of standardization for items such as the interface of the human control console to the vehicle, a common scripting language, and a data port to access vehicle state information.

Crashworthiness Standards

The crashworthiness standards will be reviewed again but this time with a framework that is focused on different seating configurations (i.e., unconventional seating). Due to all of the implications of topics related to seating configuration on crashworthiness and occupant protection, the first portion of this effort was focused on providing a timely evaluation of ADS-DVs with conventional seating only. As the assessment of different concept vehicles in this report indicates, many different seating configurations are possible. Therefore, results presented herein will need to be expanded upon for those potential configurations.

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APPENDIX A: DEFINITIONS

ADS-Related Definitions Incorporated from SAE International's Recommended Practice J3016, Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles	
Automated Driving System (ADS)	The hardware and software that are collectively capable of performing the entire dynamic driving task (DDT) on a sustained basis, regardless of whether it is limited to a specific operational design domain (ODD); this term is used specifically to describe a level 3, 4, or 5 driving automation system (SAE International, 2018, p. 3).
Operational Design Domain (ODD)	Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics (SAE International, 2018, p. 14).
Dynamic Driving Task (DDT)	All of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints, and including without limitation: • Lateral vehicle motion control via steering (operational); • Longitudinal vehicle motion control via acceleration and deceleration (operational); • Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical); • Object and event response execution (operational and tactical); • Maneuver planning (tactical); and • Enhancing conspicuity via lighting, signaling and gesturing, etc. (tactical) (SAE International, 2018, p. 6).
Automated Driving System - Dedicated Vehicle (ADS-DV)	Based on Section 3.3 of SAE International (2018) "a vehicle designed to be operated exclusively by a level 4 or level 5 ADS during all trips within its given ODD [Operational Design Domain] limitations (if any)" and which may lack manual vehicle control systems such as braking, accelerating, steering, and transmission gear selection input devices. Additional considerations identified by SAE International in its definition of ADS-DV include the following (SAE International, 2018, p. 4): ADS-DVs might be operated temporarily by a conventional or remote driver: (1) to manage transient deviations from the ODD, (2) to address a system failure, or (3) while in a marshalling yard before being dispatched.
Translation Note	ADS-related definitions are interchangeable with the driver, seating, and driving control definitions options. SAE International's definition of ADS-DV indicates that some ADS-DVs could contain driving controls and be used to describe a level 3 driving automation system as well as level 4 and level 5 systems. For the purposes of this project, the FMVSS technical translation options focused on a particular type of ADS-DV, a vehicle designed to be operated exclusively by an SAE level 4 or level 5 ADS for all trips, and which is not equipped with manually operated driving controls.

Driver Definitions		
Currently specified in 49 CFR § 571.3	*Driver* means the occupant of a motor vehicle seated immediately behind the steering control system.	
	Potential Option 1	**Potential Option 2**
Driver	*Driver* means: (1) the occupant (human driver) of a motor vehicle seated immediately behind the manually operated driving controls, and (2) the ADS (ADS driver), for ADS-equipped vehicles when the ADS is engaged. When the ADS is not engaged, the definition in paragraph (1) applies.	*Driver* means the occupant of a motor vehicle seated immediately behind the manually operated driving controls.
Translation Note	Driver definition Options 1 or 2 are interchangeable with the ADS-related, seating, and driving control definitions.	
	Option 1 incorporates the ADS into the definition of "driver." Therefore "driver" would refer to either a human driver or an ADS. "Human driver" is used when only (1) applies, and "ADS driver" is used when only (2) applies.	Under Option 2, the "driver" always refers to a human driver. The ADS would perform the driving of an ADS-DV and be incorporated into the standards independently from "driver."

Designated Seating Positions and Driving Controls Definitions		
Currently specified in 49 CFR § 571.3	*DSP* means a seat location that has a seating surface width, as described in section 571.10(c), of at least 330 mm (13 inches), and section 571.10 provides a method for calculating the number of DSPs based on the width of the seat.	
	Potential Set 1	**Potential Set 2**
Driver's Designated Seating Position (driver's seat or driver's seating position)	Means a DSP immediately behind the manually operated driving controls positioned such that an occupant can operate the manual driving controls, regardless of whether the occupant is in active control of the vehicle.	Means a DSP providing immediate access to the manually operated driving controls.
Manually Operated Driving Controls	Means the system used by an occupant to manipulate the vehicle's lateral (steering) and/or longitudinal (acceleration and deceleration) motion in real time.	Means (a) the system used by an occupant for real-time sustained manipulation of the motor vehicle's heading (steering) and/or speed (accelerator and brake); (b) positioned such that they can be used by an occupant; (c) regardless of whether the occupant is actively manipulating the vehicle's motion.
	Potential Set (1 or 2) A	**Potential Set (1 or 2) B**
Passenger Designated Seating Position (Passenger Seat or Passenger Seating Position)	Means any DSP other than the driver's DSP.	Means any DSP other than the driver's DSP. Specifically, a seating position with stowed manually operated driving controls is a passenger DSP.
Steering Control (Wheel)	Means the manually operated driving control used to manipulate the vehicle's heading.	
Translation Note	Driver's DSP and manually operated driving controls are grouped into sets. The definitions of "passenger DSP" and "steering control" are the same for both Set 1 and Set 2. There are two options (A and B) for the definition of passenger DSP.	
	Driver's DSP definition from Set 1 should be used in conjunction with the manually operated driving controls definition from Set 1.	Driver's DSP definition from Set 2 should be used in conjunction with the manually operated driving controls definition from Set 2.

Bidirectional Vehicle Definitions		
	Potential Option 1	**Potential Option 2**
Bidirectional Vehicle	Means an ADS-equipped vehicle without manually operated driving controls that can perform the DDT across an equivalent range of speed and heading control in two opposite directions.	Means a motor vehicle that operates across an equivalent range of speed and heading control in two opposite directions.
Translation Note	Instead of translating within each standard, bidirectional vehicles could be addressed generically in Subpart A of 49 CFR Part 571. In addition to the Section 571.3 definition, a new section could be added to clarify the application.	

Applicability of the FMVSS to Bidirectional Vehicles	
Bidirectional Vehicle	Each applicable standard set forth in Subpart B of this Part shall apply to bidirectional vehicles in both directions of travel.
Translation Note	A new subsection (g) of section 571.7, or a new section 571.11 could be added to clarify the translations for the applicability of the FMVSS to bidirectional vehicles.

APPENDIX B: FMVSS TECHNICAL TRANSLATION WORKSHEETS

This appendix provides technical translation options summaries for each FMVSS of focus during near-term research, followed by tables of technical translation options and their potential considerations. Only technical translations that were assessed as either a "1-Translation is straightforward" or "2-Limited research may be beneficial" are shown in this appendix. Any additional considerations for discussion with regard to the sections of the FMVSS that were assessed as a "0-Not performed" are captured within the main body of this report. If the creation of a potential additional section to the FMVSS was considered, the top header row will contain the original section number in the far left hand column, and a unique section number followed by "Added for ADS-DV Translation" in the center column. (See FMVSS No. 102, S3.1.1.2 below for an example.) Text colored in red font corresponds to the word or phrase that was either changed or omitted from the regulatory text into one of the technical translation options. Occasionally, there is text colored in red font in the Regulatory Text column that cites an incorporated reference. The reference analysis was not captured in the tables below, please see **Appendix D** for more information.

FMVSS NO. 102: TRANSMISSION SHIFT POSITION SEQUENCE, STARTER INTERLOCK, AND TRANSMISSION BRAKING EFFECT

Technical Translation Options Summary: *The overall technical translation approach was to try to eliminate the dependency on a human driver or a specific control implementation for both humans and automated driving system-dedicated vehicles (ADS-DVs) by providing changes to the language. The options are interchangeable. The applicable driver definition approach is noted for each where appropriate.*

FMVSS No. 102, S1. Purpose and scope.			
Regulatory Text	**Translation Options**		**Potential Considerations**
This standard specifies the requirements for the transmission shift position sequence, a starter interlock, and for a braking effect of automatic transmissions, to reduce the likelihood of shifting errors, to prevent starter engagement by the driver when the transmission is in any drive position, and to provide supplemental braking at speeds below 40 kilometers per hour (25 miles per hour).	**Option 1**	...to prevent starter engagement when the transmission is in any drive position…	Removes the reference to the driver. May not want to remove this dependency, which provides clarity on who/what is performing the action.
	Option 2	Retain current language.	Uses driver definition 1. No translation necessary..

FMVSS No. 102, S3.1.1 Automatic transmissions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Location of transmission shift positions on passenger cars. A neutral position shall be located between forward drive and reverse drive positions.	**Option 1**	Location of transmission shift positions on passenger cars. A neutral position shall be located between forward drive and reverse drive positions unless other means exist to ensure transmission cannot inadvertently be shifted directly between forward and reverse positions.	An ADS-DV may not be inadvertently shifted. Addresses dependent clauses that reference sequence dependency. Could potentially allow means to test or verify that transmission cannot be inadvertently shifted directly between forward and reverse. Consistent requirement for ADS-DVs and vehicles operated by a human driver..
	Option 2	Location of transmission shift positions on passenger cars. A neutral position shall be located between forward drive and reverse drive positions unless conditions are met for S3.1.1.2.	An ADS-DV may not be inadvertently shifted. Maintains current requirements for vehicles operated by a human driver. May requires means to test or verify that transmission cannot be inadvertently shifted directly between forward and reverse. Requires additional sub clause.
	Option 3	Location of transmission shift positions on passenger cars. A neutral position shall be located between forward drive and reverse drive positions for vehicles that can be operated by a human driver.	Translation option clarifies neutral position specific for human drivers.
	Option 4	Location of transmission shift positions on passenger cars. If there are manually operated driving controls, a neutral position shall be…	Translation option clarifies neutral position specifically for manually operated driving controls.

S3.1 Transmission shift levers.	FMVSS No. 102, S3.1.1.2 Added for ADS-DV translation.		
Regulatory Text	**Translation Options**		**Potential Considerations**
Standard Text Provided as an Option.	**Option 1**	Retain current language.	.
	Option 2	While the ADS is engaged, the transmission cannot be inadvertently shifted directly between forward and reverse positions.	An ADS may not be inadvertently shifted. Provides dependency definition for option 2 S3.1.1. May require a means to test or verify that transmission cannot be inadvertently shifted directly between forward and reverse. Requires additional sub clause.

FMVSS No. 102, S3.1.3 Starter interlock.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Except as provided in S3.1.3.1 through S3.1.3.3, the engine starter shall be inoperative when the transmission shift position is in a forward or reverse drive position.	**Option 1**	Except as provided in S3.1.3.1 through S3.1.3.3, the engine starter shall be inoperative when the transmission is in a forward or reverse drive position.	This option removes the reference to the shift position. May eliminate ambiguity if the vehicle does not have standard controls. Note that this is used in S3.1.3.1.b. For an ADS-DV, visual means for NHTSA to verify compliance may not be available.
	Option 2	Retain current language.	
	Option 3	... transmission shift position or the ADS-DV longitudinal control is engaged.	This option does not assume any particular control. For an ADS-DV, visual means for NHTSA to verify compliance may not be available.

FMVSS No. 102, S3.1.3.1 Starter interlock.			
Regulatory Text	**Translation Options**		**Potential Considerations**
After the driver has activated the vehicle's propulsion system: (a) The engine may stop and restart automatically when the transmission shift position is in any forward drive gear; (b) The engine may not automatically stop when the transmission is in reverse gear; and (c) The engine may automatically restart in reverse gear only if the vehicle satisfies (1) and (2): (1) When the engine is automatically stopped in a forward drive shift position and the driver selects Reverse, the engine restarts immediately whenever the service brake is applied. (2) When the engine is automatically stopped in a forward drive shift position and the driver selects Reverse, the engine does not start automatically if the service brake is not applied.	**Option 1**	After the vehicle's propulsion system has been activated: (a) The engine may start and stop when the transmission is in any forward drive state. … (1) When the engine is automatically stopped in a forward drive state and the transmission is placed in Reverse, the engine restarts immediately whenever the service brake is applied. (2) When the engine is automatically stopped in a forward state and the transmission is placed in Reverse, the engine does not start automatically if the service brake is not applied.	Removes reference to driver and shift position. May eliminate the dependency on a driver and physical shift position. For an ADS-DV, visual means for NHTSA to verify compliance may not be available.

FMVSS No. 102, S3.1.3.2 Starter interlock.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Notwithstanding S3.1.3.1, the engine may stop and start at any time after the driver has activated the vehicle's propulsion system if the vehicle can meet the requirements specified in paragraphs (a) and (b): (a) For passenger cars, multi-purpose passenger vehicles, trucks and buses with a GVWR less than or equal to 4,536 kg (10,000 pounds), the vehicle's propulsion system can propel the vehicle in the normal travel mode in all forward and reverse drive gears without the engine operating. For passenger cars, multipurpose passenger vehicles, trucks and buses with a GVWR greater than 4,536 kg (10,000 pounds), the vehicle's propulsion system can propel the vehicle in the normal travel mode in Reverse and at least one forward drive gear without the engine operating. (b) If the engine automatically starts while the vehicle is traveling at a steady speed and steady accelerator control setting, the engine does not cause the vehicle to accelerate.	**Option 1**	Retain current language.	Uses driver definition 1. No text change required for this option.
	Option 2	Notwithstanding S3.1.3.1, the engine may stop and start at any time after the vehicle's propulsion system has been activated if the vehicle can meet the requirements specified in paragraphs (a) and (b):	Removes reference to driver. May not provide a means for NHTSA to verify compliance.

FMVSS No. 102, S3.1.3.3 Starter interlock.			
Regulatory Text	**Translation Options**		**Potential Considerations**
If the transmission shift position is in Park, automatically stopping or restarting the engine shall not take the transmission out of Park.	**Option 1**	If the transmission is in Park, automatically stopping or restarting the engine shall not take the transmission out of Park.	Removes reference to shift position. May eliminate the dependency on a driver and physical shift position. For an ADS-DV, visual means for NHTSA to verify compliance may not be available.

FMVSS No. 102, S3.1.4.1 Identification of shift positions and of shift position sequence.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Except as specified in S3.1.4.3, if the transmission shift position sequence includes a park position, identification of shift positions, including the positions in relation to each other and the position selected, shall be displayed in view of the driver whenever any of the following conditions exist: (a) The ignition is in a position where the transmission can be shifted; or (b) The transmission is not in park.	**Option 1**	...shall be communicated to the driver …	Uses driver definition 1. Eliminates the dependency on a display. Opens the possibility of other communication means to human drivers (e.g., auditory). May need to provide conditional language such as "via visual or electronic means." May need a means to confirm operation for ADS.
	Option 2	Except as specified in S3.1.4.3, if the transmission position sequence includes a park position, identification of positions, including the positions in relation to each other and the position selected, shall be displayed in view of the driver in a vehicle with a transmission shift mechanism intended for operation by a human driver, and shall be communicated to the ADS in a vehicle equipped with such a system, whenever any of the following conditions exist:...	Uses driver definition 2. Separates the human and ADS. If taken out of context, exclusion of "shift" could be ambiguous. "Shift" could be kept as currently stated while keeping the distinction between human and ADS.
	Option 3	Except as specified in S3.1.4.3, if the transmission shift position sequence includes a park position, identification of shift positions, including the positions in relation to each other and the position selected, shall be displayed in view of the human driver whenever any of the following conditions exist:	Use driver definition 2. Only display information for vehicle operated by a human driver.

FMVSS No. 102, S3.1.4.2 Identification of shift positions and of shift position sequence.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Except as specified in S3.1.4.3, if the transmission shift position sequence does not include a park position, identification of shift positions, including the positions in relation to each other and the position selected, shall be displayed in view of the driver whenever the ignition is in a position in which the engine is capable of operation.	**Option 1**	...shall be communicated to the driver …	Uses driver definition 1. Eliminates the dependency on a display. Opens the possibility of other communication means to human drivers (e.g., auditory). May need to provide conditional language such as "via visual or electronic means." May need a means to confirm operation for ADS.
	Option 2	Except as specified in S3.1.4.3, if the transmission position sequence does not include a park position, identification of positions, including the positions in relation to each other and the position selected, shall be displayed in view of the driver in a vehicle with a transmission shift mechanism intended for operation by a human driver, and shall be communicated to the ADS driver in a vehicle equipped with such a system, whenever...	Uses driver definition 2. Separates the human and ADS. If taken out of context, exclusion of "shift" could be ambiguous. "Shift" could be kept as currently stated while keeping the distinction between human and ADS.
	Option 3	...shall be displayed in view of the human driver whenever the ignition is in a position in which the engine is capable of operation.	Use driver definition 2. Only display information for vehicle operated by a human driver.

FMVSS No. 102, S3.1.4.3 Identification of shift positions and of shift position sequence.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Such information need not be displayed when the ignition is in a position that is used only to start the vehicle.	**Option 1**	Such information need not be communicated…	Opens the possibility of other communication means to human drivers (e.g., auditory). May need to provide conditional language such as "via visual or electronic means." May need a means to confirm operation for ADS.
	Option 2	Such information need not be displayed or communicated to the ADS…	Uses driver definition 2. Separates the human and ADS.

FMVSS No. 102, S3.1.4.4 Identification of shift positions and of shift position sequence.			
Regulatory Text	**Translation Options**		**Potential Considerations**
All of the information required to be displayed by S3.1.4.1 or S3.1.4.2 shall be displayed in view of the driver in a single location. At the option of the manufacturer, redundant displays providing some or all of the information may be provided.	**Option 1**	...shall be communicated to the driver …	Eliminates the dependency on a display. Opens the possibility of other communication means to human drivers (e.g., auditory). May need to provide conditional language such as "via visual or electronic means." May need a means to confirm operation for ADS.
	Option 2	...may be provided. Such information need not be displayed or communicated to the ADS.	Uses driver definition 2. Separates the human and ADS. If taken out of context, exclusion of "shift" could be ambiguous. "Shift" could be kept as currently stated while keeping the distinction between human and ADS.
	Option 3	...shall be displayed in view of the human driver in a single location. At the option of the manufacturer, redundant displays providing some or all of the information may be provided.	Uses driver definition 2. Only display information for vehicle operated by a human driver.

S3.1 Automatic transmissions.	FMVSS No. 102, S3.1.5 Added for ADS-DV translation		
Regulatory Text	**Translation Options**		**Potential Considerations**
Standard Text Provided as an Option.	**Option 1**	Retain current language.	
	Option 2	Retain current language.	
	Option 3	The transmission state must be communicated to the ADS when engaged.	New sub clause that could be referenced by the existing clauses to address ADS operation. Does not provide means to ensure ADS complies with safety intent.

FMVSS NO. 108: LAMPS, REFLECTIVE DEVICES, AND ASSOCIATED EQUIPMENT

Technical Translation Options Summary:

Option 1 uses driver definition 1. It considers that many of the lighting system indicators remind a human driver of their selection. The Automated Driving System (ADS) controlling these lighting functions may not need to be reminded of the indicators state. Therefore, Option 1 does not communicate the state of lighting system functions controlled by the ADS. However, the ADS may need to be informed when there is a lamp failure, or when an occupant activates the hazard function. For indicators such as the hazard warning and lamp failure, Option 1 indicates to all Designated Seating Positions (DSPs).

Option 2 uses driver definition 2. It considers that the lighting system states may need to be communicated to the ADS regardless of ADS control. For indicators such as the hazard warning and lamp failure, Option 1 indicates to all DSPs.

Option 3 is similar to Option 1. However, it considers the potential to incorporate indicators as is done today with human drivers for an Automated Driving System-Dedicated Vehicle (ADS-DV) (e.g., displayed/controlled in the driver's DSP or left, front). Option 3 does have some complexities for requirements that apply to motorcycles since motorcycles would not have a left, front seating position.

It is unclear if the position to which the information is presented, as is done in the current regulation for a human driver (left, front DSP), would be a position consistently occupied as it is today with a human driver. A potential maintenance telematics screen or manufacturer-specified locations may be alternatives, as noted in Option 3.

FMVSS No. 108, S4 Definitions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Semiautomatic headlamp beam switching device is one which provides either automatic or manual control of beam switching at the option of the driver. When the control is automatic the headlamps switch from the upper beam to the lower beam when illuminated by the headlamps on an approaching vehicle and switch back to the upper beam when the road ahead is dark. When the control is manual, the driver may obtain either beam manually regardless of the conditions ahead of the vehicle.	**Option 1**	Semiautomatic headlamp beam switching device is one which provides either automatic or manual control of beam switching. When the control is automatic, the headlamps switch from the upper beam to the lower beam when illuminated by the headlamps on an approaching vehicle and switch back to the upper beam when the road ahead is dark. When the control is manual, the driver may obtain either beam manually regardless of the conditions ahead of the vehicle.	Removes the clause "...at the option of the driver," which does not change the context of the definition.
	Option 2	Retain current language.	Uses driver definition 2. This option allows text to remain the same. Reference to driver is not necessarily needed and addressed in the requirements.

FMVSS No. 108, S4 Definitions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Turn signal operating unit means an operating unit that is part of a turn signal system by which the operator of a vehicle causes the signal units to function.	**Option 1**	Retain current language.	No translation is needed if this refers to the control only. An automated system would not need this. Allows for automated vehicles without a human driver.
	Option 2	Turn signal operating unit means a driver controlled device that is part of a turn signal system by which the driver of a vehicle causes the turn signal lamp units to function.	Uses driver definition 2. The turn signal operating unit is only relevant for a human driver.

FMVSS No. 108, S4 Definitions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Vehicular hazard warning signal operating unit means a driver controlled device which causes all required turn signal lamps to flash simultaneously to indicate to approaching drivers the presence of a vehicular hazard.	**Option 1**	Vehicular hazard warning signal operating unit means a device which causes all required turn signal lamps to flash simultaneously to indicate the presence of a vehicular hazard.	Interchangeable across options. Uses a generic approach and removes specific driver controlled device. The control and visibility are translated in S6.6.2. Definition works for both human drivers and Automated Driving System-Dedicated Vehicles (ADS-DVs). The control may not need to be addressed in the definition as it is done in the current regulation. However, retaining the control requirements for a human driver and occupants of an ADS-DV would then need to be addressed outside of the definition section.
	Option 2	Vehicular hazard warning signal operating unit means a device that is controlled by a driver or when an ADS is engaged, it is controlled by the ADS which causes all required turn signal lamps to flash simultaneously to indicate to approaching road users the presence of a vehicular hazard.	Uses driver definition 2. Unchangeable across options, may require driver/ADS reference update. Specifies control and allows operation by driver and, when ADS is engaged, the ADS. Definition works for both drivers and ADS-DVs. Potential concerns could arise if implemented with lower levels of automation, which are outside the scope of this project. Definition is complex and the detail on who can control the warning is addressed in later sections.

FMVSS No. 108, S6.1.3.4.1 Interior mounting.			
Regulatory Text	**Translation Options**		**Potential Considerations**
A high-mounted stop lamp mounted inside the vehicle must have means provided to minimize reflections from the light of the lamp upon the rear window glazing that might be visible to the driver when viewed directly, or indirectly in the rearview mirror.	**Option 1**	A high-mounted stop lamp mounted inside the vehicle must have means provided to minimize reflections from the light of the lamp upon the rear window glazing that might be visible to the human driver and/or ADS sensing equipment when viewed directly, or indirectly in the rearview mirror.	Uses driver definition 1. Interchangeable across options, may require driver/ADS reference update. ADS-DVs may not have a rearview mirror, in which case the reflection requirements would not be critical. However, the need to limit glare would still be needed for ADS-DV equipment. The scope of the project is only looking at SAE Levels 4 and 5; this could have implications for ADSsat lower levels.

FMVSS No. 108, S6.6.1 Associated equipment.			
Regulatory Text	**Translation Options**		**Potential Considerations**
All vehicles to which this standard applies, except trailers, must be equipped with a turn signal operating unit, a turn signal flasher, a turn signal pilot indicator, a headlamp beam switching device, and an upper beam headlamp indicator meeting the requirements of S9.	**Option 1**	All vehicles to which this standard applies, except trailers, must be equipped with a turn signal operating unit, a turn signal flasher, a headlamp beam switching device, and an upper beam headlamp indicator meeting the requirements of S9. All vehicles operated by a human driver, except trailers, must be equipped with a turn signal pilot indicator meeting the requirements of S9.	Uses driver definition 1. Interchangeable across options, may require driver/ADS reference update. Maintains controls and indicators for human drivers and allows control by ADS. Removes indicators for ADS-DVs.
	Option 2	All vehicles to which this standard applies, except trailers, must be equipped with a turn signal operating unit, a turn signal flasher, a headlamp beam switching device, and an upper beam headlamp indicator meeting the requirements of S9. All vehicles operated by a driver, except trailers, must be equipped with a turn signal pilot indicator meeting the requirements of S9.	Uses driver definition 2. Interchangeable across options, may require driver/ADS reference update. Maintains controls and indicators for human drivers and allows control by ADS. Removes indicators for ADS-DVs.

FMVSS No. 108, S6.6.2 Associated equipment.			
Regulatory Text	**Translation Options**		**Potential Considerations**
All vehicles to which this standard applies except trailers and motorcycles must be equipped with a vehicular hazard warning operating unit, a vehicular hazard warning signal flasher, and a vehicular hazard warning signal pilot indicator meeting the requirements of S9.	**Option 1**	All vehicles that can be operated by a human driver to which this standard applies except trailers and motorcycles must be equipped with a human driver controlled vehicular hazard warning operating unit, a vehicular hazard warning signal flasher, and a vehicular hazard warning signal pilot indicator meeting the requirements of S9. All vehicles that can be operated by an ADS driver to which this standard applies except trailers and motorcycles must be equipped with the capability of the ADS driver activating the vehicular hazard warning signal flashers and the ability for all DSPs to activate the hazard light system. A pilot indicator visible by all DSPs must also be included.	Uses driver definition 1. Maintains controls and indicators for human drivers and allows control by an ADS. Adds "a human driver controlled" which was removed for the vehicular hazard warning signal definition section to retain current regulatory requirement. Removes indicators for ADS-DVs. Requires control and visibility to all occupants. However, "all DSP's" could be modified to other DSP approahces (e.g., front, left seating position). Allows for control of the signaling systems by the ADS rather than strictly manual control.
	Option 2	All vehicles that can be operated by a driver to which this standard applies except trailers and motorcycles must be equipped with a vehicular hazard warning operating unit, a vehicular hazard warning signal flasher, and a vehicular hazard warning signal pilot indicator meeting the requirements of S9. All vehicles that can be operated by an ADS to which this standard applies except trailers and motorcycles must be equipped with the capability of the ADS activating the vehicular hazard warning signal flashers and the ability for all DSPs to activate the hazard light system. A pilot indicator visible by all ADS-DV DSPs must also be included.	Uses driver definition 2. Maintains controls and indicators for human drivers and allows control by an ADS. Allows for control of the signaling systems by the ADS rather than strictly manual control. Expands control location and visibility from one position to all positions for ADS-DVs. In a vehicle operated by a human driver, the licensed driver controls the hazard warning. For an ADS-DV, there may be occupants that do not know how and in which situations to activate the hazard warning. This may have an impact on how other road users react to hazard warnings.

FMVSS No. 108, S6.6.2 Associated equipment.			
Regulatory Text	**Translation Options**		**Potential Considerations**
	Option 3	All vehicles that can be operated by a driver to which this standard applies except trailers and motorcycles must be equipped with a vehicular hazard warning operating unit, a vehicular hazard warning signal flasher, and a vehicular hazard warning signal pilot indicator meeting the requirements of S9. All vehicles that can be operated by an ADS to which this standard applies except trailers and motorcycles must be equipped with the capability of the ADS activating the vehicular hazard warning signal flashers and the ability for the left, front seating position to activate the hazard light system. A pilot indicator visible by the ADS-DV's left, front seating position must also be included.	Uses driver definition 2. Maintains controls and indicators for human drivers and allows control by an ADS. Requires control and visibility to the left, front ADS-DV seating position. It is unclear if providing the information as it is done in the current regulation for a human driver (left, front DSP) would be a position consistently occupied as it is today with a human driver. The left, front could be translated to OEM's specified position as another option. OEM's may be able to position the hazard control in the location most expected to be occupied. Allows for control of the signaling systems by the ADS rather than strictly manual control. Similar location for control and visibility for an ADS-DV and vehicles driven by a human driver.

FMVSS No. 108, S7.1.1.5 Activation flash.			
Regulatory Text	**Translation Options**		**Potential Considerations**
See Tables I-a and I-c.	**Option 1**	See Tables I-a and I-c: Flash when turn signals activated by the driver and ADS	Uses driver definition 1. Interchangeable across options, may require driver/ADS reference update. Translation options shown for text inside table. Allows for activation by human driver and ADS.
	Option 2	See Tables I-a and I-c: Flash when turn signals activated by the driver and ADS.	Uses driver definition 2. Interchangeable across options, may require driver/ADS. Translation options shown for text inside table. Allows for activation by human driver and ADS.

FMVSS No. 108, S9.1.1 Turn signal operating unit.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The turn signal operating unit installed on passenger cars, multipurpose passenger vehicles, trucks, and buses less than 2032 mm in overall width must be self-canceling by steering wheel rotation and capable of cancellation by a manually operated control.	**Option 1**	For vehicles that can be operated by a human driver, the turn signal operating unit installed on passenger cars, multipurpose passenger vehicles, trucks, and buses less than 2032 mm in overall width must be self-canceling by steering wheel rotation and capable of cancellation by a manually operated control. For vehicles operated by an ADS, the turn signal on an ADS-DV must cancel after completion of the maneuver that warranted the activation of the turn signals.	Uses driver definition 1. Interchangeable across options may require driver/ADS reference update. Allows for control of the signaling systems by the ADS rather than strictly manual control. Cancellation of the turn signal does not specify performance requirements.

FMVSS No. 108, S9.1.1 Turn signal operating unit.			
Regulatory Text	**Translation Options**		**Potential Considerations**
	Option 2	Except as provided in S9.1.1.1, the turn signal operating unit installed on passenger cars, multipurpose passenger vehicles, trucks, and buses less than 2032 mm in overall width that can be operated by a driver must be self-canceling by steering wheel rotation and capable of cancellation by a manually operated control. S9.1.1.1 The turn signal function on an ADS-DV must cancel after completion of the turn or lane change.	Uses driver definition 2. Interchangeable across options may require driver/ADS reference update. Proposes addition of new section S9.1.1.1 for ADS-DVS. The options only state that the turn signal should cancel; there are no performance requirements for the canceling action. This allows for the same flexibility as a driver has today to cancel whenever they want. May be viewed as an expansion of scope. There may need to be further research to define completion of a turn or lane change to provide specific performance requirements.
	Option 3	The turn signal operating unit installed on passenger cars, multipurpose passenger vehicles, trucks, and buses less than 2032 mm in overall width must be self-canceling by steering rotation and capable of cancellation by a manually operated control.	Interchangeable across options may require driver/ADS reference update. This option removes reference to the "wheel," permitting the developer to identify the appropriate hardware/method of canceling based on steering input.

FMVSS No. 108, S9.3.1 Turn signal pilot indicator.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Each vehicle equipped with a turn signal operating unit where any turn signal lamp is not visible to the driver must also have an illuminated pilot indicator to provide a clear and unmistakable indication that the turn signal system is activated.	**Option 1**	For vehicles that can be operated by a human driver, each vehicle equipped with a turn signal operating unit where any turn signal lamp is not visible to the human driver must also have an illuminated pilot indicator to provide a clear and unmistakable indication that the turn signal system is activated.	Uses driver definition 1. Removes turn signal operating unit requirement, which reminds a human driver that the turn signals are on. The ADS is controlling operation of the turn signals and will know the turn signal state it is controlling. Therefore, based on this assumption it does not require state to be communicated to the ADS in this Option. There could be some value in having such turn signal indicators in an ADS-DV to provide occupants with information regarding the intended path of the vehicle so they would be prepared when the vehicle makes a turn. This would raise the issue of whether such indicator(s) would need to be visible to occupants located at all Designated Seating Positions (DSPs) or only some specified DSPs.
	Option 2	For vehicles that can be operated by a driver, each vehicle equipped with a turn signal operating unit where any turn signal lamp is not visible to the driver must also have an illuminated pilot indicator to provide a clear and unmistakable indication that the turn signal system is activated. For vehicles operated by an ADS, each vehicle equipped with a turn signal operating unit must communicate the turn signal state to the ADS.	Uses driver definition 2. Removes turn signal operating unit requirement, which reminds a human driver that the turn signals are on. Requires turn signal state to be communicated to the ADS. There could be some value in having such turn signal indicators in an ADS-DV to provide occupants with information regarding the intended path of the vehicle so they would be prepared when the vehicle makes a turn. This would raise the issue of whether such indicator(s) would need to be visible to occupants located at all DSPs or only in some specified DSPs.

FMVSS No. 108, S9.3.1 Turn signal pilot indicator.			
Regulatory Text	**Translation Options**		**Potential Considerations**
	Option 3	For vehicles that can be operated by a driver, each vehicle equipped with a turn signal operating unit where any turn signal lamp is not visible to the driver must also have an illuminated pilot indicator to provide a clear and unmistakable indication that the turn signal system is activated. For vehicles operated by an ADS, each vehicle must have a turn signal lamp visible to the left, front seating position which indicates when the turn signal system is activated by the ADS.	Uses driver definition 2. Maintains current requirements for human drivers and turn signal lamp as visible to the left, front seating position for an ADS-DV. Does not require state to be communicated to the ADS. ADS is controlling operation of the turn signals.

FMVSS No. 108, S9.3.4.1 Indicator size and color.			
Regulatory Text	**Translation Options**		**Potential Considerations**
If the indicator is located inside the vehicle it must emit a green colored light and have a minimum area equivalent to a 3⁄16 in diameter circle.	**Option 1**	For vehicles that can be operated by a human driver, if the indicator is located inside the vehicle it must emit a green colored light and have a minimum area equivalent to a 3⁄16 in diameter circle.	Uses driver definition 1.
	Option 2	For vehicles that can be operated by a driver, if the indicator is located inside the vehicle it must emit a green colored light and have a minimum area equivalent to a 3⁄16 in diameter circle.	Uses driver definition 2.

FMVSS No. 108, S9.3.4.2 Indicator size and color.			
Regulatory Text	**Translation Options**		**Potential Considerations**
If the indicator is located outside of the vehicle it must emit a yellow light and have a minimum projected illuminated area of 0.1 sq. in.	**Option 1**	For vehicles that can be operated by a human driver, if the indicator is located outside of the vehicle it must emit a yellow light and have a minimum projected illuminated area of 0.1 sq. in.	Uses driver definition 1.
	Option 2	For vehicles that can be operated by a driver, if the indicator is located outside of the vehicle it must emit a yellow light and have a minimum projected illuminated area of 0.1 sq. in.	Uses driver definition 2.

FMVSS No. 108, S9.3.5 Indicator size and color.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The minimum required illuminated area of the indicator must be visible to any tangent on the 95th eyellipse as defined in SAE Recommended Practice J941b (1969) (incorporated by reference, see §571.5), with the steering wheel turned to a straight ahead driving position and in the design location for an adjustable wheel or column.	**Option 1**	If equipped with an indicator, the minimum required illuminated area must be visible to any tangent on the 95th eyellipse as defined in SAE Recommended Practice J941b (1969) (incorporated by reference, see §571.5), with the steering wheel turned to a straight ahead driving position and in the design location for an adjustable wheel or column.	Indicators may not be required for an ADS-DV in Option 1.
	Option 2	Same as Option 1.	

FMVSS No. 108, S9.3.5 Indicator size and color.			
Regulatory Text	**Translation Options**		**Potential Considerations**
	Option 3	For the purpose of this standard and for vehicles that can be operated by a driver, the minimum required illuminated area of the indicator must be visible to any tangent on the 95th eyellipse as defined in SAE Recommended Practice J941b (1969) (incorporated by reference, see §571.5), with the steering wheel turned to a straight ahead driving position and in the design location for an adjustable wheel or column. For the purpose of this standard and for vehicles that can be operated by an ADS, the indicator must be visible to the left, front seating position.	Uses driver definition 2. Option 3 would be used if NHTSA wishes to incorporate the approach of maintaining indicators as implemented today. More research may be needed in order to develop performance criteria for locating information intended for ADS-DV occupants.

FMVSS No. 108, S9.3.6 Turn signal lamp failure.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Failure of one or more turn signal lamps such that the minimum photometric performance specified in Tables VI or VII is not being met must be indicated by the turn signal pilot indicator by a "steady on", "steady off", or by a significant change in the flashing rate, except when a variable-load turn signal flasher is used on a multipurpose passenger vehicle, truck, or bus 2032 mm or more in overall width, on a truck that is capable of accommodating a slide in camper, or on any vehicle equipped to tow trailers.	**Option 1**	For vehicles operated by a human driver, failure of one or more turn signal lamps such that the minimum photometric performance specified in Tables VI or VII is not being met must be indicated by the turn signal pilot indicator by a "steady on," "steady off," or by a significant change in the flashing rate, except when a variable-load turn signal flasher is used on a multipurpose passenger vehicle, truck, or bus 2032 mm or more in overall width, on a truck that is capable of accommodating a slide in camper, or on any vehicle equipped to tow trailers. For vehicles operated by an ADS driver, failure of one or more turn signal lamps such that the minimum photometric performance specified in Tables VI or VII is not being met must be communicated to the ADS and an indication must be provided to all DSPs.	Uses driver definition 1. Allows for failures to be reported to the ADS rather than only signaling to the vehicle operator. May be viewed as an expansion over current standard to indicate to all DSP's. May need a new indication method.

FMVSS No. 108, S9.3.6 Turn signal lamp failure.			
Regulatory Text	**Translation Options**		**Potential Considerations**
	Option 2	For vehicles operated by a driver, failure of one or more turn signal lamps such that the minimum photometric performance specified in Tables VI or VII is not being met must be indicated by the turn signal pilot indicator by a "steady on," "steady off," or by a significant change in the flashing rate, except when a variable-load turn signal flasher is used on a multipurpose passenger vehicle, truck, or bus 2032 mm or more in overall width, on a truck that is capable of accommodating a slide in camper, or on any vehicle equipped to tow trailers. For vehicles operated by an ADS, failure of one or more turn signal lamps such that the minimum photometric performance specified in Tables VI or VII is not being met must be communicated to the ADS and an indication must be provided to all DSPs.	Uses driver definition 2. Allows for failures to be reported to the ADS rather than only signaling to the vehicle operator. May be viewed as an expansion over current standard to indicate to all DSPs. May need a new indication method.

continued....	FMVSS No. 108, S9.3.6 Turn signal lamp failure		
Regulatory Text	**Translation Options**		**Potential Considerations**
Failure of one or more turn signal lamps such that the minimum photometric performance specified in Tables VI or VII is not being met must be indicated by the turn signal pilot indicator by a "steady on", "steady off", or by a significant change in the flashing rate, except when a variable-load turn signal flasher is used on a multipurpose passenger vehicle, truck, or bus 2032 mm or more in overall width, on a truck that is capable of accommodating a slide in camper, or on any vehicle equipped to tow trailers.	**Option 3**	Failure of one or more turn signal lamps such that the minimum photometric performance specified in Tables VI or VII is not being met must be indicated by the turn signal pilot indicator by a "steady on," "steady off," or by a significant change in the flashing rate, except when a variable-load turn signal flasher is used on a multipurpose passenger vehicle, truck, or bus 2032 mm or more in overall width, on a truck that is capable of accommodating a slide in camper, or on any vehicle equipped to tow trailers. For vehicles operated by an ADS, failure of one or more turn signal lamps such that the minimum photometric performance specified in Tables VI or VII is not being met must be communicated to the ADS and an indication must be provided to left, front DSP.	Uses driver definition 2. Similar to today's location. Another alternative would be update left, front to a manufacturer-specified position or a specific maintenance telematics screen or panel within the compartment.
	Option 4	For vehicles operated by a human driver, failure of one or more turn signal lamps such that the minimum photometric performance specified in Tables VI or VII is not being met must be indicated by the turn signal pilot indicator by a "steady on," "steady off," or by a significant change in the flashing rate, except when a variable-load turn signal flasher is used on a multipurpose passenger vehicle, truck, or bus 2032 mm or more in overall width, on a truck that is capable of accommodating a slide in camper, or on any vehicle equipped to tow trailers. For vehicles operated by an ADS driver, failure of one or more turn signal lamps such that the minimum photometric performance specified in Tables VI or VII is not being met must be communicated to the ADS.	Uses driver definition 1. Maintains current text for human driver. For an ADS-DV, failure of a turn signal lamp must be communicated to the ADS.

FMVSS No. 108, S9.4 Headlamp beam switching device.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Each vehicle must have a means of switching between lower and upper beams designed and located so that it may be operated conveniently by a simple movement of the driver's hand or foot. The switch must have no dead point and, except as provided by S6.1.5.2, the lower and upper beams must not be energized simultaneously except momentarily for temporary signaling purposes or during switching between beams.	**Option 1**	Each vehicle that can be operated by a human driver must have a means of switching between lower and upper beams designed and located so that it may be operated conveniently by a simple movement of the driver's hand or foot. The switch must have no dead point and, except as provided by S6.1.5.2, the lower and upper beams must not be energized simultaneously except momentarily for temporary signaling purposes or during switching between beams. Each vehicle operated by an ADS driver must have a means of switching between lower and upper beams that can be operated by the ADS driver. The switch must have no dead point and, except as provided by S6.1.5.2, the lower and upper beams must not be energized simultaneously except momentarily for temporary signaling purposes or during switching between beams.	Uses driver definition 1. Maintains current requirements for a vehicle operated by a human driver and allows for headlamp switching by an ADS. Does not require state to be communicated to the ADS. ADS controls operation of the headlamp beam switching device.
	Option 2	Each vehicle that can be operated by a driver must have a means of switching between lower and upper beams designed and located so that it may be operated conveniently by a simple movement of the driver's hand or foot. The switch must have no dead point and, except as provided by S6.1.5.2, the lower and upper beams must not be energized simultaneously except momentarily for temporary signaling purposes or during switching between beams. Each vehicle operated by an ADS must have a means of switching between lower and upper beams that can be operated by the ADS. The switch must have no dead point and, except as provided by S6.1.5.2, the lower and upper beams must not be energized simultaneously except momentarily for temporary signaling purposes or during switching between beams. The state of the headlamp beam switching devices must be communicated to the ADS.	Uses driver definition 2. Maintains current requirements for a vehicle operated by a human driver and allows for headlamp switching by an ADS. Requires headlamp beam switching devices' state to be communicated to the ADS.

FMVSS No. 108, S9.4.1 Semi-automatic headlamp beam switching device.			
Regulatory Text	**Translation Options**		**Potential Considerations**
As an alternative to S9.4, a vehicle may be equipped with a semi-automatic means of switching between lower and upper beams.	**Option 1**	As an alternative to S9.4, a vehicle may be equipped with a semi-automatic means of switching between lower and upper beams. Semi-automatic headlamps are not allowed in an ADS-DV.	This would be a fully automatic system in an ADS-DV so semi-automatic headlamps are not allowed. Interchangeable with the other options.

FMVSS No. 108, S9.4.1.1 Operating instructions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Each semi-automatic headlamp switching device must include operating instructions to permit a driver to operate the device correctly including; how to turn the automatic control on and off, how to adjust the provided sensitivity control, and any other specific instructions applicable to the particular device.	**Option 1**	Each semi-automatic headlamp switching device must include operating instructions to permit a human driver to operate the device correctly including; how to turn the automatic control on and off, how to adjust the provided sensitivity control, and any other specific instructions applicable to the particular device.	Uses driver definition 1. Clarifies application is only for human drivers.
	Option 2	Each semi-automatic headlamp switching device must include operating instructions to permit operation of the device correctly including; how to turn the automatic control on and off, how to adjust the provided sensitivity control, and any other specific instructions applicable to the particular device.	Interchangeable with other options. This option removes the reference to driver.

FMVSS No. 108, S9.4.1.2 Manual override.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The device must include a means convenient to the driver for switching to the opposite beam from the one provided.	**Option 1**	The device must include a means convenient to the human driver for switching to the opposite beam from the one provided.	Uses driver definition 1. Interchangeable across options, may require driver/ADS. Clarifies application is only for human drivers.
	Option 2	The device must include a means convenient for switching to the opposite beam from the one provided.	Interchangable across options. This option removes the reference to driver.

FMVSS No. 108, S9.5 Upper beam headlamp indicator.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Each vehicle must have a means for indicating to the driver when the upper beams of the headlighting system are activated.	**Option 1**	Retain current language.	Uses driver definition 1.
	Option 2	Each vehicle must have a means for indicating to the driver and ADS when the upper beams of the headlighting system are activated.	Uses driver definition 2. Upper beam headlamp state must be indicated to the ADS. Communicated was not used to stay consistent with current language.
	Option 3	Except for motorcycles, each vehicle must have a means for indicating to the left, front seating position when the upper beams of the headlighting system are activated. Each motorcycle must have a means for indicating to the front seating position when the upper beams of the headlighting system are activated.	Provides an option to continue to display upper beam headlamp indicators in an ADS-DV similar to what is done today for a human driver vehicle.

FMVSS No. 108, S9.5.1 Indicator size and location.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The upper beam headlamp indicator must have a minimum area equivalent to that of a 3⁄16 in diameter circle, and be plainly visible to drivers of all heights under normal driving conditions when headlamps are required.	**Option 1**	For vehicles that can be operated by a human driver, the upper beam headlamp indicator must have a minimum area equivalent to that of a 3⁄16 in diameter circle, and be plainly visible to human drivers of all heights under normal driving conditions when headlamps are required.	Uses driver definition 1.
	Option 2	For vehicles that can be operated by a driver, the upper beam headlamp indicator must have a minimum area equivalent to that of a 3⁄16 in diameter circle, and be plainly visible to drivers of all heights under normal driving conditions when headlamps are required.	Uses driver definition 2.
	Option 3	Except for motorcycles, each vehicle's upper beam headlamp indicator must have a minimum area equivalent to that of a 3⁄16 in diameter circle, and be plainly visible to the left, front seating position of all heights under normal driving conditions when headlamps are required. Each motorcycle's upper beam headlamp indicator must have a minimum area equivalent to that of a 3⁄16 in diameter circle, and be plainly visible to the left, front seating position of all heights under normal driving conditions when headlamps are required.	Provides an option to continue to display upper beam headlamp indicators in an ADS-DV similar to what is done today for a vehicle operated by a human driver.

FMVSS No. 108, S9.6.1 Vehicular hazard warning signal operating unit.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The unit may be an independent device or it may be combined with the turn signal operating unit. If combined with the turn signal operating unit, the actuating motion of the hazard function must differ from the actuating motion of the turn signal function.	**Option 1**	Retain current language.	Interchangeable across options.
	Option 2	The unit may be an independent device or it may be combined with the turn signal operating unit. If combined with the turn signal operating unit, the actuating of the hazard function must differ from the actuating of the turn signal function.	Interchangeable across options. Remove "motion" to make the activation agnostic to driver type..

FMVSS No. 108, S9.6.2 Operating unit switch.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The unit must operate independently of the ignition or equivalent switch. If the actuation of the hazard function requires the operation of more than one switch, a means must be provided for actuating all switches simultaneously by a single driver action.	**Option 1**	Except as provided in S9.6.2.1, the unit must operate independently of the ignition or equivalent switch. If the actuation of the hazard function requires the operation of more than one switch, a means must be provided for actuating all switches simultaneously by a single action. S9.6.2.1 In an ADS-DV, the unit must operate independently of the ignition or equivalent switch by the ADS driver. A means for all DSPs to activate the hazard flashers must also be provided. If the Hazards are manually activated by the occupants, this status must be communicated to the ADS driver.	Uses driver definition 1. Allows for hazards to be ADS-controlled outside of the vehicle ignition. Also allows for manual operation outside of the ADS if the ignition is off. The human driver activates the hazard warning today and is aware of its status. The ADS should also recognize when an occupant has activated the hazard. Requires communicating the hazard status to the ADS and may be beyond the scope of the current requirements. Proposes addition of new section S9.6.2.1.

FMVSS No. 108, S9.6.2 Operating unit switch.			
Regulatory Text	**Translation Options**		**Potential Considerations**
	Option 2	Except as provided in S9.6.2.1, the unit must operate independently of the ignition or equivalent switch. If the actuation of the hazard function requires the operation of more than one switch, a means must be provided for actuating all switches simultaneously by a single action. S9.6.2.1 In an ADS-DV, the unit must operate independently of the ignition or equivalent switch by the ADS. A means for all DSPs to activate the hazard flashers must also be provided. The actuation of the hazard function must be communicated to the ADS.	Uses driver definition 2. Allows for hazards to be ADS-controlled outside of the vehicle ignition. Also allows for manual operation outside of the ADS if the ignition is off. The human driver activates the hazard warning today and is aware of its status. The ADS should also recognize when an occupant has activated the hazard. Proposes addition of new section S9.6.2.1.
	Option 3	Except as provided in S9.6.2.1, the unit must operate independently of the ignition or equivalent switch. If the actuation of the hazard function requires the operation of more than one switch, a means must be provided for actuating all switches simultaneously by a single action. S9.6.2.1 In an ADS-DV, the unit must operate independently of the ignition or equivalent switch by the ADS. A means for the left, front seating position to activate the hazard flashers must also be provided.	Uses driver definition 2. Hazard activation operation for left front seating for both vehicles equpped with manually operated driving controls and ADS-DVs. Proposes addition of new section S9.6.2.1.

FMVSS No. 108, S10.7 Activation.			
Regulatory Text	**Translation Options**		**Potential Considerations**
See Tables I-a and I-c, Table II, and S6.1.5.	**Option 1**	See Tables I-a and I-c, Table II, and S6.1.5: The wiring harness or connector assembly of each headlighting system must be designed so that only those light sources intended for meeting lower beam photometrics are energized when the lower beam has been activated by the ADS driver or when selector switch is in the lower beam position, and that only those light sources intended for meeting upper beam photometrics are energized when the upper beam selector has been activated by the ADS driver or when the switch is in the upper beam position, except for certain systems listed in Table II.	Uses driver definition 1. Interchangeable across options, may need driver/ADS reference updated. Tables I-a and I-c for lower beam headlamps device activation translation option..
	Option 2	See Tables I-a and I-c, Table II, and S6.1.5: The wiring harness or connector assembly of each headlighting system must be designed so that only those light sources intended for meeting lower beam photometrics are energized when the lower beam has been activated by the ADS or when selector switch is in the lower beam position, and that only those light sources intended for meeting upper beam photometrics are energized when the upper beam selector has been activated by the ADS or when the switch is in the upper beam position, except for certain systems listed in Table II.	Uses driver definition 2. Tables I-a and I-c for lower beam headlamps device activation translation option.

FMVSS No. 108, S10.17.5.1 Modulation.			
Regulatory Text	**Translation Options**		**Potential Considerations**
(h) Means must be provided so that both the lower and upper beam functions at design voltage when the headlamp control switch is in either the lower or upper beam position when the modulator is off.	**Option 1**	(h) Means must be provided so that both the lower and upper beam function at design voltage when the headlamp control is in either the lower or upper beam position when the modulator is off, if the vehicle is equipped with a high beam function.	Allows for ADS control. Interchangeable across options, may need driver/ADS reference updated.
	Option 2	(h) If equipped, means must be provided so that both the lower and upper beam function at the designed voltage when the headlamp controls switch or the ADS has placed the lighting in either the lower or upper beam position when the modulator is off, if the vehicle is equipped with a high beam function.	Allows for ADS control. Interchangeable across options, may need driver/ADS reference updated.

FMVSS No. 108, S12.5 Headlamp concealment device requirements.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Except for cases of malfunction covered by S12.2, each headlamp concealment device must, within an ambient temperature range of −20 °F to + 120 °F, be capable of being fully opened in not more than 3 seconds after the actuation of a driver-operated control.	**Option 1**	Except for cases of malfunction covered by S12.2, each headlamp concealment device must, within an ambient temperature range of −20 °F to + 120 °F, be capable of being fully opened in not more than 3 seconds after actuation.	Interchangeable across options. Makes control actionable by a human driver or ADS and can be used interchangeably with all options.

FMVSS No. 108, S12.6 Headlamp concealment device requirements.			
Regulatory Text	**Translation Options**		**Potential Considerations**
As an alternative to complying with the requirements of S12.1 through S12.5, a vehicle with headlamps incorporating VHAD or visual/optical aiming in accordance with this standard may meet the requirements for Concealable lamps in paragraph 5.14 of UNECE Regulation 48 page 17 (incorporated by reference, see §571.5), in the English language version.	**Option 1**	As an alternative to complying with the requirements of S12.1 through S12.5, a vehicle with headlamps incorporating VHAD or visual/optical aiming in accordance with this standard may meet the following requirements for concealable lamps. Vehicles that can be operated by a human driver may meet (a)-(f) and vehicles that are operated by an ADS driver may meet (a), (b), (d), (e) and (f): (a) The concealment of lamps shall be prohibited, with the exception of the main-beam headlamps, the dipped-beam headlamps and the front fog lamps, which may be concealed when they are not in use. (b) In the event of any failure affecting the operation of the concealment device(s) the lamps shall remain in the position of use, if already in use, or shall be capable of being moved into the position of use without the aid of tools. (c) It shall be possible to move the lamps into the position of use and to switch them on by means of a single control, without excluding the possibility of moving them into the position of use without switching them on. However, in the case of grouped main-beam and dipped-beam headlamps, the control referred to above is required only to activate the dipped-beam headlamps. (d) It shall not be possible, from the driver's seat of a vehicle that can be operated by a human driver to deliberately stop the movement of switched-on lamps before they reach the position of use. (e) If there is a danger of dazzling other road users by the transition of the lamps' positions, they may light up only when they have reached their position of use. (f) When the concealment device has a temperature of -30 °C to +50 °C the headlamps shall be capable of reaching the position of use within three seconds of initial operation of the control.	5.14 of UNECE Regulation 48 was translated directly instead of being referenced. The following translation suggestions were completed: Uses driver definition 1. Interchangeable across options, may require driver/ADS reference update. Clarifies that switching of the headlamps from the driver's seat is applicable to human-operated vehicles and accounts for ADS control.

continued...	FMVSS No. 108, S12.6 Headlamp concealment device requirements.		
Regulatory Text	**Translation Options**		**Potential Considerations**
As an alternative to complying with the requirements of S12.1 through S12.5, a vehicle with headlamps incorporating VHAD or visual/optical aiming in accordance with this standard may meet the requirements for Concealable lamps in paragraph 5.14 of UNECE Regulation 48 page 17 (incorporated by reference, see §571.5), in the English language version.	**Option 2**	As an alternative to complying with the requirements of S12.1 through S12.5, a vehicle with headlamps incorporating VHAD or visual/optical aiming in accordance with this standard may meet the following requirements for concealable lamps. Vehicles that can be operated by a driver may meet (a)-(f) and vehicles that are operated by an ADS may meet (a), (b), (d), (e) and (f): (a) The concealment of lamps shall be prohibited, with the exception of the main-beam headlamps, the dipped-beam headlamps and the front fog lamps, which may be concealed when they are not in use. (b) In the event of any failure affecting the operation of the concealment device(s) the lamps shall remain in the position of use, if already in use, or shall be capable of being moved into the position of use without the aid of tools. (c) It shall be possible to move the lamps into the position of use and to switch them on by means of a single control, without excluding the possibility of moving them into the position of use without switching them on. However, in the case of grouped main-beam and dipped-beam headlamps, the control referred to above is required only to activate the dipped-beam headlamps (d) It shall not be possible deliberately, from the driver's seat of a vehicle operated by a human driver to stop the movement of switched-on lamps before they reach the position of use. (e) If there is a danger of dazzling other road users by the transition of the lamps positions, they may light up only when they have reached their position of use. (f) When the concealment device has a temperature of -30 °C to +50 °C the headlamps shall be capable of reaching the position of use within three seconds of initial operation of the control.	5.14 of UNECE Regulation 48 was translated directly instead of being referenced. The following translation suggestions were completed: Uses driver definition 2. Interchangeable across options, may require driver/ADS reference update. Clarifies that switching of the headlamps from the driver's seat is applicable to human-operated vehicles and accounts for ADS control.

FMVSS NO. 114: THEFT PROTECTION AND ROLLAWAY PREVENTION

Technical Translation Options Summary: *The technical translation options use language that reference a particular action or vehicle condition rather than a specific design implementation or entity performing an action (e.g., "transmission state" versus "gear selection control" and "the key can be removed" versus "the user can remove the key"). The options are interchangeable.*

FMVSS No. 114, S4. Definitions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Key means a physical device or an electronic code which, when inserted into the starting system (by physical or electronic means), enables the vehicle operator to activate the engine or motor.	**Option 1**	*Key* means a physical device or an electronic code which, when inserted into the starting system (by physical or electronic means), enables activation of the engine or motor.	Removes reference to operator..

FMVSS No. 114, S5.1.3 Theft protection.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Except as specified below, an audible warning to the vehicle operator must be activated whenever the key is in the starting system and the door located closest to the driver's designated seating position is opened. An audible warning to the vehicle operator need not activate:	**Option 1**	…driver's designated seating position or any other designated seating position(s) as selected by the manufacturer is opened ... (d) If the ADS is engaged.	Allows option for additional seating positions and for the existing exclusions to remain unchanged while providing an exclusion for ADSs. Does not guarantee the warning is near the primary occupant and eliminates the requirement for any warning to be provided by an ADS-DV.

FMVSS No. 114, S5.1.3 Theft protection.			
Regulatory Text	**Translation Options**		**Potential Considerations**
(a) After the key has been inserted into the starting system, and before the driver takes further action; or (b) If the key is in the starting system in a manner or position that allows the engine or motor to be started or to continue operating; or (c) For mechanical keys and starting systems, after the key has been withdrawn to a position from which it may not be turned.	**Option 2**	Retain current language.	Retain current language based on the definition options of the driver's Designated Seating Position (DSP) and driver. Applicable based on definition options for DSP.
	Option 3	Except as specified below, an audible warning to the vehicle operator or must be activated whenever the key is in the starting system and the door located closest to the driver's designated seating position is opened. If the vehicle is an ADS-DV, an audible warning must be provided to the occupant(s). An audible warning to the vehicle operator need not activate: (a) After the key has been inserted into the starting system, and before the driver or ADS takes further action; or (b) If the key is in the starting system in a manner or position that allows the engine or motor to be started or to continue operating; or (c) For mechanical keys and starting systems, after the key has been withdrawn to a position from which it may not be turned.	Leaves the audible warning requirement for all vehicles. Makes a distinction between a human-operated vehicle and an ADS-DV. The occupant may or may not be capable of addressing the alert. Since there is no assumed primary position of seating, the warning might need to be provided so it can be heard by an occupant in any seating position.

FMVSS No. 114, S5.2.2 Rollaway prevention in vehicles equipped with transmissions with a "park" position.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Except as specified in S5.2.4, the vehicle must be designed such that the transmission or gear selection control cannot move from the "park" position, unless the key is in the starting system.	**Option 1**	Retain current language.	As written, the "gear selection control" is not required.
	Option 2	...key is in the starting system or operating state.	

FMVSS No. 114, S5.2.3 Key removal override option.			
Regulatory Text	**Translation Options**		**Potential Considerations**
At the option of the manufacturer, the key may be removed from the starting system without the transmission or gear selection control in the "park" position under one of the following conditions: (a) In the event of electrical failure, including battery discharge, the vehicle may permit key removal from the starting system without the transmission or gear	**Option 1**	(b)...a device by which the key can be removed from the starting system…. (c)...a device by which the key can be removed from the starting system….	Removes the dependency on the person or entity (ADS) that is removing the key.
	Option 2	(b)...a device by which the user or the ADS can remove the key from the starting system…. (c)...a device by which the user or the ADS can remove the key from the starting system….	Makes a distinction between human and ADS.

FMVSS No. 114, S5.2.3 Key removal override option.			
Regulatory Text	**Translation Options**		**Potential Considerations**
selection control locked in the "park" position; or (b) Provided that steering or self-mobility is prevented, the vehicle may have a device by which the user can remove the key from the starting system without the transmission or gear selection control locked in "park." This device must require: (i) The use of a tool, and (ii) Simultaneous activation of the device and removal of the key; or (c) Provided that steering or self-mobility is prevented, the vehicle may have a device by which the user can remove the key from the starting system without the transmission or gear selection control locked in "park." This device must be covered by an opaque surface which, when installed: (i) Prevents sight of and use of the device, and (ii) Can be removed only by using a screwdriver or other tool.	**Option 3**	(b)...a device by which the user or the ADS can remove the key from the starting system… (c)...a device by which the user or the ADS can remove the key from the starting system…	Makes a distinction between human and ADS.

FMVSS No. 114, S5.2.4 Gear selection control override option.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The vehicle may have a device by which the user can move the gear selection control from "park" after the key has been removed from the starting system. This device must be operable by one of the three options below: (a) By use of the key; or (b) By a means other than the key, provided steering or forward self-mobility is prevented when the key is removed from the starting system. Such a means must require: (i) The use of a tool, and (ii) Simultaneous activation of this means and movement of the gear selection control from "park;" or (c) By a means other than the key, provided steering or forward self-mobility is prevented when the key is removed from the starting system. This device must be covered by an opaque surface which, when installed: (i) Prevents sight of and use of the device, and (ii) Can be removed only by using a screwdriver or other tool.	**Option 1**	…device by which the gear selection control or transmission state can be moved from "park" after the key has been removed...	This assumes a human might want to change the state of the transmission. Use cases for this may include diagnosis/repair of the vehicle, in which case option (b) might likely apply, assuming something like a diagnostic tool could fall under this category (e.g., plug in an electronic device which allows for manual control of some/all of the vehicle functionality).
	Option 2	…device by which the user or ADS can move the gear selection control or change the transmission state from "park"...	Makes a distinction between human and ADS.
	Option 3	…device by which the user or ADS can move the gear selection control or change the transmission state from "park"...	Makes a distinction between human and ADS.

FMVSS No. 114, S5.3 Brake transmission shift interlock.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Each motor vehicle manufactured on or after September 1, 2010 with a GVWR of 4,536 kilograms (10,000 pounds) or less with an automatic transmission that includes a "park" position shall be equipped with a system that requires the service brake to be depressed before the transmission can be shifted out of "park." This system shall function in any starting system key position in which the transmission can be shifted out of "park." This section does not apply to trailers or motorcycles.	**Option 1**	…requires the service brake to be applied before…	Provides a generic means of activation of service brake rather than specific motion. May require a means to demonstrate this condition.

FMVSS No. 114, S6.1.1 Test conditions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The vehicle shall be tested at curb weight plus 91 kg (including the driver).	**Option 1**	The vehicle shall be tested at curb weight plus 91 kg (including the driver, if any).	

FMVSS No. 114, S6.2.1 Test procedure.			
Regulatory Text	**Translation Options**		**Potential Considerations**
(a) Activate the starting system using the key. (b) Move the gear selection control to any gear selection position or any other position where it will remain without assistance, including a position between any detent positions, except for the "park" position. (c) Attempt to remove the key in each gear selection position.	**Option 1**	(a) Activate the starting system. (b) Move the gear selection control or set the transmission state… (c) Attempt to remove the key in each gear selection or transmission state.	May require means to confirm the state of the ADS.

FMVSS No. 114, S6.2.2 Test procedure.			
Regulatory Text	**Translation Options**		**Potential Considerations**
(a) Drive the vehicle forward up a 10 percent grade and stop it with the service brakes. (b) Apply the parking brake (if present). (c) Move the gear selection control to "park." (d) Note the vehicle position. (e) Release the parking brake. Release the service brakes. (f) Remove the key. (g) Verify that the gear selection control or transmission is locked in "park." (h) Verify that the vehicle, at rest, has moved no more than 150 mm from the position noted prior to release of the brakes.	**Option 1**	(c) Move the gear selection control or set the transmission state to "park." (e) Disengage the parking brake and the service brakes.	May require means to confirm the state of the ADS.

FMVSS No. 114, S6.2.3 Test procedure.			
Regulatory Text	**Translation Options**		**Potential Considerations**
(a) Drive the vehicle forward down a 10 percent grade and stop it with the service brakes. (b) Apply the parking brake (if present). (c) Move the gear selection control to "park." (d) Note the vehicle position. (e) Release the parking brake. Release the service brakes. (f) Remove the key. (g) Verify that the gear selection control or transmission is locked in "park." (h) Verify that the vehicle, at rest, has moved no more than 150 mm from the position noted prior to release of the brakes.	**Option 1**	(e) Disengage the parking brake (if present) and the service brakes.	

FMVSS NO. 118: POWER-OPERATED WINDOW, PARTITION, AND ROOF PANEL SYSTEMS

Technical Translation Options Summary: *The current regulation assumes that a human driver will be present and able to supervise the operation of the power windows, partitions, and roof panels. The regulation uses indirect measures, such as door opening and key position, to assess whether a driver is present. There are three technical translation options: Option 1 addresses unsupervised window operation by removing exceptions to requiring ADS-DVs to comply with S5 since driver presence cannot be assumed, whereas Option 2 assumes that occupants riding in an ADS-DV are capable of safe window operation based on the level of maturity that would be needed to arrange a ride in an ADS-DV. This option does modify S4(e) from front doors to any door for an ADS-DV and retains the current language for human-operated vehicles. It would not allow window closure after a door has been opened. Option 3 provides an additional derivative of Option 2 and translates S4(e) from front doors to any door for both ADS-DVs and human-operated vehicles. However, this option may expand today's standard.*

FMVSS No. 118, S4. Operating requirements.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Except as provided in S5, power operated window, partition, or roof panel systems may be closed only in the following circumstances:	**Option 1**	For vehicles operated by a human driver, except as provided in S5, power operated window, partition, or roof panel systems may be closed only in the following circumstances: (a) - (g). For vehicles operated by an ADS, except as provided in S5, power operated window, partition, or roof panel systems may be closed only in the following circumstances (b), (c), (d), (f), and (g).	Uses driver definition 1. Attempts to address unsupervised operation by removing the exceptions to S5 closure that assumes a licensed driver is inside the vehicle to supervise closure. Attempts to address potential unsupervised window closure by a child or someone who may not be able to safely operate the windows inside the vehicle by removing the S5 exceptions. Limits exceptions to S5.
	Option 2	Retain current language for option 2.	Translation suggested for (e).
	Option 3	Retain current language for option 3.	Translation suggested for (e).

FMVSS No. 118, S4. Operating requirements.			
Regulatory Text	**Translation Options**		**Potential Considerations**
(e) During the interval between the time the locking device which controls the activation of the vehicle's engine is turned off and the opening of either of a two-door vehicle's doors or, in the case of a vehicle with more than two doors, the opening of either of its front doors;	**Option 1**	Retain current language	(e) would not apply to an ADS-DV for option 1.
	Option 2	(e) During the interval between the time the locking device which controls the activation of the vehicle's engine is turned off and the opening of its front doors for vehicles operated by a driver and any doors for vehicles that can be operated by an ADS;	Uses driver definition 2. Maintains current language for a vehicle operated by a human driver. "Any doors" and "ADS-DV" may be applied to address the unknown of which door the supervising occupant may be exiting. Maintains current language for vehicles operated by a human driver. For an ADS-DV, Option 2 expands the exceptions to S5 and may expand today's regulation from front doors to any doors for an ADS-DV.
	Option 3	(e) During the interval between the time the locking device which controls the activation of the vehicle's engine is turned off and the opening of any of the vehicle's doors.	This option does not allow for closure when any doors are opened for both vehicles operated by a human driver and ADS-DVs.

FMVSS NO. 138: TIRE PRESSURE MONITORING SYSTEMS

Technical Translation Options Summary: *The technical translation options summary includes three main aspects.*

1. How to communicate the detection of a low tire pressure state and Tire Pressure Monitoring System (TPMS) malfunction to the Automated Driving System (ADS) under the same circumstances that currently initiates a telltale illumination to a human driver.

2. How the low tire pressure state and TPMS malfunction may be presented in an ADS-Dedicated Vehicle (ADS-DV).

3. Alternatives for the required written instructions that retains the warnings of significant under-inflation of tires and the resulting safety problems.

There are four main technical translation options and one additional option with further suggested language considerations. The options are outlined as follows: Option 1 applies driver definition 1 and communicates the low tire pressure state and malfunction to only the ADS; Option 2 applies driver definition 2, communicates the low tire pressure state and malfunction to the ADS and displays the telltale information to all Designated Seating Positions (DSPs); Option 3 applies driver definition 2, communicates the low tire pressure state and malfunction to the ADS and displays the telltale information to the left, front seating position (e.g., consistent to what would be done for a conventional vehicle with a human driver); Option 4 is very similar to Option 3, but instead of the telltale information displaying the telltale information to the left, front seating position, it would be at a manufacturer-specified position. In addition to the four options, a fifth option includes further language consideration for removing the reference to driver that could be interchangeable with the other options. Options 1–4 are not necessarily interchangeable, but are noted when interchangeability is possible.

FMVSS No. 138, S1 Purpose and scope.			
Regulatory Text	**Translation Options**		**Potential Considerations**
This standard specifies performance requirements for tire pressure monitoring systems (TPMSs) to warn drivers of significant under-inflation of tires and the resulting safety problems.	**Option 1**	Retain current language.	Uses driver definition 1. By updating the "driver" definition to include ADS, creates a straightforward approach to translating the standard text. Defining "driver" to mean the human or the ADS may not provide clarity in the application of the requirements (e.g., further considerations for a dual-use vehicle regarding warning recipient).
	Option 2	...to warn drivers and Automated Driving Systems (ADSs) of significant under-inflation of tires and the resulting safety problems.	Uses driver definition 2. This option clarifies who is being provided the warning. Retains current driver definition. Language may need to consider clarifying system engagement status as appropriate.

FMVSS No. 138, S3 Definitions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Lightly loaded vehicle weight means unloaded vehicle weight plus the weight of a mass of 180 kg (396 pounds), including test driver and instrumentation.	**Option 1**	Lightly loaded vehicle weight means unloaded vehicle weight plus the weight of a mass of 180 kg (396 pounds), including on-board test personnel (if any) and instrumentation.	May be used interchangeably with all the options. Maintains consistent test loading to current FMVSS.
	Option 2	Lightly loaded vehicle weight means unloaded vehicle weight plus the weight of a mass of 180 kg (396 pounds).	Removes "including test driver and instrumentation." Can be used interchangeably with all the options. Suitable for ADS-DVs and vehicles operated by a human driver. May not clarify that the 180 lbs includes tester and instrumentation.

continued…	FMVSS No. 138, S3 Definitions.		
Regulatory Text	**Translation Options**		**Potential Considerations**
Tire pressure monitoring system means a system that detects when one or more of a vehicle's tires is significantly under-inflated and illuminates a low tire pressure warning telltale.	**Option 1**	Tire pressure monitoring system means a system that detects when one or more of a vehicle's tires is significantly under-inflated and communicates the low tire pressure condition.	May be used across the other options.

FMVSS No. 138, S4.2 TPMS detection requirements.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The tire pressure monitoring system must: (a) Illuminate a low tire pressure warning telltale not more than 20 minutes after the inflation pressure in one or more of the vehicle's tires, up to a total of four tires, is equal to or less than either the pressure 25 percent below the vehicle manufacturer's recommended cold inflation pressure, or the pressure specified in the 3rd column of Table 1 of this standard for the corresponding type of tire, whichever is higher; (b) Continue to illuminate the low tire pressure warning telltale as long as the pressure in any of the vehicle's tires is equal to or less than the pressure specified in S4.2(a), and the ignition locking system is in the "On" ("Run") position, whether or not the engine is running, or until manually reset in accordance with the vehicle manufacturer's instructions.	**Option 1**	The tire pressure monitoring system must: (a) Indicate a low tire pressure state not more than 20 minutes after the inflation pressure in one or more of the vehicle's tires, up to a total of four tires, is equal to or less than either the pressure 25 percent below the vehicle manufacturer's recommended cold inflation pressure, or the pressure specified in the 3rd column of Table 1 of this standard for the corresponding type of tire, whichever is higher; (b) Continue to indicate the low tire pressure state as long as the pressure in any of the vehicle's tires is equal to or less than the pressure specified in S4.2(a), and the ignition locking system is in the "On" ("Run") position, whether or not the engine is running, or until reset in accordance with the vehicle manufacturer's instructions.	Interchangeable with other options. Removes "manually" as a reset condition. Minimal changes to the language. It may be potentially unclear to whom the indication is directed.
	Option 2	The tire pressure monitoring system must illuminate a low tire pressure warning telltale for vehicles operated by a driver and must indicate the state to the ADS for vehicles operated by an ADS, as specified in (a) and (b): (a) Not more than 20 minutes after the inflation pressure in one or more of the vehicle's tires, up to a total of four tires, is equal to or less than either the pressure 25 percent below the vehicle manufacturer's recommended cold inflation pressure, or the pressure specified in the 3rd column of Table 1 of this standard for the corresponding type of tire, whichever is higher; (b) As long as the pressure in any of the vehicle's tires is equal to or less than the pressure specified in S4.2(a), and the ignition locking system is in the "On" ("Run") position, whether or not the engine is running, or until manually reset in accordance with the vehicle manufacturer's instructions.	Interchangeable with other options. Further considerations may be needed for level 3 ADS (level 3 ADS is out of the scope of this project). When a level 3 ADS is operating the vehicle, the telltales may not have to be illuminated with the approach used in this translation. However, when a human driver is supervising, it may be appropriate to have the human driver telltale available.

FMVSS No. 138, S4.3 Low tire pressure warning telltale.			
Regulatory Text	**Translation Options**		**Potential Considerations**
S4.3 Low tire pressure warning telltale.	**Option 1**	S4.3 Low tire pressure warning detection.	.

FMVSS No. 138, S4.3.1 Low tire pressure warning telltale.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Each tire pressure monitoring system must include a low tire pressure warning telltale that: (a) Is mounted inside the occupant compartment in front of and in clear view of the driver; (b) Is identified by one of the symbols shown for the "Low Tire Pressure" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); and (c) Is illuminated under the conditions specified in S4.2.	**Option 1**	For vehicles that can be operated by a human driver, each tire pressure monitoring system must include a low tire pressure warning telltale that: (a) Is mounted inside the occupant compartment in front of and in clear view of the human driver; (b) Is identified by one of the symbols shown for the "Low Tire Pressure" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); and (c) Is illuminated under the conditions specified in S4.2.	Uses driver definition 1. Maintains current S4.3 text for vehicles operated by human drivers, removes human driver telltale for ADS-DVs, and adds new S4.3.4 to specify communicating the low tire pressure state. Retains current regulation language for human-operated systems. May provide clarity for responsibility (e.g., ADS determines response as human drivers do today). Does not provide tire inflation warning to the non-occupant or occupant who may have the responsibility for vehicle maintenance. Further considerations may be needed for mixed-function ADSs when telltale is required (e.g., continuous or only when ADS is engaged).

FMVSS No. 138, S4.3.1 Low tire pressure warning telltale.			
Regulatory Text	**Translation Options**		**Potential Considerations**
	Option 2	For vehicles operated by a driver, each tire pressure monitoring system must include a low tire pressure warning telltale that: (a) Is mounted inside the occupant compartment in front of and in clear view of the driver; (b) Is identified by one of the symbols shown for the "Low Tire Pressure" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); and (c) Is illuminated under the conditions specified in S4.2. For vehicles operated by an ADS, each tire pressure monitoring system must include a low tire pressure warning telltale that: (a) Is mounted inside the occupant compartment in front of and in clear view of all Designated Seating Positions (DSPs); (b) Is identified by one of the symbols shown for the "Low Tire Pressure" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); and (c) Is illuminated under the conditions specified in S4.2.	Uses driver definition 2. All occupants would be provided a telltale that is currently provided to a human driver. Maintains current regulation language for human-operated systems. The language differs from option 1 which uses "can be operated." Low tire pressure warning is provided to all occupants, available for maintenance checks and occupants who may want this information. Today, the human driver takes actions and the information may not be provided to all the passengers or the owner if they are different from the human driver. Another consideration is that not all potential occupants may be able to react to the illuminated warning and there may not be a location that is viewable by all seating locations. Potentially extends current telltale locations to multiple locations.

continued…	FMVSS No. 138, S4.3.1 Low tire pressure warning telltale.		
Regulatory Text	**Translation Options**		**Potential Considerations**
Each tire pressure monitoring system must include a low tire pressure warning telltale that: (a) Is mounted inside the occupant compartment in front of and in clear view of the driver; (b) Is identified by one of the symbols shown for the "Low Tire Pressure" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); and (c) Is illuminated under the conditions specified in S4.2.	**Option 3**	Each tire pressure monitoring system must include a low tire pressure warning telltale that: (a) Is mounted inside the occupant compartment in front of and in clear view of the driver's designated seating position for vehicles that can be operated by a driver; (b) Is mounted inside the occupant compartment in front of and in clear view of the front, left seating position for ADS-DVs; (c) Is identified by one of the symbols shown for the "Low Tire Pressure" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); and (d) Is illuminated under the conditions specified in S4.2.	Front, left seating position would provide telltale information similar to where the information is provided to the human driver today. Maintains current regulation language for human-operated systems. Low tire pressure warning is provided in front, left position, available for maintenance checks and occupants who may want to check this information before riding. Aligns with current regulation. Today, the human driver takes actions and the information may not be provided to all the passengers or the owner if they are different from the human driver. Another consideration is that not all potential occupants may be able to react to the illuminated warning and there may not be a location that is viewable by all seating locations.
	Option 4	Each tire pressure monitoring system must include a low tire pressure warning telltale that: (a) Is mounted inside the occupant compartment in front of and in clear view of the driver's designated seating position (DSP) for vehicles that can be operated by a driver; (b) Is mounted inside the occupant compartment in front of and in clear view of the front, left seating position for ADS-DVs; (c) Is identified by one of the symbols shown for the "Low Tire Pressure" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); and (d) Is illuminated under the conditions specified in S4.2.	Uses driver definition 2. Suggests a maintenance location for some telltales. Maintains current regulation language for human-operated systems. Low tire pressure warning may be available for maintenance checks and occupants who may want to check this information before riding. Does not need to be a manufacturer's specified location. Maintenance location could be defined in FMVSS, so all telltales could be provided in one location. May not necessarily be available while seated in a designated seating location and potentially need to be checked beforehand.

FMVSS No. 138, S4.3.2 Low tire pressure warning telltale.			
Regulatory Text	**Translation Options**		**Potential Considerations**
In the case of a telltale that identifies which tire(s) is (are) under-inflated, each tire in the symbol for that telltale must illuminate when the tire it represents is under-inflated to the extent specified in S4.2.	**Option 1**	For vehicles that can be operated by a human driver, in the case of a telltale that identifies which tire(s) is (are) under-inflated, each tire in the symbol for that telltale must illuminate when the tire it represents is under-inflated to the extent specified in S4.2.	Uses driver definition 1. Maintains current regulation language for human-driven systems. Potential considerations may be needed for mixed functionalities regarding when the ADS telltale is required.
	Option 2	Retain current language.	
	Option 3	Retain current language.	
	Option 4	Retain current language.	

FMVSS No. 138, S4.3.3 Low tire pressure warning telltale.			
Regulatory Text	**Translation Options**		**Potential Considerations**
(a) Except as provided in paragraph (b) of this section, each low tire pressure warning telltale must illuminate as a check of lamp function either when the ignition locking system is activated to the "On" ("Run") position when the engine is not running, or when the ignition locking system is in a position between "On" ("Run") and "Start" that is designated by the manufacturer as a check position.	**Option 1**	For vehicles that can be operated by a human driver, (a) Except as provided in paragraph (b) of this section, each low tire pressure warning telltale must illuminate as a check of lamp function either when the ignition locking system is activated to the "On" ("Run") position when the engine is not running, or when the ignition locking system is in a position between "On" ("Run") and "Start" that is designated by the manufacturer as a check position. (b) The low tire pressure warning telltale need not illuminate when a starter interlock is in operation.	Uses driver definition 1. Maintains current regulation language for human-operated systems. Potential considerations may be needed for mixed functionalities regarding when the ADS telltale is required. (e.g., continuous or only when ADS is engaged).

FMVSS No. 138, S4.3.3 Low tire pressure warning telltale.			
Regulatory Text	**Translation Options**		**Potential Considerations**
(b) The low tire pressure warning telltale need not illuminate when a starter interlock is in operation.	**Option 2**	Retain current language.	
	Option 3	Retain current language.	
	Option 4	Retain current language.	

S4.3 Low tire pressure warning telltale.	FMVSS No. 138, S4.3.4 Added for ADS-DV translation		
Regulatory Text	**Translation Options**		**Potential Considerations**
Standard Text Provided as an Option.	**Option 1**	For vehicles operated by an ADS driver, if the tire pressure monitoring system identifies which tires(s) is (are) under-inflated then the ADS-DV must communicate the low tire pressure state for each tire to the ADS as specified in S4.2.	Check lamp function not needed because there is no lamp in Option 1.

S4.4 TPMS malfunction.	FMVSS No. 138, S4.4.1(a) Added for ADS-DV translation		
Regulatory Text	**Translation Options**		**Potential Considerations**
(a) The vehicle shall be equipped with a tire pressure monitoring system that includes a telltale that provides a warning to the driver not more than 20 minutes after the occurrence of a malfunction that affects the generation or transmission of control or response signals in the vehicle's tire pressure monitoring system. The vehicle's TPMS malfunction	**Option 1**	For vehicles operated by a human driver, (a) the vehicle shall be equipped with a tire pressure monitoring system that includes a telltale that provides a warning to the human driver not more than 20 minutes after the occurrence of a malfunction that affects the generation or transmission of control or response signals in the vehicle's tire pressure monitoring system. The vehicle's TPMS malfunction indicator shall meet the requirements of either S4.4.1(b) or S4.4.1(c).	Uses driver definition 1. Maintain current S4.4 text for vehicles operated by a human driver and add new ADS-DV text under S4.4.2. Maintains current regulation language for human-operated systems.

S4.4 TPMS malfunction.	FMVSS No. 138, S4.4.1(a) Added for ADS-DV translation		
Regulatory Text	**Translation Options**		**Potential Considerations**
indicator shall meet the requirements of either S4.4(b) or S4.4(c).	**Option 2**	For vehicles operated by a driver, (a) the vehicle shall be equipped with a tire pressure monitoring system that includes a telltale that provides a warning to the driver not more than 20 minutes after the occurrence of a malfunction that affects the generation or transmission of control or response signals in the vehicle's tire pressure monitoring system. The vehicle's TPMS malfunction indicator shall meet the requirements of either S4.4.1(b) or S4.4.1(c).	Uses driver definition 2. Maintains current regulation language for human-operated systems.
	Option 3	Same as Option 2.	
	Option 4	Same as Option 2.	

S4.4 TPMS malfunction.	FMVSS No. 138, S4.4.1 (b)-(c) Added for ADS-DV translation		
Regulatory Text	**Translation Options**		**Potential Considerations**
(b) The vehicle meets the requirements of S4.4(a) when equipped with a dedicated TPMS malfunction telltale that: (1) Is mounted inside the occupant compartment in front of and in clear view of the driver; (2) Is identified by the word "TPMS" as described under the "Tire Pressure Monitoring System Malfunction" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); (3) Continues to illuminate the TPMS malfunction telltale under the conditions specified in S4.4(a) for as long as the malfunction exists, whenever the ignition locking system is in the "On" ("Run") position; and (4) (I) Except as provided in paragraph (ii), each dedicated TPMS malfunction telltale must be activated as a check of lamp function either when the ignition locking system is activated to the "On" ("Run") position when the engine is not running, or when the ignition locking system is in a position between "On" ("Run") and "Start" that is designated by the manufacturer as a check position. (ii) The dedicated TPMS malfunction telltale need not be activated when a starter interlock is in operation.	**Option 1**	b) Dedicated TPMS malfunction telltale. The vehicle meets the requirements of S4.4.1(a) when equipped with a dedicated TPMS malfunction telltale that: (1) Is mounted inside the occupant compartment in front of and in clear view of the human driver; (2) Is identified by the word "TPMS" as described under the "Tire Pressure Monitoring System Malfunction" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); (3) Continues to illuminate the TPMS malfunction telltale under the conditions specified in S4.4.1(a)... (c) Combination low tire pressure/TPMS malfunction telltale. The vehicle meets the requirements of S4.4.1(a) when equipped with a combined Low Tire Pressure/TPMS malfunction telltale that..: (2) Flashes for a period of at least 60 seconds but no longer than 90 seconds upon detection of any condition specified in S4.4.1(a)... after the ignition locking system is activated to the "On" ("Run") position. After each period of prescribed flashing, the telltale must remain continuously illuminated as long as a malfunction exists and the ignition locking system is in the "On" ("Run") position. This flashing and illumination sequence must be repeated each time the ignition locking system is placed in the "On" ("Run") position until the situation causing the malfunction has been corrected. Multiple malfunctions occurring during any ignition cycle may, but are not required to, reinitiate the prescribed flashing sequence.	Uses driver definition 1. Maintains current regulation language for human-operated systems. The required communication of the malfunction state is to the ADS and may not be provided to occupants.

continued... S4.4 TPMS malfunction.	FMVSS No. 138, S4.4.1 (b)-(c) Added for ADS-DV translation		
Regulatory Text	**Translation Options**		**Potential Considerations**
(c) Combination low tire pressure/TPMS malfunction telltale. The vehicle meets the requirements of S4.4(a) when equipped with a combined Low Tire Pressure/TPMS malfunction telltale that: (1) Meets the requirements of S4.2 and S4.3; and (2) Flashes for a period of at least 60 seconds but no longer than 90 seconds upon detection of any condition specified in S4.4(a) after the ignition locking system is activated to the "On" ("Run") position. After each period of prescribed flashing, the telltale must remain continuously illuminated as long as a malfunction exists and the ignition locking system is in the "On" ("Run") position. This flashing and illumination sequence must be repeated each time the ignition locking system is placed in the "On" ("Run") position until the situation causing the malfunction has been corrected. Multiple malfunctions occurring during any ignition cycle may, but are not required to, reinitiate the prescribed flashing sequence.	**Option 2**	b) Dedicated TPMS malfunction telltale. The vehicle meets the requirements of S4.4.1(a) when equipped with a dedicated TPMS malfunction telltale that: (1) Is mounted inside the occupant compartment in front of and in clear view of the human driver; (2) Is identified by the word "TPMS" as described under the "Tire Pressure Monitoring System Malfunction" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); (3) Continues to illuminate the TPMS malfunction telltale under the conditions specified in S4.4.1(a)... (c) Combination low tire pressure/TPMS malfunction telltale. The vehicle meets the requirements of S4.4.1(a) when equipped with a combined Low Tire Pressure/TPMS malfunction telltale that... (2) Flashes for a period of at least 60 seconds but no longer than 90 seconds upon detection of any condition specified in S4.4.1(a)	Uses driver definition 2. Can be used interchangeably with the other options.
	Option 3	Same as Option 2.	
	Option 4	Same as Option 2.	

S4.4 TPMS malfunction.	FMVSS No. 138, S4.4.2(a) Added for ADS-DV translation		
Regulatory Text	**Translation Options**		**Potential Considerations**
Standard Text Provided as an Option.	**Option 1**	For vehicles operated by an ADS driver: (a) the ADS-DV shall be equipped with a tire pressure monitoring system that communicates the malfunction that affects the generation or transmission of control or response signals in the vehicle's tire pressure monitoring system to the ADS driver not more than 20 minutes after the occurrence.	Uses driver definition 1. Can be used interchangeably with the other options. Does not provide tire inflation malfunction information within the occupant compartment. Check function not required Option 1 (no telltales). Further considerations may be needed for mixed-function ADSs regarding when the telltale is required (e.g., continuous or only when ADS is engaged).
	Option 2	For vehicles operated by an ADS: (a) the ADS-DV shall be equipped with a tire pressure monitoring system that communicates the malfunction that affects the generation or transmission of control or response signals in the vehicle's tire pressure monitoring system to the ADS driver not more than 20 minutes after the occurrence.	Uses driver definition 2.
	Option 3	Same as Option 2.	
	Option 4	Same as Option 2.	

continued... S4.4 TPMS malfunction.	FMVSS No. 138, S4.4.2(b)-(c) Added for ADS-DV translation		
Regulatory Text	**Translation Options**		**Potential Considerations**
Standard Text Provided as an Option.	**Option 1**	(b) Dedicated TPMS malfunction telltale. The vehicle meets the requirements of S4.4.2(a) when equipped with a TPMS malfunction indicator that: (1) Is mounted inside the occupant compartment in front of and in clear view of all DSPs for vehicles operated by an ADS; (2) Is identified by the word "TPMS" as described under the "Tire Pressure Monitoring System Malfunction" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); (3) Continues to communicate the TPMS malfunction state under the conditions specified in S4.4(a) for as long as the malfunction exists, whenever the ignition locking system is in the "On" ("Run") position; and (4) (I) Except as provided in paragraph (ii), the communication to the ADS must be activated as a check of function indication either when the ignition locking system is activated to the "On" ("Run") position when the engine is not running, or when the ignition locking system is in a position between "On" ("Run") and "Start" that is designated by the manufacturer as a check position. (ii) The TPMS malfunction state does need not to communicate to ADS when a starter interlock is in operation (c) Combination low tire pressure/TPMS malfunction telltale. The ADS-DV meets the requirements of S4.4(a) when equipped with a combined Low Tire Pressure/TPMS malfunction indicator that: (1) Meets the requirements of S4.2 and S4.3; and (2) Flashes for a period of at least 60 seconds but no longer than 90 seconds upon detection of any condition specified in S4.4.2(a) after the ignition locking system is activated to the "On" ("Run") position. After each period of prescribed flashing, the telltale must remain continuously illuminated as long as a malfunction exists and the ignition locking system is in the "On" ("Run") position. This flashing and illumination sequence must be repeated each time the ignition locking system is placed in the "On" ("Run") position until the situation causing the malfunction has been corrected. Multiple malfunctions occurring during any ignition cycle may, but are not required to, reinitiate the prescribed flashing sequence.	Uses driver definition 1. Maintains current regulation language for human-operated systems. The required communication of the malfunction state is to the ADS and may not be provided to occupants.

continued... S4.4 TPMS malfunction.	FMVSS No. 138, S4.4.2(b)-(c) Added for ADS-DV translation		
Regulatory Text	**Translation Options**		**Potential Considerations**
Standard Text Provided as an Option.	**Option 2**	(b) Dedicated TPMS malfunction telltale. The vehicle meets the requirements of S4.4.2(a) when equipped with a TPMS malfunction indicator that: (1) Is mounted inside the occupant compartment in front of and in clear view of the left, front seating position for vehicles that can be operated by an ADS; (2) Is identified by the word "TPMS" as described under the "Tire Pressure Monitoring System Malfunction" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); (3) continues to communicate the TPMS malfunction state under the conditions specified in S4.4(a) for as long as the malfunction exists, whenever the ignition locking system is in the "On" ("Run") position; and (4) (I) Except as provided in paragraph (ii), the communication to the ADS must be activated as a check of function indication either when the ignition locking system is activated to the "On" ("Run") position when the engine is not running, or when the ignition locking system is in a position between "On" ("Run") and "Start" that is designated by the manufacturer as a check position. (ii) The TPMS malfunction state does not need to communicate to the ADS when a starter interlock is in operation (c) Combination low tire pressure/TPMS malfunction telltale. The ADS-DV meets the requirements of S4.4(a) when equipped with a combined Low Tire Pressure/TPMS malfunction indicator that: (1) Meets the requirements of S4.2 and S4.3; and (2) Flashes for a period of at least 60 seconds but no longer than 90 seconds upon detection of any condition specified in S4.4.2(a) after the ignition locking system is activated to the "On" ("Run") position. After each period of prescribed flashing, the telltale must remain continuously illuminated as long as a malfunction exists and the ignition locking system is in the "On" ("Run") position. This flashing and illumination sequence must be repeated each time the ignition locking system is placed in the "On" ("Run") position until the situation causing the malfunction has been corrected. Multiple malfunctions occurring during any ignition cycle may, but are not required to, reinitiate the prescribed flashing sequence.	Uses driver definition 2. Provides malfunction warning to the ADS and left front seating positions. Warning is provided in the same circumstances as current standard. An occupant may not be seated in or be able to see the left, front position. Some occupants may not have the capability to respond.

continued... S4.4 TPMS malfunction.	FMVSS No. 138, S4.4.2(b)-(c) Added for ADS-DV translation		
Regulatory Text	**Translation Options**		**Potential Considerations**
Standard Text Provided as an Option.	**Option 3**	(b) Dedicated TPMS malfunction telltale. The vehicle meets the requirements of S4.4.2(a) when equipped with a TPMS malfunction indicator that: (1) Is mounted inside the occupant compartment in a manufacturer specified maintenance location for vehicles that can be operated by an ADS; (2) Is identified by the word "TPMS" as described under the "Tire Pressure Monitoring System Malfunction" Telltale in Table 1 of Standard No. 101 (49 CFR 571.101); (3) continues to communicate the TPMS malfunction state under the conditions specified in S4.4(a) for as long as the malfunction exists, whenever the ignition locking system is in the "On" ("Run") position; and (4) (I) Except as provided in paragraph (ii), the communication to the ADS must be activated as a check of function indication either when the ignition locking system is activated to the "On" ("Run") position when the engine is not running, or when the ignition locking system is in a position between "On" ("Run") and "Start" that is designated by the manufacturer as a check position. (ii) The TPMS malfunction state does need not to communicate to ADS when a starter interlock is in operation. (c) Combination low tire pressure/TPMS malfunction telltale. The ADS-DV meets the requirements of S4.4(a) when equipped with a combined Low Tire Pressure/TPMS malfunction indicator that: (1) Meets the requirements of S4.2 and S4.3; and (2) Flashes for a period of at least 60 seconds but no longer than 90 seconds upon detection of any condition specified in S4.4.2(a) after the ignition locking system is activated to the "On" ("Run") position. After each period of prescribed flashing, the telltale must remain continuously illuminated as long as a malfunction exists and the ignition locking system is in the "On" ("Run") position. This flashing and illumination sequence must be repeated each time the ignition locking system is placed in the "On" ("Run") position until the situation causing the malfunction has been corrected. Multiple malfunctions occurring during any ignition cycle may, but are not required to, reinitiate the prescribed flashing sequence.	This option includes a new maintenance location for some telltales and malfunctions. Malfunction information may be available for maintenance checks and occupants who may want to check this information before riding. This option includes malfunction information provided in one location. Although, the translation states manufacturer specified, the location could be specified in FMVSS No. 101. May not necessarily be available while seated in a designated seating location and may potentially need to be checked beforehand.

FMVSS No. 138, S4.5 Written instructions.
Regulatory Text
(a) Beginning on September 1, 2006, the owner's manual in each vehicle certified as complying with S4 must provide an image of the Low Tire Pressure Telltale symbol (and an image of the TPMS Malfunction Telltale warning ("TPMS"), if a dedicated telltale is utilized for this function) with the following statement in English: Each tire, including the spare (if provided), should be checked monthly when cold and inflated to the inflation pressure recommended by the vehicle manufacturer on the vehicle placard or tire inflation pressure label. (If your vehicle has tires of a different size than the size indicated on the vehicle placard or tire inflation pressure label, you should determine the proper tire inflation pressure for those tires.) As an added safety feature, your vehicle has been equipped with a tire pressure monitoring system (TPMS) that illuminates a low tire pressure telltale when one or more of your tires is significantly under-inflated. Accordingly, when the low tire pressure telltale illuminates, you should stop and check your tires as soon as possible, and inflate them to the proper pressure. Driving on a significantly under-inflated tire causes the tire to overheat and can lead to tire failure. Under-inflation also reduces fuel efficiency and tire tread life, and may affect the vehicle's handling and stopping ability. Please note that the TPMS is not a substitute for proper tire maintenance, and it is the driver's responsibility to maintain correct tire pressure, even if under-inflation has not reached the level to trigger illumination of the TPMS low tire pressure telltale. [The following paragraph is required for all vehicles certified to the standard starting on September 1, 2007 and for vehicles voluntarily equipped with a compliant TPMS MIL before that time.] Your vehicle has also been equipped with a TPMS malfunction indicator to indicate when the system is not operating properly. [For vehicles with a dedicated MIL telltale, add the following statement: The TPMS malfunction indicator is provided by a separate telltale, which displays the symbol "TPMS" when illuminated.] [For vehicles with a combined low tire pressure/MIL telltale, add the following statement: The TPMS malfunction indicator is combined with the low tire pressure telltale. When the system detects a malfunction, the telltale will flash for approximately one minute and then remain continuously illuminated. This sequence will continue upon subsequent vehicle start-ups as long as the malfunction exists.] When the malfunction indicator is illuminated, the system may not be able to detect or signal low tire pressure as intended. TPMS malfunctions may occur for a variety of reasons, including the installation of replacement or alternate tires or wheels on the vehicle that prevent the TPMS from functioning properly. Always check the TPMS malfunction telltale after replacing one or more tires or wheels on your vehicle to ensure that the replacement or alternate tires and wheels allow the TPMS to continue to function properly.

continued…	FMVSS No. 138, S4.5 Written instructions.		
Regulatory Text	**Translation Options**		**Potential Considerations**
See above.	**Option 1**	For vehicles operated by a human driver... ...Always check the TPMS malfunction telltale after replacing one or more tires or wheels on your vehicle to ensure that the replacement or alternate tires and wheels allow the TPMS to continue to function properly. For vehicles operated by an ADS driver, the owner's manual in each vehicle certified as complying with S4 must provide the following statement in English:... ...As an added safety feature, your vehicle has been equipped with a tire pressure monitoring system (TPMS). Driving on a significantly under-inflated tire causes the tire to overheat and can lead to tire failure. Under-inflation also reduces fuel efficiency and tire tread life, and may affect the vehicle's handling and stopping ability. Please note that the TPMS is not a substitute for proper tire maintenance, and it is imperative that the vehicle's tires are maintained with the correct tire pressure.	Maintains owner's manual language for vehicles operated by a human driver and adds the following language for ADS-DVs: For vehicles operated by an ADS driver, the owner's manual in each vehicle certified as complying with S4 must provide the following statement in English: Please note that the TPMS is not a substitute for proper tire maintenance, and it is imperative that the vehicle's tires are maintained with the correct tire pressure. Provides instructions for person(s) responsible for vehicle maintenance. Maintains low tire pressure language for human drivers. In this option the low tire pressure warning information is provided to the ADS and not necessarily the person(s) responsible for the vehicle maintenance.

continued…	FMVSS No. 138, S4.5 Written instructions.		
Regulatory Text	**Translation Options**		**Potential Considerations**
See above	**Option 2**	(a) The owner's manual in each vehicle certified as complying with S4 must provide the following statement in English: Each tire, including the spare (if provided), should be checked monthly when cold and inflated to the inflation pressure recommended by the vehicle manufacturer on the vehicle placard or tire inflation pressure label. (If the vehicle has tires of a different size... As an added safety feature, the vehicle has been equipped with a tire pressure monitoring system (TPMS) that monitors when one or more of your tires is significantly under-inflated. Significantly under-inflated tires causes tires to overheat and can lead to tire failure. Under-inflation also reduces fuel efficiency and tire tread life, and may affect the vehicle's handling and stopping ability. In addition to the above, the owner's manual in each vehicle certified as complying with S4 must provide an image of the Low Tire Pressure Telltale symbol (and an image of the TPMS Malfunction Telltale warning ("TPMS"), if a dedicated telltale is utilized for this function) with the following statement in English: Please note that the TPMS is not a substitute for proper tire maintenance, and it is imperative that the vehicle's tires are maintained with the correct tire pressure, even if under-inflation has not reached the level to trigger illumination of the TPMS low tire pressure telltale. Your vehicle has also been equipped with a TPMS malfunction indicator to indicate when the system is not operating properly. [For vehicles with...	Option 2 would be interchangeable with Option 3 and 4. However, it is not intended to work with Option 1. Maintains current written instructions for person(s) responsible for vehicle maintenance. Maintains low tire pressure language for human drivers and ADSs.

continued…	FMVSS No. 138, S4.5 Written instructions.		
Regulatory Text	**Translation Options**		**Potential Considerations**
See above.	**Option 3**	Same as Option 2.	
	Option 4	Same as Option 2.	

FMVSS No. 138, S5.2 Road test surface.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Compliance testing is conducted on any portion of the Southern Loop of the Treadwear Test Course defined in Appendix A and Figure 2 of section 575.104 of this chapter. The road surface is dry during testing.	**Option 1**	Compliance testing is conducted on any portion of the Southern Loop of the Treadwear Test Course defined in appendix A and Figure 2 of section 575.104 of this chapter or an equivalent road surface and loop. The road surface is dry during testing.	Further research may be needed to define equivalency (e.g., surface type, loop geometry).
	Option 2	Retain current language.	Future research may consider if potential translations are needed for road test surface.
	Option 3	Same as Option 2.	
	Option 4	Same as Option 2.	

FMVSS No. 138, S5.3.5 Brake pedal application.			
Regulatory Text	**Translation Options**		**Potential Considerations**
S5.3.5 Brake pedal application. Driving time shall not accumulate during service brake application.	**Option 1**	S5.3.5 Brake application. Driving time shall not accumulate during service brake application.	Pedal would need to be removed in section header.
	Option 2	S5.3.5 Brake application. Operating time shall not accumulate during service brake application.	Remove "pedal" from section header. Replace "driving" with "operating."

S6 Test procedures.	FMVSS No. 138, S6.1 Added for ADS-DV translation		
Regulatory Text	**Translation Options**		**Potential Considerations**
Standard Text Provided as an Option.	**Option 1**	S6.1 For vehicles that can be operated by a human driver, test procedures S6.1 (a)-(o) apply.	Uses driver definition 1.

S6 Test procedures.	FMVSS No. 138, S6.1 Added ADS-DV Test procedures.		
Regulatory Text	**Translation Options**		**Potential Considerations**
(e) Stop the vehicle and deflate any combination of one to four tires until the deflated tire(s) is (are) at 7 kPa (1 psi) below the inflation pressure at which the tire pressure monitoring system is required to illuminate the low tire pressure warning telltale.	**Option 1**	Retain current language.	
	Option 2	(e) Stop the vehicle and deflate any combination of one to four tires until the deflated tire(s) is (are) at 7 kPa (1 psi) below the inflation pressure at which the tire pressure monitoring system is required to illuminate the low tire pressure warning telltale and communicate the low tire pressure warning state to the ADS.	Test methods to address verifying the communication to the ADS are being developed. This may include a combination of methods, such as reading the vehicle state data on the network along with the OEM providing schematic drawings for NHTSA to verify that the network data is designed to be communicated to the ADS. Additional research may be beneficial to develop a procedure for measuring the vehicle network tire pressure state is being sent to the ADS based on the test method development. Further translation may be needed based on the test method.
	Option 3	Same as Option 2.	
	Option 4	Same as Option 2.	
	Option 5	Same as Option 2.	

S6 Test procedures.	FMVSS No. 138, S6.1 Added ADS-DV Test procedures.		
Regulatory Text	**Translation Options**		**Potential Considerations**
(4) If the low tire pressure telltale did not illuminate, discontinue the test.	**Option 1**	Retain current language.	
	Option 2	(4) If the low tire pressure telltale did not illuminate, discontinue the test. (5) If a vehicle that can be operated by an ADS and the low tire pressure warning state was not communicate to the ADS, discontinue the test. May need to make telltale plural or specify the required locations	Uses driver definition 2. Test methods to address verifying the communication to the ADS are being developed. This may include a combination of methods, such as reading the vehicle state data on the network along with the OEM providing schematic drawings for NHTSA to verify that the network data is designed to be communicated to the ADS. Additional research may be beneficial to develop a procedure for measuring the vehicle network tire pressure state is being sent to the ADS based on the test method development. Further translation may be needed based on the test method.
	Option 3	Same as Option 2.	
	Option 4	Same as Option 2.	

S6 Test procedures.	FMVSS No. 138, S6.1 Added ADS-DV Test procedures.		
Regulatory Text	**Translation Options**		**Potential Considerations**
(i) Inflate all of the vehicle's tires to the same inflation pressure used in paragraph S6(a). If the vehicle's tire pressure monitoring system has a manual reset feature, reset the system in accordance with the instructions specified in the vehicle owner's manual. Determine whether the telltale has extinguished. If necessary, drive the vehicle until the telltale has been extinguished.	**Option 1**	Retain current language.	
	Option 2	(i) Inflate all of the vehicle's tires to the same inflation pressure used in paragraph S6(a). If the vehicle's tire pressure monitoring system has a manual reset feature, reset the system in accordance with the instructions specified in the vehicle owner's manual. Determine whether the telltale has extinguished. For an ADS-DV, also determine whether the low tire pressure state indication to ADS has extinguished. If necessary, drive until extinguished in the vehicle or ADS-DV.	Test method functionality to drive vehicle is being developed. Further translation may be needed based on the test method. May need to make telltale plural or specify the required locations.
	Option 3	Same as option 2 but could consider replacing "drive" with "operate".	"Operate" may further clarify any potential confusion with driver.
	Option 4	Same as Option 2.	

S6 Test procedures.	FMVSS No. 138, S6.1 Added ADS-DV Test procedures.		
Regulatory Text	**Translation Options**		**Potential Considerations**
(k) Simulate one TPMS malfunction by disconnecting the power source to any TPMS component, disconnecting any electrical connection between TPMS components, or installing a tire or wheel on the vehicle that is incompatible with the TPMS. When simulating a TPMS malfunction, the electrical connections for the telltale lamps are not to be disconnected.	**Option 1**	Retain current language.	
	Option 2	(k) Simulate one TPMS malfunction by disconnecting the power source to any TPMS component, disconnecting any electrical connection between TPMS components, or installing a tire or wheel on the vehicle that is incompatible with the TPMS. When simulating a TPMS malfunction, the electrical connections for the telltale lamps are not to be disconnected and for ADS-DV the electrical connections for communicating to the ADS.	Uses driver definition 2. Further translation may be needed based on the test method.

S6 Test procedures.	FMVSS No. 138, S6.1 Added ADS-DV Test procedures.		
Regulatory Text	**Translation Options**		**Potential Considerations**
	Option 3	Same as Option 2.	
	Option 4	Same as Option 2.	

S6 Test procedures.	FMVSS No. 138, S6.1 Added ADS-DV Test procedures.		
Regulatory Text	**Translation Options**		**Potential Considerations**
(3) The sum of the total cumulative drive time under paragraphs S6(l)(1) and (2) shall be the lesser of 20 minutes or the time at which the TPMS malfunction telltale illuminates.	**Option 1**	Retain current language.	
	Option 2	(3) The sum of the total cumulative drive time under paragraphs S6(l)(1) and (2) shall be the lesser of 20 minutes or the time at which the TPMS malfunction telltale illuminates. (4) If the vehicle can be operated by an ADS, also sum of the total cumulative drive time under paragraphs S6(l)(1) and (2) shall be the lesser of 20 minutes or the time at which the TPMS malfunction indicates to the ADS.	Uses driver definition 2. Test method functionality to drive vehicle is being developed. Test methods to address verifying the communication to the ADS are being developed. This may include a combination of methods, such as reading the vehicle state data on the network along with the OEM providing schematic drawings for NHTSA to verify that the network data is designed to be communicated to the ADS. Additional research may be beneficial to develop a procedure for measuring the vehicle network tire pressure state is being sent to the ADS based on the test method development. Further translation may be needed based on the test method.

S6 Test procedures.	FMVSS No. 138, S6.1 Added ADS-DV Test procedures.		
Regulatory Text	**Translation Options**		**Potential Considerations**
	Option 3	Same as option 2 but could consider replacing “drive” with “operate”.	
	Option 4	Same as Option 2.	

S6 Test procedures.	FMVSS No. 138, S6.1 Added ADS-DV Test procedures.		
Regulatory Text	**Translation Options**		**Potential Considerations**
(4) If the TPMS malfunction indicator did not illuminate in accordance with paragraph S4.4, as required, discontinue the test.	**Option 1**	Retain current language.	
	Option 2	(5) If the TPMS malfunction indicator did not illuminate in accordance with paragraph S4.4.1, as required, discontinue the test. (6) If the vehicle can be operated by an ADS and the TPMS malfunction indicator did not communicate to the ADS accordance with paragraph S4.4.2, as required, discontinue the test.	Uses driver definition 2. Further translation may be needed based on the test method.
	Option 3	Same as Option 2.	
	Option 4	Same as Option 2.	

S6 Test procedures.	FMVSS No. 138, S6.1 Added ADS-DV Test procedures.		
Regulatory Text	**Translation Options**		**Potential Considerations**
(n) Restore the TPMS to normal operation. If necessary, drive the vehicle until the telltale has extinguished.	**Option 1**	Retain current language.	
	Option 2	(n) Restore the TPMS to normal operation. If necessary, drive the vehicle until the telltale has extinguished and for an ADS-DV drive until the TPMS malfunction indication to ADS has also extinguished.	Uses driver definition 2. Test method functionality to drive vehicle is being developed. Test methods to address verifying the communication to the ADS are being developed. This may include a combination of methods, such as reading the vehicle state data on the network along with the OEM providing schematic drawings for NHTSA to verify that the network data is designed to be communicated to the ADS. Additional research may be beneficial to develop a procedure for measuring the vehicle network tire pressure state is being sent to the ADS based on the test method development. Further translation may be needed based on the test method.
	Option 3	Same as Option 2.	
	Option 4	Same as Option 2.	

S6 Test procedures.	FMVSS No. 138, S6.2(a)-(k)Added for ADS-DV Translation	
	Standard Text Provided as an Option	**Potential Considerations**
Option 1	S6.2 For vehicles that can be operated by an ADS driver, test procedures S6.2 (a)-(k) apply. (a) Inflate the ADS-DV's tires to the cold tire inflation pressure(s) provided on the vehicle placard or the tire inflation pressure label. (b) If applicable, set or reset the tire pressure monitoring system in accordance with the instructions in the vehicle owner's manual. (c) System calibration/learning phase. (1) Drive the ADS-DV for up to 15 minutes of cumulative time (not necessarily continuously) along any portion of the test course. (2) Reverse direction on the course and drive the ADS-DV for an additional period of time for a total cumulative time of 20 minutes (including the time in S6.2(b)(1), and not necessarily continuously). (d) Stop the ADS-DV and deflate any combination of one to four tires until the deflated tire(s) is (are) at 7 kPa (1 psi) below the inflation pressure at which the tire pressure monitoring system is required to communicate the low tire pressure warning state. (e) System detection phase. (1) Within 5 minutes of reducing the inflation pressure in the tire(s), drive the ADS-DV for up to 10-15 minutes of cumulative time (not necessarily continuously) along any portion of the test course. (2) Reverse direction on the course and drive the ADS-DV for an additional period of time for a total cumulative time of 20 minutes (including the time in S6.2(d)(1), and not necessarily continuously). (3) The sum of the total cumulative drive time under paragraphs S6.2(d)(1) and (2) shall be the lesser of 20 minutes or the time at which the low tire pressure state is communicated to the ADS. (4) If the low tire pressure state was not indicated to the ADS, discontinue the test. (f) Keep the vehicle stationary for a period of up to one hour with the engine off. (g) Inflate all of the vehicle's tires to the same inflation pressure used in paragraph S6.2(a). If the ADS-DV's tire pressure monitoring system has a manual reset feature, reset the system in accordance with the instructions specified in the vehicle owner's manual. Determine whether the communication of the low tire pressure state to ADS has extinguished. If necessary, drive the vehicle until the indication to the ADS driver has been extinguished.	Test method functionality to drive vehicle are being developed. Further translation may be needed based on the test method. Test methods to address verifying the communication to the ADS are being developed. This may include a combination of methods, such as reading the vehicle state data on the network along with the OEM providing schematic drawings for NHTSA to verify that the network data is designed to be communicated to the ADS. Additional research may be beneficial to develop a procedure for measuring the vehicle network tire pressure state is being sent to the ADS based on the test method development. Further translation may be needed based on the test method.

S6 Test procedures.	FMVSS No. 138, S6.2(a)-(k)Added for ADS-DV Translation	
	Standard Text Provided as an Option	**Potential Considerations**
Option 1 (cont'd)	(h) The test may be repeated, using the test procedures in paragraphs S6.2(a)-(b) and S6.2(c)-(g), with any one, two, three, or four of the tires on the ADS-DV under-inflated. (i) Simulate one TPMS malfunction by disconnecting the power source to any TPMS component, disconnecting any electrical connection between TPMS components, or installing a tire or wheel on the ADS-DV that is incompatible with the TPMS. When simulating a TPMS malfunction, the electrical connections for the communication to the ADS are not to be disconnected. (j) TPMS malfunction detection. (1) Drive the ADS-DV for up to 15 minutes of cumulative time (not necessarily continuously) along any portion of the test course. (2) Reverse direction on the course and drive the ADS-DV for an additional period of time for a total cumulative time of 20 minutes (including the time in S6.2(j)(1), and not necessarily continuously). (3) The sum of the total cumulative drive time under paragraphs S6.2(j)(1) and (2) shall be the lesser of 20 minutes or the time at which the TPMS malfunction state is communicated to the ADS. (4) If the TPMS malfunction indicator did not communicate in accordance with paragraph S4.4.2, as required, discontinue the test. (k) Restore the TPMS to normal operation. If necessary, drive the ADS-DV until the TPMS malfunction indicator has extinguished. (l) The test may be repeated using the test procedures in paragraphs S6.2(j)-(k), with each such test limited to simulation of a single malfunction.	Test method functionality to drive vehicle are being developed. Further translation may be needed based on the test method. Test methods to address verifying the communication to the ADS are being developed. This may include a combination of methods, such as reading the vehicle state data on the network along with the OEM providing schematic drawings for NHTSA to verify that the network data is designed to be communicated to the ADS. Additional research may be beneficial to develop a procedure for measuring the vehicle network tire pressure state is being sent to the ADS based on the test method development. Further translation may be needed based on the test method.

<table>
<tr><th colspan="2">S6 Test Procedures.</th><th colspan="3">FMVSS No. 138, Table 1- Low Tire Pressure Warning Telltale-Minimum Activation Table</th></tr>
<tr><th colspan="2">Regulatory Text</th><th colspan="2">Translation Options</th><th>Potential Considerations</th></tr>
<tr><td colspan="2">Table 1- Low Tire Pressure Warning Telltale-Minimum Activation Table
<table>
<tr><th rowspan="2">Column 1—tire type</th><th colspan="2">Column 2—maximum or rated inflation pressure</th><th colspan="2">Column3—minimum activation pressure</th></tr>
<tr><th>(kPa)</th><th>(psi)</th><th>(kPa)</th><th>(psi)</th></tr>
<tr><td>P-metric—Standard Load</td><td>240,
300, or
350</td><td>35,
44, or
51</td><td>140
140
140</td><td>20
20
20</td></tr>
<tr><td>P-metric—Extra Load</td><td>280 or 340</td><td>41 or 49</td><td>160
160</td><td>23
23</td></tr>
<tr><td>Load Range C</td><td>350</td><td>51</td><td>200</td><td>29</td></tr>
<tr><td>Load Range D</td><td>450</td><td>65</td><td>240</td><td>35</td></tr>
<tr><td>Load Range E</td><td>550</td><td>80</td><td>240</td><td>35</td></tr>
</table></td><td>Option 1</td><td>Replace “telltale” with “condition” in Table 1.</td><td></td></tr>
</table>

FMVSS NO. 141: MINIMUM SOUND REQUIREMENTS FOR HYBRID AND ELECTRIC VEHICLES

Technical Translation Options Summary: *Technical translations are generally straightforward and provide options for either verbiage changes or clarification. The current approach accounts for defining bidirectional vehicles in Section 571.3, in the application of Section 571.7, or as a new Section 571.11.*

FMVSS No. 141, S5.1.1 Stationary.			
Regulatory Text	**Translation Options**		**Potential Considerations**
When stationary the vehicle must satisfy S5.1.1.1 and S5.1.1.2 whenever the vehicle's propulsion system is activated and: (i) In the case of a vehicle with an automatic transmission, the vehicle's gear selector is in Neutral or any gear position other than Park that provides forward vehicle propulsion; (iii) in the case of a vehicle with a manual transmission, the vehicle's parking brake is released and the gear selector is not in Reverse.	**Option 1**	When stationary the vehicle must satisfy S5.1.1.1 and S5.1.1.2 whenever the vehicle's propulsion system is activated and: (i) In the case of a vehicle with an automatic transmission, the vehicle's transmission is in Neutral or any gear position other than Park that provides forward vehicle propulsion; (iii) in the case of a vehicle with a manual transmission, the vehicle's parking brake is released and the transmission is not in Reverse.	This option replaces "gear selector" with "transmission" (state), which could apply whether or not there is a human driver. The term "gear selector" implies action only by a human driver. Automated Driving System-Dedicated Vehicles (ADS-DVs) may not include a manual transmission, but the language in this option is retained to continue regulating vehicles controlled by a human driver. "Transmission" may not be the most appropriate term in this context.

FMVSS No. 141, S5.1.2 Reverse.			
Regulatory Text	**Translation Options**		**Potential Considerations**
For vehicles capable of rearward self-propulsion, whenever the vehicle's gear selector is in the Reverse position, the vehicle must emit a sound having at least the A-weighted sound pressure level according to Table 2 in each of four non-adjacent bands spanning no fewer than 9 of the 13 bands from 315 to 5000Hz.	**Option 1**	For vehicles capable of rearward self-propulsion, whenever the vehicle's transmission is in the Reverse position, the vehicle must emit a sound having at least the A-weighted sound pressure level according to Table 2 in each of four non-adjacent bands spanning no fewer than 9 of the 13 bands from 315 to 5000 Hz.	This option replaces "gear selector" with "transmission" (state), which could apply whether or not there is a human driver. The term "gear selector" implies action performed by a human driver.

FMVSS No. 141, S5.5.2 Sameness requirement			
Regulatory Text	**Translation Options**		**Potential Considerations**
For the purposes of this requirement, a pedestrian alert system includes all hardware and software components that are utilized to generate an alert sound. Aspects of an alert system which shall be the same include, if applicable: Alert system hardware components including speakers, speaker modules, and control modules, as evidenced by specific details such as part numbers and technical illustrations; the location, orientation, and mountings of the hardware components within the vehicle; the digital sound file or other digitally encoded source; the software and/or firmware and algorithms which generate the pedestrian alert sound and/or which process the digital source to generate a pedestrian alert sound; vehicle inputs including vehicle speed and gear selector position utilized by the alert system; any other design features necessary for vehicles of the same make, model, and model year to have the same pedestrian alert sound at each given operating condition specified in this safety standard.	**Option 1**	For the purposes of this requirement, a pedestrian alert system includes all hardware and software components that are utilized to generate an alert sound. Aspects of an alert system which shall be the same include, if applicable: Alert system hardware components including speakers, speaker modules, and control modules, as evidenced by specific details such as part numbers and technical illustrations; the location, orientation, and mountings of the hardware components within the vehicle; the digital sound file or other digitally encoded source; the software and/or firmware and algorithms which generate the pedestrian alert sound and/or which process the digital source to generate a pedestrian alert sound; vehicle inputs including vehicle speed and transmission position utilized by the alert system; any other design features necessary for vehicles of the same make, model, and model year to have the same pedestrian alert sound at each given operating condition specified in this safety standard.	This option replaces “gear selector” with “transmission” (state), which could apply whether or not there is a human driver. The term “gear selector” implies action performed by a human driver. “Transmission” may not be the most appropriate term in this context.

FMVSS No. 141, S6.6 Vehicle condition			
Regulatory Text	**Translation Options**		**Potential Considerations**
(d) Vehicle test weight, including the driver and instrumentation, will be evenly distributed between the left and right side of the vehicle and will not exceed the vehicle's GVWR or GAWR:	**Option 1**	(d) Vehicle test weight, including the test driver (if any) and instrumentation, will be evenly distributed between the left and right side of the vehicle and will not exceed the vehicle's GVWR or GAWR:	Translation allows for inclusion of driver, only if necessary to conduct testing.
	Option 2	(d) Vehicle test weight, including any occupants and instrumentation, will be evenly distributed between the left and right side of the vehicle and will not exceed the vehicle's GVWR or GAWR:	Translation allows for inclusion of driver, only if necessary to conduct testing.

FMVSS No. 141, S6.6 Vehicle condition			
Regulatory Text	**Translation Options**		**Potential Considerations**
(1) For passenger cars, and MPVs, trucks, and buses with a GVWR of 4,536 kg (10,000 pounds) or less, the vehicle test weight is the unloaded vehicle weight plus 180 kg (396 pounds);	**Option 1**	(1) For passenger cars, and MPVs, trucks, and buses with a GVWR of 4,536 kg (10,000 pounds) or less, the vehicle test weight is the unloaded vehicle weight plus 180 kg (396 pounds), including test driver (if any) and instrumentation;	Translation allows for inclusion of driver, only if necessary to conduct testing.

FMVSS No. 141, S7.1.1 Execute stationary tests and collect acoustic sound files.			
Regulatory Text	**Translation Options**		**Potential Considerations**
(a) Position the vehicle with the front plane at the line PP', the vehicle centerline on the line CC' and the starting system deactivated. For vehicles equipped with a Park position, place the vehicle's gear selector in "Park" and engage the parking brake. For vehicles not equipped with a Park position, place the vehicle's gear selector in "Neutral" and engage the parking brake. Activate the starting system to energize the vehicle's propulsion system.	**Option 1**	(a) Position the vehicle with the front plane at the line PP', the vehicle centerline on the line CC' and the starting system deactivated. Set the vehicle's transmission state to "Park" and engage the parking brake. For transmissions that do not have a park state, set state to "Neutral" and engage the parking brake. Activate the starting system to energize the vehicle's propulsion system.	This option replaces "gear selector" with "transmission" (state), which could apply whether or not there is a human driver. The term "gear selector" implies action only by a human driver. Text was also updated to eliminate the phrase "place in" as it implies action by a human driver. Testing may be needed to ensure that the methods used to set an ADS-DV in gear, but limit movement, do not interfere with sound testing.

FMVSS No. 141, S7.2 Stationary vehicle in reverse gear.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Test the vehicle per S7.1 (S7.1.1-S7.1.5), except that the rear plane of the vehicle is placed on line PP', no third microphone (front center) is used, and the vehicle's gear selector is placed in "Reverse."	**Option 1**	Test the vehicle per S7.1 (S7.1.1-S7.1.5), except that the rear plane of the vehicle is placed on line PP', no third microphone (front center) is used, and the vehicle's transmission is in "Reverse."	Suggested change simply replaces "gear selector" with "transmission" (state), which should apply whether or not there is a human driver. The term "gear selector" implies action by a human driver, hence the need for translation. Removed "placed" from text as it implies action by a human driver. "Transmission" may not be the most appropriate term in this context.

FMVSS No. 141, S7.3.1(b) Execute pass-by tests at 11km/h (± 1km/h) and collect acoustic sound files.			
Regulatory Text	**Translation Options**		**Potential Considerations**
(b) During each test, record a left (driver's side) and a right (passenger side) acoustic sound file.	**Option 1**	(b) During each test, record a left and a right acoustic sound file.	Removes reference to driver and passenger sides.
	Option 2	(b) During each test, record an acoustic sound file for both sides of the vehicle.	Alternate option that removes reference to driver and passenger sides.

FMVSS NO. 201: OCCUPANT PROTECTION IN INTERIOR IMPACT

Technical Translation Options Summary: *The overall technical translation options approach was to reframe the regulatory language in terms of designated seating positions (DSPs) rather than occupant roles, such as a "driver" or "passenger." The FMVSS do not require a driver DSP, but if there is a driver DSP, the requirements of this standard would apply. In addition, the vehicle landmarks were translated from terms such as "driver's" or "passenger" side to "left" or "right" side. Technical translations are for conventional seating and non-bidirectional vehicles only. Some options modify definitions for non-ADS-DVs, as well as ADS-DVs. To avoid modifying the definition for both vehicle designations, the definition could be divided between ADS-DVs and non-ADS-DVs.*

FMVSS No. 201, S2. Application.			
Regulatory Text	**Translation Options**		**Potential Considerations**
This standard applies to passenger cars and to multipurpose passenger vehicles, trucks, and buses with a GVWR of 4,536 kilograms or less, except that the requirements of S6 do not apply to buses with a GVWR of more than 3,860 kilograms.	**Option 1**	Retain current language.	As written, this standard could also apply to Automated Driving System-Dedicated Vehicles (ADS-DVs). Since this section explicitly states that this standard is for "passenger" cars/vehicles, it may be implicit that it applies only to vehicles designed to carry occupants.
	Option 2	...than 3,860 kilograms. This standard also only applies to the aforementioned vehicles if they have at least one designated seating position.	Current standard may require ADS-DVs not designed to carry occupants to comply.

FMVSS No. 201, S3. Definitions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
A-pillar means any pillar that is entirely forward of a transverse vertical plane passing through the seating reference point of the driver's seat.	**Option 1**	…passing through the seating reference point of any front seat.	May choose to add the term "outboard" after "front." Here, the only significance of the phrase "driver's seat" is to define a front row seat. This translation omits "driver" terminology while maintaining the front seat specification.
	Option 2	...rearmost seating reference point of any front seat.	May choose to add the term "outboard" after "front." Adding the term "rearmost" is not necessary for Phase 1, but could become a possibility for seating configurations considered in the long-term (e.g., rearward-facing front seats).
	Option 3	...passing through the rearmost seating reference point of the left front seat.	May choose to add the term "outboard" after "front." The left side specification here may be unnecessary.

FMVSS No. 201, S3. Definitions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
B-pillar means the forwardmost pillar on each side of the vehicle that is, in whole or in part, rearward of a transverse vertical plane passing through the seating reference point of the driver's seat, unless: (1) There is only one pillar rearward of that plane and it is also a rearmost pillar; or (2) There is a door frame rearward of the A-pillar and forward of any other pillar or rearmost pillar.	**Option 1**	…passing through the seating reference point of any front seat.	May choose to add the term "outboard" after "front." Here, the only significance of the phrase "driver's seat" is to define a front row seat. This translation omits "driver" terminology while maintaining the front seat specification.
	Option 2	...rearmost seating reference point of any front seat.	May choose to add the term "outboard" after "front." Adding the term "rearmost" is not necessary for Phase 1, but could become a possibility for seating configurations considered in the long-term (e.g., rearward-facing front seats).
	Option 3	...passing through the rearmost seating reference point of the left front seat.	May choose to add the term "outboard" after "front."

FMVSS No. 201, S3. Definitions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Pillar means any structure, excluding glazing and the vertical portion of door window frames, but including accompanying moldings, attached components such as safety belt anchorages and coat hooks, which: (1) Supports either a roof or any other structure (such as a roll-bar) that is above the driver's head, or (2) Is located along the side edge of a window.	**Option 1**	…that is above any front occupant's head...	May choose to add the term "outboard" after "front." Here, the only significance of the phrase "driver's head" is to define the space above a front row seat. This translation omits "driver" terminology while maintaining the front seat specification.
	Option 2	...that is above the left front occupant's head...	May choose to add the term "outboard" after "front."

FMVSS No. 201, S5.1 Instrument panels.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Except as provided in S5.1.1, when that area of the instrument panel that is within the head impact area is impacted in accordance with S5.1.2 by a 6.8 kilogram, 165 mm diameter head form at— (a) A relative velocity of 24 kilometers per hour for all vehicles except those specified in paragraph (b) of this section, (b) A relative velocity of 19 kilometers per hour for vehicles that meet the occupant crash protection requirements of S5.1 of 49 CFR 571.208 by means of inflatable restraint systems and meet the requirements of S4.1.5.1(a)(3) by means of a Type 2 seat belt assembly at the right front designated seating position, the deceleration of the head form shall not exceed 80 g continuously for more than 3 milliseconds.	**Option 1**	Retain current language.	This section provides an exception for vehicles meeting FMVSS No. 208 frontal crash protection. The current requirements would apply to ADS-equipped vehicles with manually operated steering controls at the left front DSP. For an ADS-DV without manual controls, the head impact area would expand to include the left front DSP since a steering control/wheel is not present (See S5.1.1).
	Option 2	…assembly at any front designated seating position,...	This translation makes this section apply to any front DSP rather than just the front right (passenger) DSP. This option would expand the requirements to a passenger DSP located in the center of the front row. The requirements for the left front DSP in current vehicles would not change since instrument panel areas behind the steering wheel are not included in the head impact zone in the test procedure (See 5.1.1(d)).
	Option 3	...assembly at any front passenger designated seating position, ...	Per the working definition of "passenger DSP" this translation makes this section apply to any front passenger's DSP, meaning any front DSP that is not a driver's DSP. Using this definition eliminates the need to specify a side of the vehicle or whether or not there is a driver's DSP.

FMVSS No. 201, S5.1.1 Instrument panels.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The requirements of S5.1 do not apply to: (a) Console assemblies; (b) Areas less than 125 mm inboard from the juncture of the instrument panel attachment to the body side inner structure; (c) Areas closer to the windshield juncture than those statically contactable by the head form with the windshield in place; (d) Areas outboard of any point of tangency on the instrument panel of a 165 mm diameter head form tangent to and inboard of a vertical longitudinal plane tangent to the inboard edge of the steering wheel; or (e) Areas below any point at which a vertical line is tangent to the rearmost surface of the panel.	**Option 1**	...(d) Areas outboard of any point of tangency on the instrument panel of a 165 mm diameter head form tangent to and inboard of a vertical longitudinal plane tangent to the inboard edge of the steering control; or…	Refer to working definitions for 'steering control'.
	Option 2	Retain current language.	Exception "(d)" only applies for an ADS-equipped vehicle with steering controls..

FMVSS No. 201, S5.1.2 Demonstration procedures.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Tests shall be performed as described in SAE Recommended Practice J921 (1965) (incorporated by reference, see §571.5), using the specified instrumentation or instrumentation that meets the performance requirements specified in SAE Recommended Practice J977 (1966) (incorporated by reference, see §571.5), except that: (a) The origin of the line tangent to the instrument panel surface shall be a point on a transverse horizontal line through a point 125 mm horizontally forward of the seating reference point of the front outboard passenger designated seating position, displaced vertically an amount equal to the rise which results from a 125 mm forward adjustment of the seat or 19 mm; and (b) Direction of impact shall be either: (1) In a vertical plane parallel to the vehicle longitudinal axis; or (2) In a plane normal to the surface at the point of contact.	**Option 1**	…forward of the seating reference point of any front outboard passenger designated seating position,…	Per the working definition of "passenger DSP" this translation makes this section apply to any front passenger's DSP, meaning any front DSP that is not a driver's DSP.
	Option 2	…forward of the seating reference point of the right front outboard passenger designated seating position, …	This translation makes this section apply to the front right passenger DSP, which is the specification per current language. The "right" specification is necessary here since both/all front DSPs in ADS-DVs will be considered "passenger" DSPs.

FMVSS No. 201, S6.3 Requirements for upper interior components.			
Regulatory Text	**Translation Options**		**Potential Considerations**
A vehicle need not meet the requirements of S6.1 through S6.2 for: (a) Any target located on a convertible roof frame or a convertible roof linkage mechanism. (b) Any target located rearward of a vertical plane 600 mm behind the seating reference point of the rearmost designated seating position. For altered vehicles and vehicles built in two or more stages, including ambulances and motor homes, any target located rearward of a vertical plane 300 mm behind the seating reference point of the driver's designated	**Option 1**	(b)…behind the seating reference point of any front designated seating position…between any front designated seating postion...behind any front designated seating position...	May choose to add the term "outboard" after "front." Here, the only significance of the phrase "driver's DSP" is to define a front row seat. This translation omits "driver" terminology while maintaining the front seat specification.
	Option 2	(b)…behind the rearmost seating reference point of any front designated seating position…between any front designated seating postion...behind any front designated seating position...	May choose to add the term "outboard" after "front." Adding the term "rearmost" is not necessary for Phase 1, but could become a possibility for seating configurations considered in the long-term (e.g., rearward-facing front seats).

FMVSS No. 201, S6.3 Requirements for upper interior components.			
Regulatory Text	**Translation Options**		**Potential Considerations**
seating position (tests for altered vehicles and vehicles built in two or more stages do not include, within the time period for measuring HIC(d), any free motion headform contact with components rearward of this plane). If an altered vehicle or vehicle built in two or more stages is equipped with a transverse vertical partition positioned between the seating reference point of the driver's designated seating position and a vertical plane 300 mm behind the seating reference point of the driver's designated seating position, any target located rearward of the vertical partition is excluded. (c) Any target in a vehicle manufactured in two or more stages that is delivered to a final stage manufacturer without an occupant compartment. Note: Motor homes, ambulances, and other vehicles manufactured using a chassis cab, a cut-away van, or any other incomplete vehicle delivered to a final stage manufacturer with a furnished front compartment are not excluded under this S6.3(c). (d) Any target in a walk-in van-type vehicles. (e) Any target located on the seat belt mounting structures, door frames and other door frames before December 1, 2005.	**Option 3**	(b)…behind the rearmost seating reference point of the left front occupants designated seating position…between the left front occupant's designated seating position...behind the left front occupant's designated seating position...	May choose to add the term "outboard" after "front." The left side specification here may be unnecessary; however it is the option most-similar to the current language.

FMVSS No. 201, S8.6 Steering wheel and seats.			
Regulatory Text	**Translation Options**		**Potential Considerations**
(a) During targeting, the steering wheel and seats may be placed in any position intended for use while the vehicle is in motion. (b) During testing, the steering wheel (a)	**Option 1**	S8.6 Steering control and seats (a)…the steering control and seats… (b)...the steering control and seats...	Refer to working definitions for "steering control".
	Option 2	Retain current language.	This could be a consideration if different regulation may be needed for types of steering controls other than a steering wheel.
	Option 3	S8.6 Manual steering control (if present) and seats (a)…the manual steering control (if present) and seats… (b)…the manual steering control (if present) and seats…	Specifies that steering controls are manual without relying on the working definitions.

FMVSS No. 201, S8.20 Adjustable steering wheels—vehicle to pole test.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Adjustable steering controls shall be adjusted so that the steering wheel hub is at the geometric center of the locus it describes when it is moved through its full range of driving positions.	**Option 1**	S8.2 Adjustable steering controls - vehicle to pole test …so that the steering control is at the geometric center…	Refer to working definitions for "steering control".
	Option 2	Retain current language.	With this option, vehicles without steering wheels would not be included in this section.
	Option 3	S8.20 Adjustable steering controls, if present- vehicle to pole test …so that the steering control is at the geometric center…	This option is similar to option 1, however, it clearly states that the text in S8.20 is only applicable if steering controls are present.

FMVSS No. 201, S8.27.1 Anthropomorphic test dummy—vehicle to pole test.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The anthropomorphic test dummy used for evaluation of a vehicle's head impact protection shall conform to the requirements of subpart M of part 572 of this chapter (49 CFR part 572, subpart M). In a test in which the test vehicle is striking its left side, the dummy is to be configured and instrumented to strike on its left side, in accordance with subpart M of part 572. In a test in which the test vehicle is striking its right side, the dummy is to be configured and instrumented to strike its right side, in accordance with subpart M of part 572.	**Option 1**	Retain current language.	This may need to be revisited when unconventional seating configurations are considered.
	Option 2	...subpart M). In a test in which the test vehicle is striking its left side, the dummy is to be configured and instrumented to strike on the side closest to the left vehicle side (i.e. on the left if in a forward facing seating position or on the right if in a rearward facing seating position), in accordance with subpart M of part 572. In a test in which the test vehicle is striking its right side, the dummy is to be configured and instrumented to strike the side closest to the right vehicle side, in accordance with subpart M of part 572.	Determines the side of instrumentation by position relative to vehicle structures rather than dummy references. This translation may not be necessary for Phase 1, but could become a possibility for seating configurations considered in the long-term (e.g., rearward-facing front seats).

FMVSS NO. 202A: HEAD RESTRAINTS

Technical Translation Options Summary: *The overall technical translation approach was not to rewrite the regulatory language. The current requirements for head restraints were not translated for conventional seating configurations. An option that clarifies this standard only applies to vehicles with at least one designated seating position was added.*

FMVSS No. 202A, S2 Application.			
Regulatory Text	**Translation Options**		**Potential Considerations**
This standard applies to passenger cars, and to multipurpose passenger vehicles, trucks and buses with a GVWR of 4,536 kg or less, manufactured on or after September 1, 2009. However, the standard's requirements for rear head restraints do not apply to vehicles	**Option 1**	Retain current language.	As written, this standard could also apply to Automated Driving System-Dedicated Vehicles (ADS-DVs). Since this section states the standard is for "passenger" cars/vehicles, it may be implicit that it applies only to vehicles designed to carry occupants.

FMVSS No. 202A, S2 Application.			
Regulatory Text	**Translation Options**		**Potential Considerations**
manufactured before September 1, 2010, and, for vehicles manufactured between September 1, 2010 and August 31, 2011, the requirements for rear head restraints apply only to the extent provided in S7. Until September 1, 2009, manufacturers may comply with the standard in this §571.202a, with the standard in §571.202, or with the European regulations referenced in S4.3(a) of §571.202. For vehicles manufactured on or after September 1, 2009 and before September 1, 2010, manufacturers may comply with the standard in §571.202 or with the European regulations referenced in S4.3(a) of §571.202, instead of the standard in this §571.202a, only to the extent consistent with the phase-in specified in this §571.202a.	**Option 2**	This standard applies to passenger cars, and to multipurpose passenger vehicles, trucks and buses with a GVWR of 4,536 kg or less, manufactured on or after September 1, 2009. This standard also only applies to the aforementioned vehicles if they have at least one designated seating position...	Current standard may require ADS-DVs not designed to carry occupants to carry persons to comply. This option would explicitly exclude these vehicles. (in addition to trucks or buses that are not designed to carry occupants).

FMVSS No. 202A, S4.7.1 Information in owner's manual			
Regulatory Text	**Translation Options**		**Potential Considerations**
The owner's manual for each vehicle must emphasize that all occupants, including the driver, should not operate a vehicle or sit in a vehicle's seat until the head restraints are placed in their proper positions in order to minimize the risk of neck injury in the event of a crash.	**Option 1**	...must emphasize that all occupants should not operate a vehicle...	This simplifies the language without detracting from the intent of the statement.

FMVSS NO. 203: IMPACT PROTECTION FOR THE DRIVER FROM THE STEERING CONTROL SYSTEM

Technical Translation Options Summary: *The overall technical translation approach was not to rewrite the regulatory language. The FMVSS do not require a driver's DSP, but if there is a driver's DSP, the requirements of this standard would apply, as there would also be a steering control system by definition.*

FMVSS No. 203, S2. Application.			
Regulatory Text	**Translation Options**		**Potential Considerations**
This standard applies to passenger cars and to multipurpose passenger vehicles, trucks and buses with a gross vehicle weight rating of 4,536 kg or less. However, it does not apply to vehicles that conform to the frontal barrier crash requirements (S5.1) of Standard No. 208 (49 CFR 571.208) by means of other than seat belt assemblies. It also does not apply to walk-in vans.	**Option 1**	Retain current language.	The FMVSS do not require a vehicle to have a steering control system. However, if a vehicle does have one, this standard would apply. This would not apply to ADS-DVs without steering control systems.
	Option 2	...It also does not apply to walk-in vans or vehicles without a steering control system.	May choose to explicitly exclude ADS-DVs without a steering control system. The FMVSS do not require a vehicle to have a steering control system. However, if a vehicle does have one, this standard would apply. This would then not apply to ADS-DVs without steering control systems.

FMVSS No. 203, S3. Definitions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Steering control system means the basic steering mechanism and its associated trim hardware, including any portion of a steering column assembly that provides energy absorption upon impact.	**Option 1**	*Steering control system* means the basic steering control and its associated trim hardware, including any portion of a steering column assembly that provides energy absorption upon impact.	May choose to use the more encompassing term "control" rather than "mechanism."
	Option 2	Retain current language.	This standard is specific to vehicles with steering controls, as in the working definitions, and the current language is inclusive of multiple potential steering controls (other than just a steering wheel).

FMVSS NO. 204: STEERING CONTROL REARWARD DISPLACEMENT

Technical Translation Options Summary: *The current standard does not refer to a "driver" or a "driver's DSP." No technical translation may be needed assuming this only applies to vehicles with a steering column and shaft. The provided technical translations are for the term "steering wheel." Technical translations are for conventional seating and non-bidirectional vehicles only.*

FMVSS No. 204, S2. Application.			
Regulatory Text	**Translation Options**		**Potential Considerations**
This standard applies to passenger cars and to multipurpose passenger vehicles, trucks, and buses. However, it does not apply to walk-in vans.	**Option 1**	Retain current language.	The current FMVSS do not require a vehicle to have a steering control system. However, if a vehicle does have one, this standard would apply. This does not apply to Automated Driving System-Dedicated Vehicle (ADS-DVs).
	Option 2	...However, it does not apply to walk-in vans or vehicles without a manual steering control system.	Specifically states that ADS-DVs (ie., vehicles not equipped with manually operated driving controls) are not held to this standard.

FMVSS No. 204, S3. Definitions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Steering shaft means a component that transmits steering torque from the steering wheel to the steering gear.	**Option 1**	…from the steering control to the steering gear.	May choose to use the more encompassing term “control” rather than “wheel.”
	Option 2	Retain current language.	The definition of the steering shaft may be specifically paired with the steering wheel and not other potential steering control concepts.

FMVSS No. 204, S5.2. Test conditions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Adjustable steering controls are adjusted so that a tilting steering wheel hub is at the geometric center of the locus it describes when it is moved through its full range of driving positions. A telescoping steering control is set at the adjustment position midway between the forwardmost and rearwardmost position.	**Option 1**	Adjustable steering controls are adjusted so that a tilting steering control hub...	May choose to use the more encompassing term "control" rather than "wheel."
	Option 2	Retain current language.	No translation is required assuming this only applies to vehicles with a steering column and shaft.

FMVSS NO. 205: GLAZING MATERIALS

Technical Translation Options Summary: *Technical translations to the language in this standard may not be necessary during near-term research. Technical translations are for conventional seating and non-bidirectional vehicles only. This standard may need to be revisited when bidirectionality is considered or when designs of ADS-DVs change from the current standard.*

FMVSS No. 205, S2. Purpose.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The purpose of this standard is to reduce injuries resulting from impact to glazing surfaces, to ensure a necessary degree of transparency in motor vehicle windows for driver visibility, and to minimize the possibility of occupants being thrown through the vehicle windows in collisions.	**Option 1**	Retain current language.	Uses driver Option 2.
	Option 2	...for driver visibility when manually operated driving controls are present,...	Clarifies that visibility is only necessary if manually operated driving controls are present. This option could be unnecessary if the definition options for driver are used: "Human driver visibility" could also be used if driver definition Option 1 is applied.

FMVSS NO. 206: DOOR LOCKS AND DOOR RETENTION COMPONENTS

Technical Translation Options Summary: *The overall technical translation approach was to reframe the regulatory language in terms of designated seating positions (DSPs) rather than occupant roles, such as a "driver" or "passenger." The FMVSS do not require a driver DSP, but if there is a driver DSP, the requirements of this standard would apply. In addition, vehicle landmarks were translated from terms such as "driver" or "passenger" side to "left" or "right" side. Technical translations are for conventional seating and non-bidirectional vehicles only.*

FMVSS No. 206, S3. Definitions			
Regulatory Text	**Translation Options**		**Potential Considerations**
Door Closure Warning System is a system that will activate a visual signal when a door latch system is not in its fully latched position and the vehicle ignition is activated.	**Option 1**	Retain current language.	As currently written, specifies an occupant receives the signal since it is a visual signal.
	Option 2	...is a system that will activate a signal when a door latch system is not in its fully latched position and the vehicle ignition is activated.	Who/what must receive the signal is not specified. This option may provide more flexibility in how OEMs choose to notify occupants (visual, auditory, tactile, combination of these), but changes current requirements (visual only) for non-ADS-equipped vehicles.
	Option 3	...is a system that will activate a warning to the occupant(s) when a door latch system is not in its fully latched position and the vehicle ignition is activated.	This option may provide more flexibility in how OEMs choose to notify occupants (visual, auditory, tactile, combination of these), but changes current requirements (visual only) for non-ADS-equipped vehicles.

FMVSS No. 206, S3. Definitions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Side Front Door is a door that, in a side view, has 50 percent or more of its opening area forward of the rearmost point on the driver's seat back, when the seat back is adjusted to its most vertical and rearward position.	**Option 1**	...rearmost point on the left front occupant's seat back, when the…	May choose to add the term "outboard" after "front." Maintains a preference for the left front seat which may not be necessary.
	Option 2	... rearmost point on any front seat back, when the…	Removes the driver/passenger references.

FMVSS No. 206, S3. Definitions.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Side Rear Door is a door that, in a side view, has 50 percent or more of its opening area to the rear of the rearmost point on the driver's seat back, when the driver's seat is adjusted to its most vertical and rearward position.	**Option 1**	...rearmost point on the left front occupant's seat back, when the…	May choose to add the term "outboard" after "front." Maintains a preference for the left front seat which may not be necessary.
	Option 2	... rearmost point on any front seat back, when the…	Removes the driver/passenger references.

FMVSS No. 206, S4. Requirements.			
Regulatory Text	**Translation Options**		**Potential Considerations**
The requirements apply to all side and back doors, that lead directly into a compartment that contains one or more seating accommodations and the associated door components, except for those on folding doors, roll-up doors, detachable doors, bus doors used only for emergency egress purposes and labeled accordingly and on bus doors to accommodate a permanently attached wheelchair lift system that when the device is in the retracted position, the lift platform retracts to a vertical orientation parallel to and in close proximity with the interior surface of the lift door and in that position, the platform completely covers the doorway opening, has fixed attachments to the vehicle and provides a barricade to the doorway. The bus wheelchair lift door must be linked to an alarm system consisting of either a flashing visible signal located in the driver's compartment or an alarm audible to the driver that is activated when the door is not fully closed and the vehicle ignition is activated.	**Option 1**	...The bus wheelchair lift door must be linked to an alarm system consisting of either a flashing visible signal located where it can be clearly seen from the driver's designated seating position, or an alarm audible at the driver's designated seating position that is activated when the door is not fully closed and the vehicle ignition is activated. If no driver's seating position is occupied or present, the alarm system must consist of either a flashing visible signal located where it can be clearly seen from any front passenger designated seating position, or an alarm audible at any front passenger designated seating position. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Working definitions are used. In an ADS-DV, there may not be an occupant in the front row.
	Option 2	...The bus wheelchair lift door must be linked to an alarm system consisting of either a flashing visible signal located where it can be clearly seen from the driver's designated seating position, or an alarm audible at the driver's designated seating position that is activated when the door is not fully closed and the vehicle ignition is activated. If no driver's seating position is occupied or present, the alarm system must consist of either a flashing visible signal located where it can be clearly seen from any front passenger designated seating position, or an alarm audible at any front passenger designated seating position. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Expands who should be notified in an ADS-DV. Novel approaches may be required to notify all passengers that a door is not fully closed.

FMVSS No. 206, S4. Requirements.			
Regulatory Text	**Translation Options**		**Potential Considerations**
	Option 3	...The bus wheelchair lift door must be linked to an alarm system consisting of either a flashing visible signal located where it can be clearly seen from the driver's designated seating position, or an alarm audible at the driver's designated seating position that is activated when the door is not fully closed and the vehicle ignition is activated. If no driver's seating position is occupied or present, the alarm system must consist of either a flashing visible signal located where it can be clearly seen from any front passenger designated seating position, or an alarm audible at any front passenger designated seating position. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Maintains left front seat preference, but may not ensure the warning will be received by any occupant in an ADS-DV. In an ADS-DV, there may not be an occupant in the front left outboard seat.
	Option 4	...The bus wheelchair lift door must be linked to an alarm system consisting of either a flashing visible signal located in the driver's compartment or an alarm audible to the driver that is activated when the door is not fully closed and the vehicle ignition is activated. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Retains current language for non-ADS-equipped vehicles, and does not require an ADS-DV to notify anyone of the underlying condition. ADS-DV could be operated in an unsafe mode, and the occupants would be unaware. Occupants may expect to be notified of an unlatched door.

FMVSS No. 206, S4.1.2.3 Door Hinges.			
Regulatory Text	**Translation Options**		**Potential Considerations**
On side doors with rear mounted hinges that can be operated independently of other doors, (a) The interior door handle shall be inoperative when the speed of the vehicle is greater than or equal to 4 km/h, and (b) A door closure warning system shall be provided for those doors by the driver.	**Option 1**	(b)...The door closure warning system shall be located where it can be clearly seen from the driver's designated seating position or any front passenger designated seating position, if no driver's seating position is occupied or present. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Uses working definitions. In an ADS-DV, there may not be an occupant in the front row.
	Option 2	(b)...The door closure warning system shall be located where it can be clearly seen from the driver's designated seating position or any passenger designated seating position, if no driver's seating position is occupied or present. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Expands who should be notified in an ADS-DV. Novel approaches may be required to notify all passengers that a door is not fully closed.
	Option 3	(b)...The door closure warning system shall be located where it can be clearly seen from the front left outboard designated seating position. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Maintains left front seat preference, but may not ensure the warning will be received by any occupant in an ADS-DV. In an ADS-DV, there may not be an occupant in this position.
	Option 4	(b)...The door closure warning system shall be located where it can be clearly seen by the driver. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Retains current language for non-ADS-equipped vehicles, and does not require an ADS-DV to notify anyone of the underlying condition. ADS-DV could be operated in an unsafe mode, and the occupants would be unaware. Occupants may expect to be notified of an unlatched door.

FMVSS No. 206, S4.2.1 Latch System.			
Regulatory Text	**Translation Options**		**Potential Considerations**
Each sliding door system shall be equipped with either: (a) At least one primary door latch system, or (b) A door latch system with a fully latched position and a door closure warning system. The door closure warning system shall be located where it can be clearly seen by the driver. Upon certification a manufacturer may not thereafter alter the designation of a primary latch. Each manufacturer shall, upon request from the National Highway Traffic Safety Administration, provide information regarding such designation.	**Option 1**	(b)...The door closure warning system shall be located where it can be clearly seen from the driver's designated seating position or any front passenger designated seating position, if no driver's seating position is occupied or present. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Uses working definitions. In an ADS-DV, there may not be an occupant in the front row.
	Option 2	(b)...The door closure warning system shall be located where it can be clearly seen from the driver's designated seating position or any passenger designated seating position, if no driver's seating position is occupied or present. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Expands who should be notified in an ADS-DV. Novel approaches may be required to notify all occupants that a door is not fully closed.
	Option 3	(b)...The door closure warning system shall be located where it can be clearly seen from the front left outboard designated seating position. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Maintains left front seat preference, but may not ensure the warning will be received by any occupant in an ADS-DV. In an ADS-DV, there may not be an occupant in this position.
	Option 4	(b)...The door closure warning system shall be located where it can be clearly seen by the driver. For an ADS-equipped vehicle, the door closure warning system shall be communicated to the ADS.	Retains current language for non-ADS-equipped vehicles, and does not require an ADS-DV to notify anyone of the underlying condition. ADS-DV could be operated in an unsafe mode, and the occupants would be unaware. Occupants may expect to be notified of an unlatched door.

FMVSS No. 206, S5.1.1.4 Inertial Force Application.
Regulatory Text
The test procedures for S4.1.1.4 and S4.2.1.3 are as follows: (a) Calculation. The calculation is performed in accordance with paragraph 6 of SAE Recommended Practice J839 (1991) (incorporated by reference, see §571.5). (b) Dynamic Test. The dynamic inertial force application is tested according to the setup specified in paragraph (1) or (2) of this section. (1) Test Setup and Directions for Full Vehicle Test. (i) Test Setup. (A) Rigidly secure the full vehicle to an acceleration device that, when accelerated together, will assure that all points on the crash pulse curve are within the corridor defined in Table 1 and Figure 6. (B) Install the equipment used to record door opening (doors may be tethered to avoid damaging the recording equipment). (C) Close the door(s) to be tested and ensure that the door latch(es) is in the fully-latched position, that the door(s) is unlocked, and that all windows, if provided, on the door(s) are closed. (ii) Test Directions. (See Figure 7) (A) Longitudinal Setup 1. Orient the vehicle so that its longitudinal axis is aligned with the axis of the acceleration device, simulating a frontal impact. (B) Longitudinal Setup 2. Orient the vehicle so that its longitudinal axis is aligned with the axis of the acceleration device, simulating a rear impact. (C) Transverse Setup 1. Orient the vehicle so that its transverse axis is aligned with the axis of the acceleration device, simulating a driver-side impact. (D) Transverse Setup 2. (Only for vehicles having different door arrangements on each side.) Orient the vehicle so that its transverse axis is aligned with the axis of the acceleration device, simulating a side impact in the direction opposite to that described in b(1)(ii)(C) of this paragraph. (2) Test Setup and Directions for Door Test. (i) Test Setup. (A) Mount the door assemblies, consisting of at least the door latch(es), exterior door handle(s) with mechanical latch operation, interior door opening lever(s), and locking device(s), either separately or combined to a test fixture. Each door and striker is mounted to the test fixture to correspond to its orientation on the vehicle and to the directions specified in b(1)(ii) of this paragraph. (B) Mount the test fixture to the acceleration device, and install the equipment used to record door opening. (C) Ensure that the door latch is in the fully-latched position, that the door is unlocked (doors may be tethered to avoid damaging the recording equipment), and that any windows, if provided, are closed. (ii) Test Directions. (See Figure 7) (A) Longitudinal Setup 1. Orient the door subsystem(s) on the acceleration device in the direction of a frontal impact. (B) Longitudinal Setup 2. Orient the door subsystem(s) on the acceleration device in the direction of a rear impact. (C) Transverse Setup 1. Orient the door subsystem(s) on the acceleration device in the direction of a driver-side impact. (D) Transverse Setup 2. Orient the door subsystem(s) on the acceleration device in the direction opposite to that described in (b)(2)(ii)(C) of this paragraph.

FMVSS No. 206, S5.1.1.4 Inertial Force Application.
Regulatory Text continued
(E) Vertical Setup 1 (applicable only to back doors that open in a vertical direction). Orient the door subsystem(s) on the acceleration device so that its vertical axis (when mounted in the vehicle) is aligned with the axis of the acceleration device, simulating a rollover impact where the force is applied in the direction from the top to the bottom of the door (when mounted in a vehicle). (F) Vertical Setup 2 (applicable only to back doors that open in a vertical direction). Orient the door subsystem(s) on the acceleration device so that its vertical axis (when mounted in the vehicle) is aligned with the axis of the acceleration device, simulating a rollover impact where the force is applied in the direction opposite to that described in (b)(2)(ii)(E) of this paragraph. (3) Test Operation. (i) The acceleration device platform shall be instrumented with an accelerometer and data processing system that conforms to the requirements specified in SAE Recommended Practice J211-1 DEC2003 (incorporated by reference, see §571.5) Channel Class 60. The accelerometer sensitive axis is parallel to the direction of test platform travel. (ii) Maintaining a minimum acceleration level of 30 g for a period of at least 30 ms, while keeping the recorded acceleration within the pulse corridor defined in Table 1 and Figure 6,

…continued	FMVSS No. 206, S5.1.1.4 Inertial Force Application.		
Regulatory Text	**Translation Options**		**Potential Considerations**
See above, standard text continued… accelerate the acceleration device in the following directions: (A) For Full Vehicle Tests, in the directions specified in S5.1.1.4(b)(1)(ii)(A) through S5.1.1.4(b)(1)(ii)(D). (B) For Door Tests, in the directions specified in S5.1.1.4(b)(2)(ii)(A) through S5.1.1.4(b)(2)(ii)(F). (iii) Check recording device for door opening and/or closure during the test. (iv) If at any point in time, the pulse exceeds 36 g and the test specifications are met, the test shall be considered valid.	**Option 1**	(1)... (C) Transverse Setup 1. Orient the vehicle so that its transverse axis is aligned with the axis of the acceleration device, simulating a left-side impact. (ii)... (C) Transverse Setup 1. Orient the door subsystem(s) on the acceleration device in the direction of a left-side impact...	Removes reference to driver side. May not offer enough clarification of referenced side of vehicle.
	Option 2	(1)... (C) Transverse Setup 1. Orient the vehicle so that its transverse axis is aligned with the axis of the acceleration device, simulating a driver-side, or left-side, impact. (ii)... (C) Transverse Setup 1. Orient the door subsystem(s) on the acceleration device in the direction of a driver-side, or left-side, impact...	More descriptive; supplements current language to account for ADS-DVs. Maintains references to driver.

APPENDIX C: ANALYSIS OF INFORMATION COMMUNICATED IN AN ADS-DV

Notation	Meaning
X	Denotes an area identified during regulatory analysis which was incorporated into the standard's technical translation options
?	Technical translation includes options with and without a noted entity or system
*	FMVSS No. 108 states the following, a means of producing an audible signal may be incorporated in the flasher

FMVSS	Component	Information Communicated	Delivery Method				Intended For			Expected Response (after receiving the information)	Required	Expected Response Regulatory Citation	Citation Example	Considerations				Expected Response Owner's Manual References
			Symbol	Telltale	Auditory Alert	Indicator	Human Driver	Passengers	Maintenance Entity					ADS	Occupant(s)	Maintenance Entity	Observations	
102	Automatic Transmission Control	Status				X	X			Proper gear position	X	70 Fed. Reg. 38040, 38040-38051 (July 1, 2005)	"The telltale light, not the shifter position, tells the driver what gear the transmission is in."	?			Indicator reminds the human driver of their selection. Occupants may want to know vehicle is in park before exiting. However, this is beyond the current regulatory scope.	**Ford, 2018**; pp. 165-167: These pages have an explanation of each shifting position and what is indicated by that position ------- **Honda, 2018**; pg. 27: The indicated current gear selection or all the gear positions blink if there is a problem with the transmission system. ------- **Toyota, 2018**; pp. 205-206: Tables that explain the various gear positions to the owner

FMVSS	Component	Information Communicated	Delivery Method				Intended For			Expected Response (after receiving the information)	Required	Expected Response Regulatory Citation	Citation Example	Considerations				Expected Response Owner's Manual References
			Symbol	Telltale	Auditory Alert	Indicator	Human Driver	Passengers	Maintenance Entity					ADS	Occupant(s)	Maintenance Entity	Observations	
108	High Beam	Identification and status	X	X			X			Proper control high beam operation	X	n/a		?			Indicator reminds the human driver of their selection. However, occupants may want to see the exterior environment. This is beyond the current regulatory scope.	**Ford, 2018**; pg. 93: It will illuminate when you switch the high beam headlamps on ------ **Honda, 2018**; pg. 27: These indicators remind you when an item is on or off *has pictures of indicators on page with text "High beams on"* ------ **Toyota, 2018**; pg. 81: The indicators inform the driver of the operating state of the vehicle's various systems *has picture of indicators including high beam indicator on page*

FMVSS	Component	Information Communicated	Delivery Method				Intended For			Expected Response (after receiving the information)	Required	Expected Response Regulatory Citation	Citation Example	Considerations				Expected Response Owner's Manual References
			Symbol	Telltale	Auditory Alert	Indicator	Human Driver	Passengers	Maintenance Entity					ADS	Occupant(s)	Maintenance Entity	Observations	
108	Turn Signal Pilot Indicator	Identification and status	X	X	*		X			Confirm proper turn signal operation	X	n/a		?			Indicator reminds the human driver of his or her turn signal selection. Occupants may want to know the future direction of the vehicle. However, this is beyond the project scope.	**Ford, 2018**; pg. 92: Illuminates when the left or right turn signal or the hazard warning flasher is turned on ---- **Honda, 2018**; pg. 27: These indicators remind you when an item is on or off *has pictures of indicators on page with text "Turn signals/hazards on"* ---- **Toyota, 2018**; pg. 81: The indicators inform the driver of the operating state of the vehicle's various systems *has picture of indicators including turn signal indicator on page*
108	Turn Signal Pilot Indicator	Lamp Failure	X		*	X	X		X	Check for burned out bulb and replace if necessary	X	n/a		X	?	?	Assuring that failed turn signal bulbs are replaced is beyond the project scope.	**Ford, 2018**; pg. 92: If the indicators stay on or flash faster, check for a burned-out bulb. See Changing a Bulb (page 273). ---- **Toyota, 2018**; pg. 211: If the indicator flashes faster than usual, check that a light bulb in the front or rear turn signal lights has not burned out.

FMVSS	Component	Information Communicated	Delivery Method				Intended For			Expected Response (after receiving the information)	Required	Expected Response Regulatory Citation	Citation Example	Considerations				Expected Response Owner's Manual References
			Symbol	Telltale	Auditory Alert	Indicator	Human Driver	Passengers	Maintenance Entity					ADS	Occupant(s)	Maintenance Entity	Observations	
108	Vehicular Hazard Warning Pilot Indicator	Identification and status	X	X	*		X			Confirm proper operation of the vehicular hazard warning signal	X	n/a		X	?	?	Non-driving occupants may want to be able to activate the vehicular hazard warning signal. Under current FMVSS No. 108, the control must be operable by the driver. However, in many vehicles, all front seat occupants can activate the hazard warning signal.	**Ford, 2018**; pg. 232: The flasher control is on the instrument panel. Use your hazard flashers when your vehicle is creating a safety hazard for other motorists. Press the flasher control and all front and rear direction indicators flash, press the button again to switch them off. ----- - **Honda, 2018**; pg. 27: These indicators remind you when an item is on or off *has pictures of indicators on page with text "Turn signals/hazards on"*
108	Position, side marker, end-outline marker, identification, or clearance lamps	Identification	X				X			Verify proper lighting system operation	x	n/a		?			Indicator reminds the human driver of his or her selection.	

FMVSS	Component	Information Communicated	Delivery Method				Intended For			Expected Response (after receiving the information)	Required	Expected Response Regulatory Citation	Citation Example	Considerations				Expected Response Owner's Manual References
			Symbol	Telltale	Auditory Alert	Indicator	Human Driver	Passengers	Maintenance Entity					ADS	Occupant(s)	Maintenance Entity	Observations	
114	Key left in starting system	Warning			X		X			Key will be removed from the starting system	X	76 Fed. Reg. 77185, 77183-77199 (Dec. 12, 2001)	To deter theft, Section 5.1.3 requires an audible alert to the driver if the driver's door is opened and the key has been left in the starting system. This serves as a reminder to the driver to always take the key.				In order for an ADS-DV's propulsion system to be turned on the ADS will need to know the key state. Therefore, the ADS may not need to be reminded.	**Ford, 2018**; pg. 95: The horn will sound twice when you exit your vehicle with the intelligent access key and your vehicle is in RUN, indicating your vehicle is still on ----- **Honda, 2018**; pg. 31: Leaving the key or remote transmitter in the vehicle can result in theft or accidental movement of the vehicle. Always take it with you whenever you leave the vehicle unattended ----- **Toyota, 2018**; pg. 71: Never leave the keys inside the vehicle when you leave the vehicle. This system is designed to help prevent vehicle theft but does not guarantee absolute security against all vehicle thefts.

FMVSS	Component	Information Communicated	Delivery Method				Intended For			Expected Response (after receiving the information)	Required	Expected Response Regulatory Citation	Citation Example	Considerations				Expected Response Owner's Manual References
			Symbol	Telltale	Auditory Alert	Indicator	Human Driver	Passengers	Maintenance Entity					ADS	Occupant(s)	Maintenance Entity	Observations	
138	Low Tire Pressure	Warning	X	X			X		X	Check tires and inflate them to the recommended pressure, or repair or replace them if necessary.	X	S4.5 Written Instructions	As an added safety feature, your vehicle has been equipped with a tire pressure monitoring system (TPMS) that illuminates a low tire pressure telltale when one or more of your tires is significantly under-inflated. Accordingly, when the low tire pressure telltale illuminates, you should stop and check your tires as soon as possible, and inflate them to the proper pressure. Driving on a significantly under-inflated tire causes the tire to overheat and can lead to tire failure. Under-inflation also reduces fuel efficiency and tire tread life and may affect the vehicle's handling and stopping ability.	X	?	?		
												70 Fed. Reg. 18137, 18136-18183 (Apr. 8. 2005)	Ninety percent of drivers will respond to a low tire pressure warning by re-inflating their tires to the recommended placard pressure.					

FMVSS	Component	Information Communicated	Delivery Method				Intended For			Expected Response (after receiving the information)	Required	Expected Response Regulatory Citation	Citation Example	Considerations				Expected Response Owner's Manual References
			Symbol	Telltale	Auditory Alert	Indicator	Human Driver	Passengers	Maintenance Entity					ADS	Occupant(s)	Maintenance Entity	Observations	
138	Low Tire Pressure	Warning	X	X			X		X	Check tires and inflate them to the recommended pressure, or repair or replace them if necessary.	X	70 Fed. Reg. 18137, 18136-18183 (Apr. 8. 2005)	Ninety percent of drivers will respond to a low tire pressure warning by re-inflating their tires to the recommended placard pressure.	X	?	?		
138	TPMS	Malfunction	X	X			X		X	Assure that TPMS is functioning properly	X	NPRM-69 Fed. Reg. 55896, 55896-55921 (Sep. 16, 2004)	We believe that these warnings are extremely important in terms of providing tire pressure information to drivers or of alerting drivers when the system is not available to provide such information.	X	X	X		

FMVSS	Component	Information Communicated	Delivery Method				Intended For			Expected Response (after receiving the information)	Required	Expected Response Regulatory Citation	Citation Example	Considerations				Expected Response Owner's Manual References
			Symbol	Telltale	Auditory Alert	Indicator	Human Driver	Passengers	Maintenance Entity					ADS	Occupant(s)	Maintenance Entity	Observations	
206	Door Closure Warning System	Warning		X			X			Door will be closed	X	75 Fed. Reg. 7374, 7370-7383 (Feb. 19, 2010)	A door closure warning system to alert the driver when the door is not in the fully latched position	X	X			**Ford, 2018**; pg. 62: If any door or the luggage compartment is open, or if the hood is open on vehicles with an anti-theft alarm or remote start, the horn sounds twice and the lamps do not flash -------- **Honda, 2018**; pg. 26: A door or the trunk is not closed. A beep sounds if open while driving. ---- **Toyota, 2018**; pg. 138: If an attempt to lock the doors is made when a door is not fully closed, a buzzer sounds continuously. Fully close the door to stop the buzzer and lock the vehicle once more.
206	Bus Wheelchair Lift Door Closure System Warning	Warning		X	X		X			Door will be closed	X	75 Fed. Reg. 7374, 7370-7383 (Feb. 19, 2010)	A door closure warning system to alert the driver when the door is not in the fully latched position	X	X			"...alert the driver when the door is not in the fully latched position..."

APPENDIX D: LISTS OF STANDARDS INCORPORATED BY REFERENCE FOR THE NEAR-TERM FMVSS

Table 15. FMVSS Reference Summary

FMVSS No.	Number of Incorporated References	No Regulatory Barrier	Translation Needed
102	0	0	0
108*	17	16	1
114	0	0	0
118	0	0	0
138	0	0	0
141**	5	5	0
201	4	4	0
202a	2	2	0
203	1	1	0
204	0	0	0
205	4	4	0
206	1	1	0
Total	**33**	**32**	**1**

*See Table 16 footnote for more details.
** See Table 17 footnote for more details.

Table 16. FMVSS No. 108 Reference List

Referenced Document	Section	Total No. of Citations	Translation Assessment	External Standard Status	Regulatory Barrier Identified
ASTM B117-73 *Standard Method of Salt Spray (Fog) Testing*	S5.2, S14.5.4.1, S14.6.3.1, S14.6.4.1.2, S 14.6.11.1.1	5	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: ASTM B117-03	None
ASTM C150-56 *Standard Specifications for Portland Cement*	S5.2, S14.5.3.2	2	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: ASTM C150-17	None
ASTM C150-77 *Standard Specification for Portland Cement*	S5.2, S14.6.5.1.2	2	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: ASTM C150-17	None
ASTM D362-84 *Standard Specification for Industrial Grade Toluene*	S5.2, S14.6.2.1.1	2	0–No Barrier	Current, withdrawn 1989, no replacement	None
ASTM D1003-92 *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*	S5.2, S14.4.2.2.4.1	2	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: ASTM D1003-13	None
ASTM D4956-90 *Standard Specification for Retroreflective Sheeting for Traffic Control*	S5.2, S8.2.1.2	2	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: ASTM D4956-17	None
ASTM E308-66 *Standard Practice for Spectrophotometry and Description of Color in CIE 1931 System*	S5.2, S14.4.2.2.4.4	3	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: E308-99	None

Referenced Document	Section	Total No. of Citations	Translation Assessment	External Standard Status	Regulatory Barrier Identified
CIE 1931 *Chromaticity Diagram*	S4, S5.2, S14.2.5.7.3	3	0–No Barrier	Current	None
SAE J567B_196404 *Bulb Sockets*	S5.2, S14.2.1.6.2	2	0–No Barrier	Current	None
SAE J573D_196812 *Lamp Bulbs and Sealed Units*	S5.2, S14.2.4.3, S14.2.1.6, S14.2.1.6.1, S14.2.1.6.2	5	0–No Barrier	Current	None
SAE J602_196308 *Headlamp Aiming Device for Mechanically Aimable Sealed Beam Headlamp Units*	S5.2, S6.4.5	2	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J602_201102	None
SAE J602_198010 *Headlamp Aiming Device for Mechanically Aimable Sealed Beam Headlamp Units*	S5.2, S10.14.7.7, S10.15.7.6, S10.18.7, S10.18.7.2	5	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J602_201102	None

Referenced Document	Section	Total No. of Citations	Translation Assessment	External Standard Status	Regulatory Barrier Identified
SAE J941b_196902 *Motor Vehicle Driver's Eye Range*	S5.2, S9.3.5	2	0–No Barrier	Current	This document refers to a driver and the position of the human in the vehicle. It would continue to apply for the purposes of the human driver and, as such, does not require translation. However, if the translation is applied differently than the options outlined in this worksheet, the reference may also need to be translated.
SAE J2009_199302 *Forward Discharge Lighting Systems*	S5.2, S11.3, S14.7.3.1.2	3	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J2009_201608	None

Referenced Document	Section	Total No. of Citations	Translation Assessment	External Standard Status	Regulatory Barrier Identified
Paragraph 5.14 of UNECE* Regulation 48 page 17 *Uniform Provisions Concerning the Approval of Vehicles with Regard to the Installation of Lighting and Light- Signalling Devices*	S12.6	1	1–Translation is straightforward	Newer document issued, but not incorporated by reference in FMVSS: U.N. Doc. No. E/ECE/324/Rev.1/Add.47/Rev.12-E/ECE/TRANS/505/Rev.1/Add.47/Rev.12, ¶ 5.14 (2014)	Document refers to the switching of the headlamps from the driver's seat. May require translation to account for ADS control and clarification of the driver.
IES LM-45-80 *IES Approved Method for Electrical and Photometric Measurements of General Service Incandescent Filament Lamps*	S5.2, S14.7.3.3	2	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: IES LM-45-00	None
OSHA Standard 29 CFR 1910.106 *Handling Storage and Use of Flammable Combustible Liquids*	S14.6.2.1.1	1	0–No Barrier	Current	None

Note: ANSI = American National Standards Institute; CIE = International Commission on Illumination; ECE = Economic Commission for Europe; IESNA = Illuminating Engineering Society of North America; OSHA = Occupational Safety and Health Administration.

*The UNECE reference is cited a total of two times, all in reference to the same document. The first mention is cited in the reference list of the standard and the second mention is in regards to the specific section Paragraph 5.14 in the requirements section. Therefore, this reference was only counted once in the summary in Table 15.

Table 17. FMVSS No. 141 Reference List

Referenced Document	Section	Total No. of Citations	Translation Assessment	External Standard Status	Regulatory Barrier Identified
ANSI S1.11-2004 *Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters*	S4	1	0–No Barrier	Current	None
ISO 10844:1994 *Acoustics–Specification of test racks for measuring noise emitted by road vehicles and their tyres*	S6.2	1	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: ISO 10844:2011	None
ISO 10844:2011 *Acoustics–Specification of test racks for measuring noise emitted by road vehicles and their tyres*	S6.2	1	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: ISO 10844:2014	None
ISO 10844:2014 *Acoustics–Specification of test racks for measuring noise emitted by road vehicles and their tyres*	S6.2	1	0–No Barrier	Current	None
S5.1 of SAE J2889-1** *Measurement of Minimum Noise Emitted by Road Vehicles*	S6.3.1	1	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J2889-1_201511	None
S5.3 of SAE J2889-1** *Measurement of Minimum Noise Emitted by Road Vehicles*	S6.3.3	1	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J2889-1_201511	None

Referenced Document	Section	Total No. of Citations	Translation Assessment	External Standard Status	Regulatory Barrier Identified
S6.1 of SAE J2889-1** *Measurement of Minimum Noise Emitted by Road Vehicles*	S6.4	1	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J2889-1_201511	None
Table 1 of SAE J2889-1** *Measurement of Minimum Noise Emitted by Road Vehicles*	S6.4	1	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J2889-1_201511	None
S7.1.1 of SAE J2889-1* *Measurement of Minimum Noise Emitted by Road Vehicles*	S6.4	1	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J2889-1_201511	None
S7.1.2.2 of SAE J2889-1** *Measurement of Minimum Noise Emitted by Road Vehicles*	S6.6	1	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J2889-1_201511	None

**Note: The reference SAE2889-1 is cited a total of six times indicating the different sections of that referenced document (e.g., S5.1, S5.3, S6.1, Table 1, S7.1.1, and S7.1.2.2). Therefore, this reference was only counted once in the summary in Table 15.

Table 18. FMVSS No. 201 Reference List

Referenced Document	Section	Total No. of Citations	Translation Assessment	External Standard Status	Regulatory Barrier Identified
SAE Recommended Practice J211_199503 *Instrumentation for Impact Tests*	S8.27.5	1	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE Recommended Practice J211-1_200312	None
S5 of SAE Recommended Practice J839b_196505 *Passenger Car Side Door Latch Systems*	S5.3.1	1	0–No Barrier	Current	None
SAE Recommended Practice J921_196506 *Instrument Panel Laboratory Impact Test Procedure*	S5.1.2, S5.2.2	2	0–No Barrier	Current	None
SAE Recommended Practice J977_196611 *Instrumentation for Laboratory Impact Tests*	S5.1.2, S5.2.2	2	0–No Barrier	Current	None

Table 19. FMVSS No. 202a Reference List

Referenced Document	Section	Total No. of Citations	Translation Assessment	External Standard Status	Regulatory Barrier Identified
SAE Standard J826_199507 *Devices for Use in Defining and Measuring Vehicle Seating Accommodation*	S3, S5, S5.1, S5.1.1, S5.2, S5.2.1, S5.2.2, S5.2.7, S5.3.4, S5.4	10	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J826_201511	None
SAE Recommended Practice J211/1_199503 *Instrumentation for Impact Test–Part 1–Electronic Instrumentation*	S5.2.5, S5.3.8, S5.3.9, S5.3.10	4	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J211/1_201403	None

Table 20. FMVSS No. 203 Reference List

Referenced Document	Section	Total No. of Citations	Translation Assessment	External Standard Status	Regulatory Barrier Identified
SAE Recommended Practice J944_198006 *Steering Control System–Passenger Car–Laboratory Test Procedure*	S5.1	1	0–No Barrier	Current	None

Table 21. FMVSS No. 205 Reference List

Referenced Document	Section	Total No. of Citations	Translation Assessment	External Standard Status	Regulatory Barrier Identified
ANSI/SAE Z26.1-1996 *American National Standard for Safety Glazing Materials for Glazing Motor Vehicles and Motor Vehicle Equipment Operating on Land Highways–Safety Standard*	S5.1, S5.1.1, S5.1.3, S5.2, S5.4, S5.5, S6.2, S6.3	8	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: ANSI/SAE Z26.1-2011	A general approach for the long term would be to incorporate and modify Table 1 of ANSI for new vehicle designs by listing which tests are applicable. This has two benefits: (1) NHTSA could state that the windshield impact requirements are applicable at other locations, or that the light stability tests (or other tests listed such as luminous transmittance, humidity, abrasion resistance, optical deviation and distortion, etc.) are not applicable to certain ADS glazing locations; and (2) ANSI would not have to be updated. This document refers to the location of safety glazing materials in relation to the driver. It would continue to apply for the purposes of the human driver, and as such, does not require translation. Translation could be required if the term "driver" by itself is chosen to be removed (e.g., "immediate left or right of the driver" to "immediate left or right of the driver designated seating position).
Annexes 18 and 19 of European Commission for Europe (ECE) Regulation No. 43 Revision 2—Amendment 1 *Uniform Provisions Concerning the Approval of Vehicles with*	S5.3.2	1	0–No Barrier	Newer document issued, but not incorporated by reference in FMVSS: U.N. Doc. No.	None

Referenced Document	Section	Total No. of Citations	Translation Assessment	External Standard Status	Regulatory Barrier Identified
Regard to the Installation of Lighting and Light-Signaling Devices				E/ECE/324/Rev.1/Add.47/Rev.12-E/ECE/TRANS/505/Rev.1/Add.42/Rev.4, Annexes 18 & 19 (2017)	
SAE Recommended Practice J100_199506 *Class "A" Vehicle Glazing Shade Bands*	S5.3.1	1	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J100_201611	This document refers to safety glazing materials which ADS-DVs may not have, such as windowless concept vehicles. However, it would continue to apply for the purposes of vehicles, both non-ADS-DVs and ADS-DVs, with such glazing materials.
SAE J673_199304 *Automotive Safety Glasses*	S5.1	1	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: SAE J673_201506	NHTSA has used this approach in FMVSS No. 104 where a portion of the SAE standard was replaced in the text of the regulation. This document refers to 'automotive safety glasses' which ADS-DV may not have, such as windowless concept vehicles. However, it would continue to apply for the purposes of vehicles, both non-ADS-DV and ADS-DV, with glass surfaces.

Table 22. FMVSS No. 206 Reference List

Referenced Document	Section	Total No. of Citations	Translation Assessment	External Standard Status	Regulatory Barrier Identified
Paragraph 6 of SAE Recommended Practice J839_199106 *Passenger Car Side Door Latch Systems*	S5.1.1.4	1	0–No Barrier	Newer standard issued, but not incorporated by reference in FMVSS: J839_199809	None

APPENDIX E: EXAMPLE ADS-DV TECHNICAL DESIGN DOCUMENTATION METHOD

This document provides an example of technical design documentation, which is one of the test methods being evaluated for use in verifying FMVSS compliance. FMVSS No. 138 was used as a test case that may be applied to other FMVSS. The information could be provided to NHTSA's Office of Vehicle Safety Compliance (OVSC) by the vehicle manufacturer for the ADS-DVs selected by NHTSA for compliance testing. The approach taken is to expand the current Test Specification Form that vehicle manufacturers complete and submit to OVSC after a vehicle is selected by NHTSA for potential testing. The Test Specification Forms do vary but some of them already include information NHTSA may need to verify that the vehicle complies with an FMVSS. The Test Specification Forms have been used as a starting point. However, the technical design documentation outlined here goes beyond what is provided today and may include manufacturer documentation used in the component, system, and vehicle design and assembly.

ADS-DV TECHNICAL DOCUMENTATION

FMVSS No.

Vehicle Model Year and Make: _____

Vehicle Model and Body Style: _____

1. List the following information for the designated standard and optional OE tires:
    A. Tire Type
    B. Tire Manufacturer
    C. Tire Name
    D. Tire Size

2. State whether the ADS-DV comes with a temporary or full size spare tire. State whether or not the Tire Pressure Monitoring System (TPMS) monitors the spare tire.

3. State whether or not the ADS-DV displays any TPMS information or messages. If so, describe what and where the information can be displayed. If the information is not visible during all trips, then explain the steps required for an occupant to obtain the information.

4. TPMS Information

NOTE: If more than one level of TPMS is offered for the same vehicle (base versus luxury), provide information for all TPMSs. If different inflation pressure sensors (direct systems) are used depending on the rim type, provide information for Items 4.B. and 4.C. for each rim offered.

A. Type:

B. Tier-one TPMS system supplier: _____

C. Inflation pressure sensor part#/model: _____

D. Provide a systems diagram of all TPMS components including anti-lock braking system (ABS) speed sensors or inflation pressure sensors, antennas, electronic control unit, display interface (module), and any other components or sensors labeled with the applicable part numbers. The diagram must include the part release date and revision date (if any), and it must identify the vehicle make(s), model(s), model year(s), and body style(s) to which it applies.

5. Telltale Configuration *[If NHTSA determines that that ADS-DVs will also need to have one or more illuminated telltales in the occupant compartment]*

A. Confirm telltale configuration:
- Combination low tire pressure / TPRM malfunction
- Low tire pressure warning telltale and dedicated TPRM malfunction

B. State whether or not the TPMS is equipped with the low tire pressure warning telltale that is the symbol identifying which tire(s) is (are) under-inflated. State whether the TPMS is equipped with both of the symbols for low tire pressure.

1.  2.  (identifies the involved tire)

C. State whether or not the TPMS is equipped with a manual reset control. If a reset control is provided, explain how and when it must be activated. Provide procedures for the proper use of the reset feature.

6. Low Tire Pressure Indicator

A. Explain system calibration requirements. State whether or not the system must execute a calibration procedure before it will properly identify an under-inflated tire.

B. Describe how the low tire pressure state is provided to the ADS. Provide a schematic diagram showing the electrical connection from the low tire state to the ADS. The

diagram must include the release date and revision level (if any), and it must identify the vehicle make(s), model(s), model year(s), and body style(s) to which it applies.

C. Provide the TPMS activation pressure set point (the pressure at which the low tire pressure warning state is communicated to the ADS and, if applicable, whether the telltale is set to illuminate). If different inflation pressures are specified for front and rear tires, indicate if the TPMS has two activation pressure set points. Provide one of the following items, either (i) or (ii).

   i. Provide the software architecture used to define what constitutes "low tire pressure" within the meaning of S4.2(a). The software architecture must include the software release date and revision level (if any).

      Or

   ii. Provide the ADS-DV network data log recorded during a FMVSS No. 138 physical test for the vehicle selected. The physical test results need to include documentation demonstrating that the S6 test procedures were followed. Provide test date, test reference number and test location.

7. TPMS Malfunction

A. For direct TPMSs, provide procedures for dismounting a tire from rim and replacing the tire. Provide procedures for removing and installing wheel electronics into rim well. Indicate special tools that are required and provide a diagram of the tire pressure sensor components.

B. For indirect TPMSs, provide detailed procedures on how to disconnect the ABS speed sensors at each wheel position.

C. List the failure modes identified by the ADS-DV's TPMS malfunction indicator.

D. Provide the specific location and procedures for accessing the TPMS fuse/circuit breaker and each component identified in the systems diagram provided in Item 4.D. Identify the locations of the TPMS wiring connection points to the ADS.

E. If the TPMS malfunction connection to the ADS is different than TPMS low tire pressure, then provide a drawing that describes the differences in how the TPMS's malfunction information is provided to the ADS. If the occupant compartment contains a telltale, indicate if the TPMS's electronic control module is hardwired to the low tire pressure warning telltale.

F. Provide any additional methods of simulating a TPMS malfunction used for certification.

G. Describe the method for the ADS receiving the malfunction within 20 minutes and maintaining the information for the duration of the malfunction. In addition to the description, provide one of the following, either (i) or (ii).

i. Provide the signal timing diagram showing for the TPMS including the ADS receiving the signal.

Or

ii. Provide the ADS-DV network data log recorded during a FMVSS No. 138 physical test for the vehicle selected. The physical test results need to include documentation demonstrating that the S6 test procedures were followed. Provide test date, test reference number and test location.

8. Owner's Manual Written Instructions

A. Indicate where and how to find the FMVSS No. 138 S4.5 written instructions.

APPENDIX F: TEST PROCEDURE IMPLEMENTATION

This section provides the results of the test method evaluation based on testing that has been performed with the test platform at test facilities for procedures based on selected sections of the test procedures for FMVSS Nos. 114 and 138 (shown below in Table 23 and Table 24). The test procedure evaluation is a unified effort across all the 100-series standards. This particular effort is an intermediate step. As discussed in Chapter 2, there are standards that will be implemented and evaluated later on in this project that are key in the evaluation of the different methods being investigated. However, this first step acted as a proof of concept for the methods being used for the evaluation. The successful demonstration of these basic functionalities provides a gating item prior to the implementation of the more complex test procedures and the initiation of validation stage.

Test Procedures Implemented

As stated, the intent of the effort is to implement and execute procedures that exercise the functionalities identified in the regulations. Towards, this end, sections were identified that would allow for an evaluation of the test methods that would be applicable to instances where the functionalities are found in other standards and test procedures. Table 23 and Table 24 show the specific procedures and steps that were implemented during near-term research. While the human control console allowed for the execution of the procedures as currently executed, the steps in the tables provide the basis for the programming that allowed the vehicle to execute the test automatically.

Table 23. Test Procedures Implemented Based on FMVSS No. 114

Reference	Description
S6.2.1	(a) Activate the starting system using the key. (b) Move the gear selection control to any gear selection position or any other position where it will remain without assistance, including a position between any detent positions, except for the Park position. (c) Attempt to remove the key in each gear selection position.
S6.2.2	(a) Drive the vehicle forward up a 10 percent grade and stop it with the service brakes. (b) Apply the parking brake (if present). (c) Move the gear selection control to Park (d) Note the vehicle position. (e) Release the parking brake. Release the service brakes. (f) Remove the key. (g) Verify that the gear selection control or transmission is locked in Park (h) Verify that the vehicle, at rest, has moved no more than 150 mm from the position noted prior to release of the brakes.
S6.2.3	(a) Drive the vehicle forward down a 10 percent grade and stop it with the service brakes. (b) Apply the parking brake (if present). (c) Move the gear selection control to Park (d) Note the vehicle position. (e) Release the parking brake. Release the service brakes. (f) Remove the key. (g) Verify that the gear selection control or transmission is locked in Park (h) Verify that the vehicle, at rest, has moved no more than 150 mm from the position noted prior to release of the brakes.

Table 24. Test Procedures Implemented Based on TP-138-03

Steps	Reference	Description
1	13.2D	With engine off in accessory mode.
1.5		Say in accessory mode for 30 sec. minimum
2	13.3J	Start Engine
3	"	Apply Brakes
4	"	Disengage Emergency Brake (if it's on)
5	"	Shift into Drive
6	"	Drive the SR-HS at 45mph (loops slower) for a total time of 20-22 min of accumulated time between (31mph and 62mph)
7	"	Return back to SSS to the spot where we started
8	"	Apply Brakes
9	"	Shift into Park
10	13.3L	Turn engine off
		Run the first test
11	13.3M	Deflate 1 tire 1 PSI below telltale activation pressure
12	13.3O	Start Engine
13	"	Apply Brakes
14	"	Disengage Emergency Brake (if it's on)
15	"	Shift into Drive
16	"	Drive the SR-HS at 45 mph (loops slower) for a total time of 15-17 min of accumulated time between (31 mph and 62 mph) or until a TPMS light comes on. If a TPMS light comes on proceed to step 18
17	"	Return back to SSS to the spot where we started
18	"	Apply Brakes
19	"	Shift into Park

Steps	Reference	Description
20	13.3R	Turn engine off
21	13.3S	Wait 5 minutes
22	13.3T	Turn engine on
23		Run for 1 min
24		Turn engine off
25	13.3W	Re-inflate tire to appropriate level
26		Start Engine
27		Apply Brakes
28		Disengage Emergency Brake (if it's on)
29		Shift into Drive
30	13.3X	Drive the SR-HS at 45mph (loops slower) for a total time of 15–17 min of accumulated time between (31 mph and 62 mph) or until a TPMS light extinguishes. If a TPMS light turns off proceed to step 32
31		Return back to SSS to the spot where we started
32		Apply Brakes
33		Shift into Park
34		Turn engine off

Functionality Working Definitions

Table 25 provides working definitions for the functionalities identified in the regulations or are needed to test for compliance.

Table 25. Working Definitions for the Functionalities

Category	Functionality	Working Definitions	Test Procedure Functionality Examples
Driving Task	Steering control	Manipulate the vehicle's heading	"Test drivers are to obey all traffic laws and adopt a non-aggressive driving style at all times during test. Increases and decreases in vehicle speed are to be smooth and steady. Steering inputs are to be smooth, steady and with purpose. The brake pedal is to be applied and released at normal rates." (FMVSS No. 138 Test Procedure, Compliance Test Execution, General, C)
	Accelerator/ speed control (vehicle/ engine)	Manipulate power to the engine, motor or other system which provides propulsion for forward movement	"With the vehicle stopped, the engine running and the transmission in gear, press the accelerator control and smoothly accelerate up to a vehicle speed of 75 + 25 km/h (31–62 mph). Drive the vehicle within this speed range for 10–15 minutes of cumulative time. Time does not accumulate when vehicle speeds are outside the speed range or when the brake pedal is applied. Timing starts when the vehicle's speed exceeds 50 km/h (31 mph) and continues as long as the vehicle is within the speed range specified. When the vehicle speed is below or above the specified speed range the test should continue but the vehicle operational time accumulated outside the speed range will not be included in the 10–15-minute test time requirement. Record the cumulative driving time." (FMVSS No. 138 Test Procedure, Compliance Test Execution, TPMS Operational Performance, J)
	Service brake application	Controls the deceleration of the vehicle (activation of the primary braking system)	"Simultaneously press the service brake and move the gear selection control to the "drive" position. The gear selection control should NOT be locked in "park"" (FMVSS No. 114 Test Procedure, Compliance Test Execution, E4)
	Parking brake	A system that retains vehicle position	"The vehicle's parking brake is to be applied and engine shut off whenever the vehicle is stopped and test personnel are outside of the vehicle." (FMVSS No. 138 Test Procedure, Compliance Test Execution, General, D)
	Gear selection	A means to change the transmission state	"Move the gear selection control to the "park" position. Disconnect the vehicle battery. Try to move the gear selection control from the "park" position. The gear selection control should be locked in "park"." (FMVSS No. 114 Test Procedure, Compliance Test Execution, B2)
	General driving	Conduct the DDT	"Drive the vehicle to any section of the test roadway defined in paragraph S5.2 of FMVSS No. 138. Stop the vehicle at the selected starting point." (FMVSS No. 138 Test Procedure, Compliance Test Execution, TPMS Operational Performance, E)
Vehicle Communication	Telltales/ warnings/ indicators	A signal or state that provides functioning or identification information	"Open the door closest to the driver's designated seating position. There shall be an audible warning." (FMVSS No. 114 Test Procedure, Compliance Test Execution, B3)
Key/ignition function	Key insertion/ removal	The use of a physical device or electronic code to activate or deactivate the vehicle's ignition or starting system	"Activate the vehicle starting system and start the engine or motor using the key." (FMVSS No. 114 Test Procedure, Compliance Test Execution, C1)
	Ignition start/ stop	Activate or deactivate the engine, motor or other system which provides propulsion to the motor vehicle using a key	"When the key that controls activation of the vehicle's engine is in the "ON" "START", or "ACCESSORY" position" (FMVSS No. 118 Test Procedure, General Requirements, A)
	Accessory mode	Ignition position that enables secondary equipment to activate (air conditioner, wipers, heat, HVAC fan, audio/video systems, etc.)	"Repeat steps 1) through 3) starting with the locking system in the "ACCESSORY" position. Skip this step if the WPRPs are not operable with the locking system in the "ACCESSORY" position." (FMVSS No. 118 Test Procedure, Compliance Test Execution, 12.1, 4)
Non-driving tasks	Door open/close	A physical system that affords occupants ingress and egress from the vehicle	"Open the door closest to the driver's designated seating position. There shall be an audible warning." (FMVSS No. 114 Test Procedure, Compliance Test Execution, B3)
	Non-driving controls	Devices that manipulate the vehicle's secondary equipment (air conditioner, wipers, heat, HVAC fan, audio/video systems, etc.)	"All accessory equipment (air conditioner, wipers, heat, HVAC fan, audio/video systems, etc.) that can be shut down, will be off. Propulsion battery cooling fans and pumps and other components of the vehicle's propulsion battery thermal management system are not considered accessory equipment." (FMVSS No. 141 Regulation Text, S6.6.)
Environmental awareness	Visibility	Systems or features that enable recognition of the external environment to safely execute the driving task	"During night time testing test vehicle headlights may be activated." (FMVSS No. 141 Regulation Text, S6.6.)

APPENDIX G: STAKEHOLDERS

Personnel from organizations listed in the tables below provided input to the technical translation options for each near-term FMVSS.

FMVSS No. 102
Advocates for Highway and Auto Safety
Apple
Auto Alliance
EMA
Honda
NIO
Waymo

FMVSS No. 108
Apple
Auto Alliance
EMA
Honda
IIHS
NIO
Waymo
Zoox

FMVSS No. 114
Advocates for Highway and Auto Safety
Apple
Auto Alliance
Honda
NIO
Waymo

FMVSS No. 118
Advocates for Highway and Auto Safety
Apple
Auto Alliance
Bosch
Honda
NIO
Waymo

FMVSS No. 138
Apple
ASC
Auto Alliance
Honda
NIO
Waymo

FMVSS No. 141
Apple
Auto Alliance
Honda
Waymo
Zoox

FMVSS No. 201
Apple
ASC
Auto Alliance
Honda
IIHS
NIO
Waymo

FMVSS No. 202
Apple
ASC
Auto Alliance
Honda
IIHS
NIO
Waymo

FMVSS No. 203
Apple
ASC
Auto Alliance
Bosch
Honda
IIHS
Waymo

FMVSS No. 204
Apple
ASC
Auto Alliance
Bosch
Honda
IIHS
NIO
Waymo

FMVSS No. 205
Apple
Auto Alliance
EMA
Honda
NIO
Waymo

FMVSS No. 206
Apple
ASC
Auto Alliance
EMA
Honda
IIHS
NIO
Waymo

Listed below are the organizations that sent representatives to the April 2018 Stakeholder Meeting in Washington, DC (VTTI, 2018a, 2018b).

Organization
Active Safety Engineering LLC
Advocates for Highway and Auto Safety
Aisin Group
Alliance of Automobile Manufacturers
Amazon
American Association of People with Disabilities
American Trucking Associations

Organization
Analog Devices, Inc.
Apple, Inc.
Association of Global Automakers, Inc.
Auto Alliance
Autoliv
Automotive Safety Council
Babst Calland
Baker & McKenzie, LLP
BMW Group
Center for Auto Safety
Community Transportation Association of America
Consumers Union, the advocacy division of Consumer Reports
Continental Automotive Systems, Inc.
Daimler AG
Dale Kardos & Associates, Inc.
Disability Rights Education & Defense Fund
Engineering Systems Inc.
Eversheds Sutherland (US) LLP
Exponent, Inc.
Faurecia Automotive Seating
Ford Motor Company
General Motors
Harman
Holland & Knight
Honda
Insurance Institute for Highway Safety
Intelligent Transportation Society of America
Jaguar Land Rover North America
Japan Automobile Standards Internationalization Center
Kenneth N. Weinstein, LLC
Lindsey Research Services
Local Motors
Luminar Technologies, Inc.
Magna International, Inc.
Mazda North American Operations
Mercedes-Benz Research & Development North America
MGA Research Corporation
Mitsubishi Motors R&D of America
Motor Equipment Manufacturers Association
Motorcycle Industry Council
NAMIC

Organization
National Automobile Dealers Association
National Council on Independent Living
National League of Cities
Navistar
New York City Mayor's Office of Federal Affairs
Nexteer Automotive
NIO
Nissan North America, Inc.
National Transportation Safety Board
Roger C. Fairchild Esq., P.C.
SAE International
SFB Consulting, LLC
SmartDrive Systems, Inc.
Stoneridge Inc.
Subaru
Takata
Tesla, Inc.
The Potomac Alliance
TK Holdings, Inc.
Toyoda Gosei North America
Toyota Motor North America, Inc.
U.S. Department of Labor
Uber
Venable LLP
Volkswagen Group
Volvo Car Group
Waymo
WTH Consulting, LLC
ZF
Zoox, Inc.

DOT HS 812 796
April 2020

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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