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Identifying Automated Driving Systems-Dedicated Vehicles (ADS-DVs) Passenger Issues for Persons with Disabilities		

RATIONALE

This information report provides a literature review, along with results from expert interviews, regarding universal design principles and guidance for the development of automated driving systems-dedicated vehicles (ADS-DVs) in order to accommodate users with visual, mild cognitive, or certain physical impairments.

This 2025 limited-scope revision incorporates editorial/general changes from the 2019 release of SAE J3171, identified in the previous reaffirmation ballot, including: correction of typos (missing commas/hyphens/words, incorrect numbering), alignment of Background description with the numerical flow of the clauses, and updating terminology and grammar for clarity and alignment with related documents. Besides those changes captured in the limited-scope revision, references were corrected where needed.

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1. SCOPE

It is expected that Level 4 and 5 automated driving systems-dedicated vehicles (ADS-DVs) will eventually enable persons to travel at will who are otherwise unable to obtain a driver's license for a conventional vehicle, namely, persons with certain visual, cognitive, and/or physical impairments. This information report focuses on these disabilities but also provides guidance for those with other disabilities. This report is limited to fleet-operated, on-demand, shared mobility scenarios, as this is widely considered to be the first way people will be able to interact with ADS-DVs. To be more specific, this report does not address fixed-route transit services or private vehicle ownership. Similarly, this report is focused on motor vehicles (refer to SAE J3016), not scooters, golf carts, etc. Lastly, this report does not address the design of chair lifts, ramps, or securements for persons who use wheeled mobility devices (WHMD) (e.g., wheelchair, electric cart, etc.), as these matters are addressed by other committees within SAE International.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606- 7323 (U.S. and Canada only) or +1 724-776-4970 (Outside U.S. and Canada), www.sae.org.

SAE J1725	Structural Modification for Personally Licensed Vehicles to Meet the Transportation Needs of Persons with Disabilities
SAE J2092	Testing of Wheelchair Lifts for Entry to or Exit from a Personally Licensed Vehicle
SAE J2093	Design Considerations for Wheelchair Lifts for Entry to or Exit from a Personally Licensed Vehicle
SAE J2249	Wheelchair Tiedown and Occupant Restraint Systems for Use in Motor Vehicles
SAE J2395	ITS In-Vehicle Message Priority
SAE J2831	Development of Design and Engineering Recommendations for In-Vehicle Alphanumeric Messages
SAE J2988	Guidelines for Speech Input and Audible Output in a Driver Vehicle Interface
SAE J3016	Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles
SAE J3163	Taxonomy and Definitions for Terms Related to Shared Mobility and Enabling Technologies

Schaupp, G., Seeanner, J., Jenkins, C., Manganelli, J. et al., "Wheelchair Users' Ingress/Egress Strategies While Transferring Into and Out of a Vehicle," SAE Technical Paper 2016-01-1433, 2016, <https://doi.org/10.4271/2016-01-1433>.

2.1.2 Non-SAE Publications

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2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 U.S. Congress Publications

Copies of these documents are available online at www.congress.gov.

Technology-Related Assistance for Individuals with Disabilities Act of 1988, S.2561, 100th Cong. (1988).

2.2.2 U.S. Access Board Publications

Copies of these documents are available online at www.access-board.gov.

U.S. Access Board. (2017) Revised 508 standards. Available from <https://www.access-board.gov/guidelines-and-standards/communications-and-it/about-the-ict-refresh/final-rule/text-of-the-standards-and-guidelines>.

2.2.3 W3C Publications

Copies of these documents are available online at www.w3.org.

World Wide Web Consortium. (2018). World Wide Web accessibility guidelines. Available from <https://www.w3.org/WAI/standards-guidelines/wcag/>.

3. DEFINITIONS

3.1 ACCESSIBILITY

The degree to which a product or service is able to be accessed or used by people with disabilities.

3.2 ASSISTIVE DEVICE

A device designed to help a person to perform a specific task (or type of task) they might not otherwise be able to perform.

3.3 AUTOMATED DRIVING SYSTEM-DEDICATED VEHICLE (ADS-DV)

A vehicle designed to be operated exclusively by a Level 4 or 5 automated driving system (ADS) for all trips within its given operational design domain limitations (if any) (refer to SAE J3016).

3.4 DISABILITY

“Disabilities is an umbrella term, covering impairments, activity limitations, and participation restrictions. An impairment is a problem in body function or structure; an activity limitation is a difficulty encountered by an individual in executing a task or action; while a participation restriction is a problem experienced by an individual in involvement in life situations” (refer to World Health Organization, 2019).

3.5 RIDESOURCING

Ridesourcing services are prearranged and on-demand transportation services for compensation in which drivers and passengers connect via digital applications. Digital applications are typically used for booking, electronic payment, and ratings (refer to SAE J3163).

NOTE: For purposes of ridesourcing services provided by ADS-DVs, the digital application would connect passengers with a particular ADS-DV, rather than with a driver of a conventional vehicle.

3.6 UNIVERSAL DESIGN

“The process of creating products and built environments to be usable by all people, to the greatest extent possible, without the need for adaptation” (refer to Pilarski and Rath, 2013).

4. ABBREVIATIONS

ADS-DV	Automated Driving System (ADS)-Dedicated Vehicle
OEM	Original Equipment Manufacturer
PWD	Persons with Disabilities
W3C	World Wide Web Consortium
WHMD	Wheeled Mobility Device

5. BACKGROUND

Over one billion people, about 15% of the world's population, have some form of disability (refer to World Health Organization, 2018). In the United States, nearly one in five, or 56.7 million, people have a disability (refer to U.S. Census Bureau, 2010). Of the 15 million Americans who report having difficulties accessing transportation services, 40% are people with disabilities. The lack of a personal vehicle is the most frequently cited reason for being homebound for persons with disabilities (PWDs) (refer to Bureau of Transportation Statistics, 2003). Over half a million disabled Americans never leave home due to the lack of access to transportation (refer to Bureau of Transportation Statistics, 2003). Almost three decades after the passage of the Americans with Disabilities Act, PWDs continue to face systemic barriers to transportation. The lack of transportation accessibility contributes to the unemployment rate being twice as high for PWDs compared to that of those with no disability (refer to Bureau of Labor Statistics, 2017). Furthermore, PWDs report transportation and affordability as main barriers to receiving needed health care (refer to World Health Organization, 2018). For those who are unable to obtain a driver's license, transportation options are often limited to walking, public transport, and for-hire services such as taxis.

Original equipment manufacturers (OEMs) and technology companies are working to develop, refine, and deploy ADS-DVs for purposes of providing transportation services (refer to Chang and Gouse, 2017). ADS-DVs—vehicles designed to be operated exclusively by an ADS as described in SAE J3016—have the potential to expand mobility opportunities for even greater numbers of people, including PWDs who are currently unable to obtain a driver's license due to certain vision, cognitive, and/or physical disabilities. This document identifies and summarizes potential passenger issues related to the use of ADS-DVs offered as part of ridesourcing services for PWD. The methods used to identify the issues presented within this report are described in Section 6. In Section 7, the difficulty of classifying people with disabilities, which is a complementary issue, is explained. These issues are then described in Section 8.

6. METHOD

6.1 Approach

The goals for this report were to identify issues unique to ADS-DV design for individuals with certain visual, cognitive, and/or physical impairments. Notwithstanding this narrower focus, the concerns of other classes of disability were also considered to the extent they involve aspects unique to ADS-DVs. For example, although this document does not address issues faced by PWDs who require wheelchair lifts or ramps, wheelchair locking mechanisms, and/or chest restraints, it does speak to issues unique to use of an ADS-DV by passengers who use WHMD, such as where an ADS-DV should stop to facilitate safer ingress/egress. Other issues related to accommodating WHMDs in passenger vehicles are addressed in SAE J1725, SAE J2092, SAE J2093, and SAE J2249.¹

The methodological approach followed in developing this document consisted of three main steps: (1) review of driver's license requirements; (2) literature review; and (3) stakeholder interviews. Each of these is described below.

6.2 Review of Driver's License Requirements

As a first step, a thorough review was conducted of driver's license requirements within the U.S., which is presented in Appendix A. Each state requires that individuals pass a knowledge test, a vision test, and a skills test to obtain a driver's license. Meeting these requirements is unlikely for individuals with certain cognitive and/or vision disabilities.

6.3 Literature Review

The literature review group focused on researching the Task Force objectives and related inquiries. Topics of interest included work currently being done to involve PWDs in design of technology and international best practices in accessible transportation for PWDs.

6.4 Stakeholder Interviews

An interview group created questionnaires, identified stakeholders, and conducted interviews. Interviewees consisted of four categories of stakeholders with specialized knowledge in disability-related issues, as presented in Table 1. Additionally, the interview guides and questionnaire used are provided in Appendix B. All interviews took place via phone with at least two SAE Task Force members in addition to the interviewee. One Task Force member served as interviewer and the other served as notetaker. The interview notes were later entered into a spreadsheet and coded for thematic analysis. This process allowed the identification of trends among the responses, which are described in Section 8.

Table 1 - Stakeholder interviews

Interviewee Categories	Primary Information Gathering Goal
PWDs	Identify barriers and workarounds
Advocates and others who work with PWDs	Identify barriers and workarounds
Experts in design for PWDs	Identify existing knowledge in universal design that could be applied to design of ADS-DVs
Government and policy experts knowledgeable about transportation and/or PWD	Identify policy measures that may facilitate ADS-DV passenger accessibility as it relates to certain PWDs

¹ The SAE Human Accommodation Devices Committee manages a group that addresses ingress/egress issues unique to persons with certain disabilities, such as required use of a WMD. This information report, which falls under the On-Road Automated Driving Committee, is therefore limited to those passenger issues that are unique to use of an ADS-DV, rather than issues common to any vehicle used to transport persons with disabilities.

7. DIFFICULTY OF CLASSIFYING DISABILITIES

The classification of disabilities is often based on the portion of the body impacted and the severity of that impact (e.g., blindness and reduced vision; deafness and reduced hearing; WHMD user and reduced ambulation). The International Classification of Functioning, Disability and Health, a World Health Organization framework for measuring health and disability, defines disability as an umbrella term for impairments, activity limitations, and participation restrictions at one or more of the three levels of human functioning: (1) at the level of body or body part; (2) the whole person; and (3) the whole person in a social context (refer to WHO, 2002). That is, a disability is only a problem when the individual tries to function in a world that has barriers for PWD. The classification of the disabilities can only be done in relation to an activity and its barriers.

If these barriers are removed, the person can fully engage in the world. By choosing to include PWDs as a passenger group to be considered in the design, more barriers can potentially be removed. This is also a useful approach to designing for as many types of people as possible. A parent with a child in a stroller, a person carrying groceries, or someone who is not fluent/literate in the local language could face similar barriers to using an ADS-DV as someone with a disability.

Currently, to overcome the barrier of being unable to obtain a driver's license, a PWD requires another human to operate a vehicle. ADS-DVs are anticipated to enable elimination of the need for assistance from another human. However, there is the potential that the design of the ADS-DV can introduce new barriers. This document describes potential barriers to be mindful of when designing ADS-DVs to be usable by more PWDs.

Furthermore, it is critical to be mindful of individual differences in how PWDs interact with the world. For example, an individual who was born blind never had the experience of seeing. An individual who lost their sight as an adult goes through an adaptation process to learn how to interact with the world. An individual who has lost their vision gradually may not be aware of the reductions in sight. Even if they are aware, they must learn new strategies to deal with the new deficits. Furthermore, the ability to adapt to vision loss (traumatic or gradual) will vary between individuals. One should not assume that all individuals who are blind or have vision impairments are the same.

This is one reason devices that are highly user-friendly to PWDs (e.g., some smart phones) have an accessibility setting. Within this setting, PWDs can make selections for how they want to interact with the device based on their own needs. These settings are often also used by tech-savvy individuals without disabilities to customize their experience. The types of settings that are available depend on the design of the technology. The things to consider when designing the technology and the settings are described in the next few sections.

8. DESIGN CONSIDERATIONS FOR PWDs

8.1 General Considerations

There are many terms associated with the process of designing for PWDs. The terms are not equivalent. Terms such as “accessible design” are about finding workarounds for people with disabilities. Other terms, such as “universal design,” “inclusive design,” and “design-for-all,” are about finding designs that work for the widest number of people. For this information report, the term “universal design” will be used.

Universal design is very similar to the human factors design approach common in the automotive development community in which designers focus on the intended passengers' functional characteristics and needs. Regarding automotive development in general, PWDs have not been considered as drivers because drivers are required to pass a vision test, a knowledge test, and a skills test to obtain a license. Within universal design, individuals with disabilities are considered part of the user group.

This means that individuals with disabilities should be consulted in all phases of development. Given that most automotive design engineers are not PWDs, it makes sense for them to consult with PWDs, who are potential passengers of their products, when attempting to design interfaces. Just as in the standard human factors approach, PWDs should be included at every phase of development from concept generation through validation testing.