



Automated Vehicle Safety Consortium™ Best Practice

AVSC00003202006

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AVSC Best Practice for Passenger-Initiated Emergency Trip Interruption

Rationale

During trips in fleet-managed automated driving system-dedicated vehicles (ADS-DVs), passengers may feel the need to interrupt the trip for emergency reasons completely unrelated to the ADS's ability to perform the dynamic driving task (DDT). While some initial research has been performed by industry groups, no standards or industry guidance currently address this topic. Passengers who are provided a degree of control (agency) over their trip in emergency situations should have improved trust in, and therefore acceptance of, ADS-DVs. Consistency across passenger-initiated emergency trip interruption features should also help establish appropriate passenger expectations and foster the development of social norms for the use of such emergency features.

Preface

The Automated Vehicle Safety Consortium™ (AVSC) is an industry program of SAE Industry Technologies Consortia (SAE ITC®) working to quickly publish best practices that will inform and lead to industry-wide standards advancing the safe deployment of automated driving systems (ADSs). The members of this consortium have decades of accumulated experience focused on safe, reliable, and high-quality transportation. They are committed to applying those principles to SAE level 4 and 5 automated vehicles so that communities, government entities, and the public can be confident that these vehicles will be deployed safely.

The Consortium recognizes the need to establish best practices for the safe operation of ADS-dedicated vehicles (ADS-DVs). These technology-neutral practices are key considerations for safely deploying ADS-DVs on public roads. Members of the AVSC intend to support the published principles and best practices in an effort to establish a suggested level for other industry participants to meet. These best practices will serve as a basis to enhance and expedite the formal industry standards development process through SAE International and other global standards development bodies. Effectively implementing these principles can help inform the development of sound and effective ADS regulations and safety assurance testing protocols that will engender public confidence in the efficacy of ADS-DVs.

Comment and open discussion on the topics are welcome in appropriate industry forums. As discussion unfolds, AVSC documents will be revised as significant information and/or new approaches come to light that would increase public trust.

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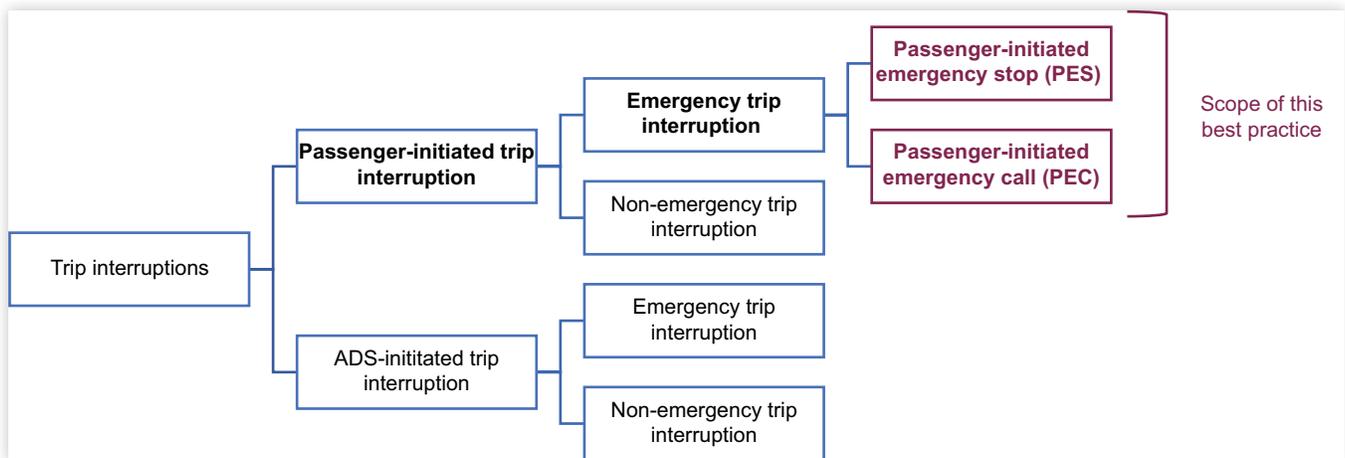
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Introduction

As passengers take trips in fleet-managed ADS-DVs, they may perceive a need to interrupt the trip due to an emergency either by stopping or altering the trip. Passengers who know they have an option to exercise some type of control in an emergency situation may have increased trust in ADS-DVs relative to those without that perceived control. In other domains, the option of explicit control over an automated system creates comparatively higher user trust levels than an implicit or no control option [1]. Providing passengers this option comes with the need for passenger education. To be clear, passengers on an SAE level 4 or 5 vehicle are *riders* with no role supervising the performance of the vehicle or any other aspect of the DDT.

There is currently no consensus on the proper balance between passenger agency and potentially introducing unexpected outcomes in dynamic traffic environments; therefore, for the foreseeable future, driverless-capable SAE level 4 and 5 ADS-operated vehicles will likely have multiple ways to initiate an ADS-DV trip interruption. To provide context for the remainder of this document and for future discussion among industry stakeholders, trip interruptions have been organized based on the initiating agent (i.e., passenger or ADS) and type of interruption (i.e., emergency or non-emergency)¹ (Figure 1).

FIGURE 1 Trip Interruptions Typology



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1. Scope

This Automated Vehicle Safety Consortium™ (AVSC) *Best Practice for Passenger-Initiated Emergency Trip Interruptions* (AVSC00003202006) provides best practices and recommended processes surrounding aspects of passenger-initiated emergency features in SAE level 4 and 5 fleet-managed ADS-DV operations. The document includes recommended criteria and processes for passenger initiation of the features from inside a vehicle, communication with passengers, communication with fleet operations, enhanced diagnoses of the situation, interaction outside the vehicle with other road users, and general post-stop actions. Because the recommendations are focused on *passenger* interaction, it is meant to apply to commercially available, deployed ADS-DVs providing trips to people.

This document provides guidance for the passenger-initiated emergency trip interruptions. These are distinct from ADS-initiated emergency trip interruptions and passenger-initiated *non-emergency* trip interruption features (Figure 1). The presence of a passenger-initiated emergency stop (PES) feature, passenger-initiated emergency call (PEC) feature, or both in ADS-DVs does not preclude a manufacturer from providing features for non-emergency stop requests, calls, or trip interruptions from inside a vehicle or through a personal interface (e.g., smartphone app). These may be used to handle important, but not emergency, situations which are outside the scope of this document.

While this best practice addresses protection against some types of foreseeable misuse, neither a passenger-initiated emergency interruption feature nor an ADS can be expected to determine the veracity or urgency of a passenger's perceived emergency. In other words, much like when dialing 9-1-1 in North America, 1-1-2 in Europe, or 1-1-9 in Japan, the recommendations in this best practice assume an emergency is taking place even if the objective reality of the situation in question turns out not to warrant such a designation. Determining the validity of a passenger's perception of an emergency or arbitrating what passengers consider an emergency is outside the scope of this document.

Because safe vehicle maneuvers will vary by use case and operational design domain (ODD), recommendations associated with route planning and specific DDT maneuvers² following the passenger's initiation of the emergency trip interruption are outside the scope of this document. Fleet operators may intervene to assess the situation in and around the ADS-DV and, if stopped, may restart³ it to redirect it to another location depending on the situation and their ability to assess the situation. Criteria for making any determination or any situational assessment of a destination by the fleet operator are outside the scope of this document. Emergency assessment processes on the part of fleet operations analysis or actions as a result of passenger-initiated emergency call are outside the scope of this document. Tele- or remote-operation of ADS-DVs is also out of scope of this document.

In addition to passenger-initiated trip interruption features, manufacturers may design the vehicle to interrupt a trip in response to certain passenger actions (e.g., opening or attempting to open the door of a moving vehicle). Trip interruptions of this nature are outside the scope of this document.

² Many factors will contribute to an ADS planning to execute a controlled stop. These include speed, location, conditions, traffic, other road users, ODD, etc. Some examples of a controlled stop that may be implemented by manufacturers include stopping in the traveled lane; pulling to the nearest curb, shoulder, median; or other situationally dependent options.

³ In this context, *restart* means the vehicle begins moving again after having come to a stop.

2. References

2.1 Applicable Documents

The following publications were referenced during development of this document. Where appropriate, documents are cited.

2.1.1 SAE Publications

Unless otherwise indicated, the latest issue of SAE publications apply. Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J3016_201806 Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles

2.1.2 Other Documents

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7. Burgstahler S., "Universal Design: Process, Principles, and Applications," University of Washington, 2015. [Online]. Available: <https://www.washington.edu/doit/universal-design-process-principles-and-applications>. [Accessed 12 May 2019].

3. Definitions

ABUSE: The intentional improper use of an ADS feature in an ADS-DV.

ADS-DEDICATED VEHICLE (ADS-DV) (SAE J3016): A *vehicle* designed to be operated exclusively by a level 4 or 5 ADS for all trips within its given *ODD* limitations (if any).

CALL-TAKER: A person fielding a passenger-initiated emergency call (PEC).

NOTE: Passenger-initiated emergency calls (PECs) should be connected from the vehicle to a human call-taker, not routed to an automated answering system for resolution of the passenger's emergency.

EMERGENCY: "An unforeseen combination of circumstances or the resulting state that calls for immediate action" or "an urgent need for assistance or relief" [2].

[ADS-DV] FLEET OPERATOR: An entity that manages a fleet of ADS-DVs as well as the services provided by said fleet.

NOTE: Fleet operator excludes non-commercially deployed, privately owned vehicles.

MINIMAL RISK CONDITION (MRC) (SAE J3016): A condition to which a user or an ADS may bring a vehicle after performing the DDT fallback in order to reduce the risk of a crash when a given trip cannot or should not be completed.

NOTE: At level 4 and 5, the ADS is capable of automatically achieving a minimal risk condition when necessary (i.e., due to ODD exit, if applicable, or due to a DDT performance-relevant system failure in the ADS or vehicle). The characteristics of automated achievement of a minimal risk condition at level 4 and 5 will vary according to the type and extent of the system failure, the ODD (if any) for the ADS feature in question, and the particular operating conditions when the system failure or ODD exit occurs. It may entail automatically bringing the vehicle to a stop within its current travel path, or it may entail a more extensive maneuver designed to remove the vehicle from an active lane of traffic and/or to automatically return the vehicle to a dispatching facility.

MISUSE: Improper use beyond, or not in keeping with, the intended purpose or the designed function [2].

NOTE: Misuse can result from an unintentional action, an intentional action based on a misunderstanding of the item's purpose, and/or misunderstanding of the situation.

PASSENGER (SAE J3016): A user in a vehicle who has no role in the operation of that vehicle.

PASSENGER-INITIATED EMERGENCY STOP (PES) [FEATURE]: An onboard vehicle system that allows passengers to send a command to the automated driving system (ADS) to bring an ADS-operated vehicle to a controlled stop in response to a passenger-determined emergency.

PASSENGER-INITIATED EMERGENCY CALL (PEC) [FEATURE]: An onboard vehicle system that allows passengers to send a communication from an automated driving system (ADS)-operated vehicle to fleet operations in response to a passenger-determined emergency.

TRIP (SAE J3016): The traversal of an entire travel pathway by a vehicle from the point of origin to a destination.

4. Trip Interruption Typology

Trip-interruptions can be grouped into those initiated by the ADS and those initiated by passengers, then subdivided into emergency and non-emergency interruptions ([Figure 1](#)).

ADS-initiated trip interruption. In SAE level 4 and 5 systems, the ADS will detect failure conditions (e.g., flat tire, sensor fault, electrical short), safety violations (e.g., opening door while in motion), or instances where the vehicle is no longer in its operational design domain (ODD). In these cases, the vehicle will implement safety protocols determined by the manufacturer, such as terminating the trip and bringing the vehicle to a minimal risk condition or executing a fail-operational protocol prior to stopping the vehicle. These protocols may vary from manufacturer to manufacturer and use case to use case.

Passenger-initiated non-emergency trip interruption (request). Non-emergency trip interruptions may be initiated by passengers. These cases may involve, but are not limited to, passenger requests for a new destination, stopping to pick up a friend walking on the sidewalk, or returning home to retrieve a forgotten item. This type of stop and the interfaces to initiate them are components of each service provider's rider experience and will likely vary by manufacturer and geography. They should be clearly distinguishable from emergency interfaces.

Passenger-initiated emergency trip interruption. This type of interruption is for emergency situations perceived by passengers on board the vehicle. Aside from the circumstances or result of a particular event, what distinguishes an emergency trip interruption from a non-emergency trip interruption is the passenger's perception of an urgent action required as a result of the event. If a passenger perceives an emergency occurring on-board an automated vehicle or in its immediate vicinity (witnessed from on-board the vehicle), time will be an important factor to the passenger. In cases where the passenger perceives the best outcome⁴ for an emergency is to come to a controlled stop, a PES function would be appropriate. Likewise, if the situation requires additional analysis or an emergency

⁴ An outcome that results in the highest probability for the most desirable results.

stop is not perceived to be required, a PEC function would enable passengers to reliably contact fleet operations for further assessment. While potential emergencies are not easily enumerated, if one is perceived by a passenger, they will expect one of two things to happen:

1. The vehicle comes to a controlled stop (PES), or
2. The vehicle delivers the passenger(s) to some location where assistance can be rendered to address the emergency (PEC)⁵.

Passenger-initiated emergency stop (PES). This feature is comprised of an onboard vehicle system that allows a passenger to send a command to bring the ADS-DV to a controlled stop as a result of the perceived emergency. Fleet operations may restart the vehicle once the stop maneuver has been completed.

Passenger-initiated emergency call (PEC). This feature allows passengers to contact fleet operations for support when needed during an emergency. Fleet operations can then take appropriate action (e.g., reroute or stop the vehicle).

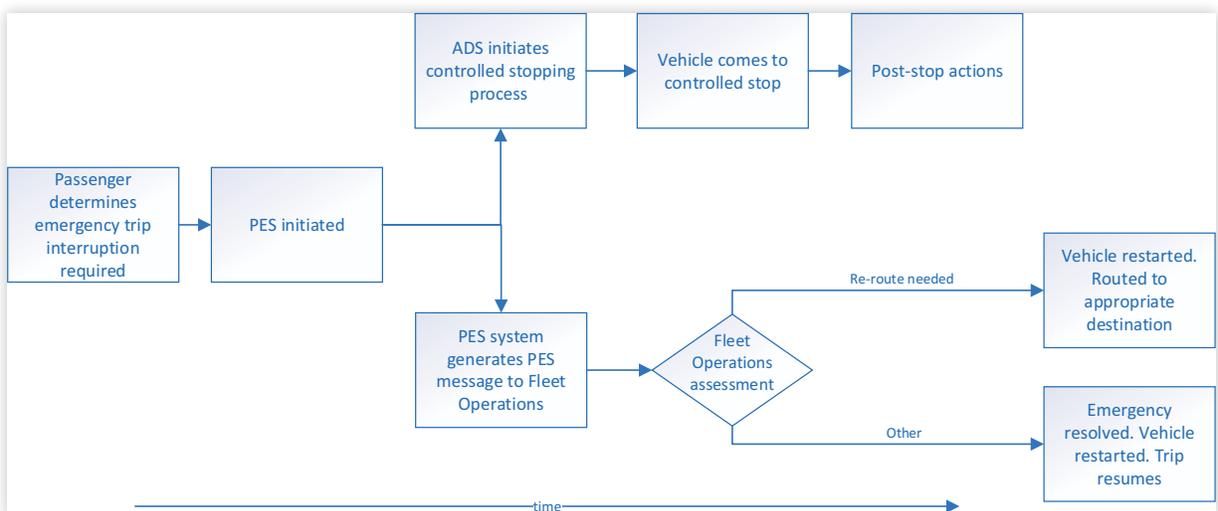
ADS-DVs should be equipped with a PES feature, a PEC feature, or both.

5. Unique Attributes and Considerations of PES and PEC

While both PES and PEC are passenger-initiated emergency trip interruptions, passengers may encounter a differing experience from each. More specifically, if initiated, a PES *will stop* the vehicle. If initiated, once the situation has been evaluated by fleet operations, a PEC *may stop* the vehicle or it *may reroute* the vehicle or result in some other action *without stopping the vehicle* such as cancelling the emergency call.

5.1 Passenger-Initiated Emergency Stop (PES)

FIGURE 2 Conceptual Processes for PES Function



A PES activation is a command from a passenger to an ADS-DV for it to come to a controlled stop in response to an emergency perceived by a passenger on board the vehicle (Figure 2). Because there is endless variation in the types of emergency events that may occur in a given ODD and an ADS cannot be expected to assess

⁵ This may or may not be the original trip destination.

non-system-related events and tailor a vehicle response specific to each of them, when used, **the PES should always bring the vehicle to a controlled stop.**

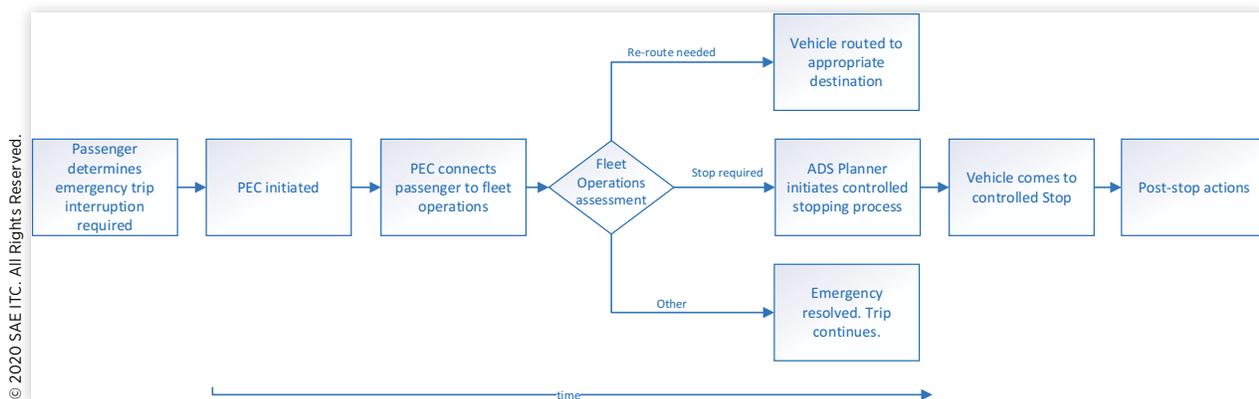
To minimize the risk of unintentional passenger initiation of the PES, the initial activation should be confirmed with a follow-on measure. The sequence, including the confirmatory measure, should be simple enough to be executed by passengers in stressful situations. The PES feature is considered fully initiated upon completion of the entire sequence. If the first step in the sequence is not followed in a reasonable amount of time by a confirmation or follow-on action, it may be advisable for the feature to reset itself to the initial default condition.

PES activation may result in the vehicle quickly coming to a controlled stop. This behavior could have undesirable secondary effects on other road users; therefore, measures should be put in place that discourage misuse and abuse of the PES feature. ADS manufacturers should take steps to educate passengers on the purpose and implications of initiating the PES feature and alternative options for trip interruption ([Section 6.2.4](#)). Education should help to minimize misuse of PES functionality as a substitute for non-emergency stop requests⁶.

When possible, passengers should be afforded a means of communicating directly with fleet operations through an embedded vehicle system when the PES feature is activated. The communication system should meet the requirements or needs of the user group (i.e., does not rely on personal communications devices). After the vehicle has stopped, fleet personnel may restart the vehicle and redirect it based on an assessment of the emergency situation.

5.2 Passenger-Initiated Emergency Call (PEC)

FIGURE 3 Conceptual Process for PEC Function



Passenger-initiated emergency call (PEC) is a vehicle-based communication from a passenger to fleet operations in response to an emergency perceived by a passenger on board the vehicle ([Figure 3](#)). Vehicle maneuvers following the initiation of a PEC feature depend on the situation assessment of the call taker; therefore, the second measure to confirm a passenger's initiation of this type of emergency trip interruption feature may be the call taker responding to the passenger's call.

Initial acknowledgment of the passenger's initiation of the PEC may be automated ([Section 6.3.1](#)), but passenger-initiated emergency calls must be connected to human call takers for assessment/diagnosis of the passenger's perceived emergency. ADS-DV emergency passenger interaction is a new topic for applied engineering with limited available operational data. Because of this, the number of fleet operations call takers may vary by manufacturer and use case and may not be a 1:1 ratio of call taker to ADS-DV. Additionally, appropriate response times are likely to vary by use case and ODD⁷. **Humans must be available to field PECs during all trips whenever passengers are on board the vehicle.**

⁶ ADS-DVs should include separate functionality for non-emergency stop requests which may be factored into the ADS longer-term (strategic) vehicle planning functions.

⁷ The National Emergency Number Association (NENA) recommends 90% of calls to 9-1-1 are answered by call takers within 10 seconds and 95% answered within 20 seconds.

Information must be available to fleet operations personnel (e.g., call takers or the humans responsible) in order to diagnose an emergency and to send commands to the ADS and directions to passengers. Responses to the PEC will be influenced by the ability of call takers to acquire and analyze information, select a course of action, and implement their decision [3]. Having situation awareness (SA) to do this consists of being able to perceive the environment, understand what the objects and state of the environment mean in the context of the passenger's call, and projecting options into a future state [4]. The appropriateness of call taker actions will require a combination of adequate SA, training and experience, and a common understanding of the desired outcomes between passengers and call takers⁸.

Methods used to provide information to PEC call takers will vary from manufacturer to manufacturer. Minimal information that should be made available includes:

- Vehicle location.
- Vehicle and ADS status.
- Visual and audio information from inside the vehicle cab.
- Perception data of the environment around the vehicle (e.g., other road users, ODD-related information).

Activation of the PEC function may result in a resolution by fleet operations without rerouting or stopping the vehicle in the event that fleet operations can resolve the emergency situation.

6. Common Attributes and Considerations of Passenger-Initiated Emergency Trip Interruption Features (PES and PEC)

The activation of an emergency trip interruption feature should elicit an immediate and predictable response.

The passenger-initiated emergency trip interruption interfaces in ADS-DVs should be easily recognizable, reasonably accessible, and always available [5]. Passenger-initiated emergency trip interruption (PES and PEC) features should have common traits (e.g., indicating use for emergencies only) but be clearly distinguishable from one another, if both are provided on the same vehicle. This will help let passengers know what to expect when the respective function is initiated. The design and placement of passenger-initiated emergency trip interruption feature interfaces should discourage unintended activation.

6.1 Situation Arbitration

ADS cannot be expected to assess non-system-related events and tailor vehicle responses specific to each situation. Once a passenger-initiated emergency trip interruption feature has been activated, the system will not question the veracity of the passenger's perception.

Fleet operators and manufacturers should take steps to educate passengers regarding the purpose and appropriate use of passenger-initiated emergency trip interruption features and other interfaces that may allow passenger interaction with the vehicle, fleet operations, or both.

6.2 Passenger Initiation

Near-term recommendations are provided in this section. As more is learned through implementation of passenger-initiated emergency trip interruption features in AV fleets, features and recommendations will evolve. Consistency both in interface design and the effects of initiating the features will help passengers calibrate their expectations and create norms around the usage of these features.

⁸ *Experience* is a contributing factor in the appropriateness of an action for a given situation [4].

6.2.1 Easily Recognizable

Passengers should be able to recognize the passenger-initiated trip interruption (PES or PEC) interface based on visual, tactile, or audio cues. Consistency should reduce passenger confusion and make the interface more recognizable. More research and experience are needed before a best practice recommendation can be made; however, visual cues may include the shape, size, location, and color of the interface itself (e.g., red octagon shape or inverted triangle).

6.2.2 Reasonably Accessible

“Reasonably accessible” means 95% of the mean distribution of expected adult passengers are able to actuate the passenger-initiated emergency trip interruption interface. In the United States, more than 25% of the population lives with some type of disability⁹ [6]. It should be noted that fleet-operated ADS-DVs are expected to provide mobility to a wide range of passengers, eventually including those unable to obtain a driver’s license such as children, persons with disabilities, and the elderly¹⁰. The precepts of universal design should apply. Manufacturers and fleet operators should consider the potential user population with respect to age, gender, size, and cognitive ability as well as the ability to see, hear, and manipulate objects [7].

Seating configuration and associated passive safety (restraint) systems in the ADS-DVs of the future are still unknown and may vary according to ODD, use case, and manufacturer. Manufacturers should assume passengers are safely positioned or secured within the vehicle when considering accessibility of passenger-initiated emergency trip interruption interfaces. Control device or interface design considerations may include actuation by touch (e.g., press, pull), sound (e.g., voice), movement (e.g., gesture), or some combination of these.

6.2.3 Always Available

Passenger-initiated emergency trip interruption features should be active during all trips whenever passengers are on board.

6.2.4 Considerations for Mitigating Potential Misuse and Abuse

Passenger-initiated emergency trip interruption features are for emergency purposes only. Educational messages should reinforce this point and potential consequences associated with initiating the feature. This information should also be available to passengers in greater detail (e.g., in the terms of service or other user agreements). Information about the passenger-initiated trip interruption features and alternative means of trip interruption will help establish passenger expectations and develop social norms that discourage improper use of the feature(s).

In the near-term, fleet-operated deployments of SAE level 4 and 5 vehicles providing Mobility as a Service (MaaS) should be equipped with instructions for initiating passenger-initiated emergency trip interruption features as part of general passenger safety information. Aspects associated with passenger-initiated emergency trip interruption features may include when to use the feature, what will happen once initiated, and instructions following initiation. Some examples of key educational messages associated with passenger education include (but are not limited to):

- For emergency use only.
- Activation of the PES may terminate the ride.
- Fleet operations will be contacted to provide additional assistance (e.g., contact emergency services, if appropriate).
- For passenger safety, video and audio monitoring may take place.
- Instructions for initiating and completing the passenger-initiated emergency trip interruption feature.
- Information about potential ADS actions upon initiation of a passenger-initiated emergency trip interruption (such as potentially bringing the vehicle to a controlled stop).
- Passenger instructions following initiation of a passenger-initiated emergency trip interruption, which may be situationally dependent.
- Potential repercussions for misuse or abuse of the passenger-initiated emergency trip interruption feature.

⁹ The CDC considers disabilities in six broad categories: (1) cognitive (serious difficulty concentrating, remembering or making decisions), (2) hearing (serious difficulty hearing or deafness), (3) mobility (serious difficulty walking or climbing stairs), (4) vision (serious difficulty seeing or blindness), (5) self-care (difficulty dressing or bathing), and (6) independent living (difficulty doing errands alone). [<https://www.cdc.gov/ncbddd/disabilityandhealth/dhds/overview.html>; accessed 11 April 2020]

¹⁰ The Americans with Disabilities Act specifications for transportation vehicles subpart b provides requirements for stop requests for buses, vans, and systems and is a good starting point for considering accessibility in passenger-initiated emergency interfaces with fleet-managed SAE level 4 and 5 ADS-DVs.

Considerations to minimize the abuse of passenger-initiated emergency trip interruption features may include levying some type of penalty for the willful misuse of the system. Recommendations for legal penalties, criminal or civil, or both, are outside the scope of this document. Over time, social norms akin to the activation of elevator alarms may develop for passenger-initiated emergency trip interruption features and may help to disincentivize abuse.

6.3 On-Board Communications and Human-Machine Interface

6.3.1 Acknowledgement (of Function Initiation)

Upon completion of an initiation sequence for a passenger-initiated trip interruption (PES or PEC), passengers should be provided an immediate audible acknowledgement that the emergency command was received by the ADS. Manufacturers should engage at least one other aspect of the human sensory system to acknowledge the passenger's initiation of the emergency trip interruption. Combinations of internal cabin lighting, audio cues, visual displays, slowing the vehicle, and other kinesthetic cues can be used to communicate and confirm passenger initiation of the emergency system.

For the PEC, acknowledgement that the emergency call was connected may come in the form of a fleet operation response to the call. The PEC interface may also communicate status of the connection until the call is received by fleet operations.

6.3.2 Enhanced Diagnosis and Interior Illumination

Fleet operators should maximize fleet operations' ability to assess relevant factors and assist with an emergency any time a passenger-initiated emergency trip interruption is initiated.

- The interior of the cabin should be illuminated.
- If controllable, reduce ambient sound.

Minimizing environmental noise in the vehicle cabin (e.g., reduce volume of entertainment media or music playing, close vents to reduce wind noise) can assist fleet operations in determining the nature of the emergency, facilitate voice communications with passengers, and enable a quicker assessment of the situation. In addition to assisting with enhanced diagnosis on the part of fleet operations, turning on interior lights and reducing the volume of radio/audio entertainment may facilitate communications among passengers and help communicate to other road users that an emergency is underway ([Section 6.3.1](#)).

6.4 Emergency Communication Outside the Vehicle

When a passenger initiates an emergency trip interruption, the following two general types of external communication should occur in order to enhance the safety and security of the passengers and other road users.

6.4.1 Communications with Other Road Users

Other road users should be alerted that an emergency maneuver may be taking place. If permitted by the presiding vehicle code and regulations, triggering vehicle hazard lights while the vehicle is coming to a stop is an example of something the ADS may do to communicate with other road users. Additionally, information should be available to first responders (e.g., access instructions) attending the emergency.

NOTE: Communications with emergency response personnel is the subject of a future AVSC Best Practice and is outside the scope of this document.

NOTE: Communication with other road users may differ between PES and PEC. The PES may result in signaling the vehicle *will stop* whereas the vehicle may not stop at all following activation of the PEC. Following an enhanced diagnosis from fleet operations, the vehicle may not behave differently at all from the perspective of other road users, if the perceived emergency were resolved (e.g., a passenger had an anxiety attack and was successfully calmed thus resolving the emergency¹¹) or if the vehicle was rerouted to address the emergency situation.

¹¹ This example is provided to illustrate a case where ADS-DV behavior may not be perceptibly different from "normal [ADS] driving." It is not meant to imply that fleet operations is responsible for providing emergency services.

6.4.2 Communication to Fleet Operations

Fleet operations should always be contacted when any passenger-initiated emergency trip interruption feature has been initiated. After remotely assessing the situation on board the vehicle, fleet operations may contact or follow-up with first responder emergency personnel for assistance or to coordinate actions. In the case of the PES or if a PEC results in a stop, fleet operations may restart the vehicle and reroute it to an appropriate emergency destination (e.g., emergency room).

NOTE: Contacting fleet operations does not preclude the vehicle or ADS from automatically contacting first responder emergency personnel directly (e.g., 9-1-1, 1-1-9, or 1-1-2). These actions may vary by manufacturer.

6.5 Post-Stop Actions

Post-stop recommendations apply to the PES and *if* the PEC results in a stop. Once the ADS has brought the vehicle to a controlled stop, the potential for safe conduct and actions by the passenger(s) should be maximized and encouraged. Specific post-stop actions of the ADS-DV depend on the situation and the ODD; however, the following general actions can be taken upon a vehicle stop as a result of a passenger-initiated emergency trip interruption:

- Passengers and fleet operations should be alerted that the emergency stop maneuver has been completed.
- The vehicle should not automatically restart or resume driving until authorized by fleet operations personnel. The ride may be terminated completely.

NOTE: Passengers and potential passengers should be educated about their inability to restart the vehicle once the PES initiation process has been completed. Likewise, once the initiation process has been completed, it cannot be aborted or undone by a passenger. The vehicle will come to a controlled stop. Educating passengers on this point can help establish expectations and norms around the use of the PES feature.

- If hazard lights were not initiated earlier in the process, they may be triggered now. If already triggered, hazard lights should continue flashing during the post-stop phase until the emergency has been resolved or the vehicle no longer warrants special attention.
- If the state of the vehicle safely permits, power should remain to allow passengers and/or fleet operations to control HVAC, communications, and door locks/opening.
- Because passenger awareness of their surroundings may be limited, passengers should be reminded to observe their surroundings and to be aware of potential hazards in the environment prior to exiting the vehicle or to remain on-board and wait for emergency personnel.

7. Summary

All ADS-DVs should be equipped with a PES function, a PEC function, or both. While SAE level 4 and 5 ADS-DVs are capable of accommodating hazards within their ODD and capable of handling vehicle or ADS faults, passengers on board those vehicles may perceive other situations that warrant an emergency interruption of their trip. Interfaces for passenger-initiated emergency trip interruption features should be distinct from other options for non-emergency trip interruptions. When a PES feature is initiated, passengers need to expect that the vehicle *will come to a controlled stop* regardless of the manufacturer of the ADS-DV. When a PEC feature is initiated, fleet operations personnel *assess the situation and determine* whether to stop the vehicle, reroute the vehicle, or continue the trip.

Passenger trips in ADS-DVs are still relatively few, so much remains to be learned about how passengers will interact in commercial settings. This document provides general recommendations for developers and fleet operators and insight into the system requirements which should encourage public trust and confidence in automated vehicles.

8. About Automated Vehicle Safety Consortium™

The objective of the Automated Vehicle Safety Consortium™ is to provide a safety framework around which automated vehicle technology can responsibly evolve in advance of the broad use of commercialized vehicles. The consortium will leverage the expertise of its current and future members and engage government and industry groups to establish safety principles and best practices. These technology-neutral principles are key considerations for deploying SAE level 4 and level 5 automated vehicles on public roads.

AVSC Vision:

Public acceptance of SAE level 4 and level 5 automated driving systems as a safe and beneficial component of transportation through industry consensus.

AVSC Mission:

The mission of the Automated Vehicle Safety Consortium™ (AVSC) is to quickly establish safety principles, common terminology, and best safety practices, leading to standards to engender public confidence in the safe operation of SAE level 4 and level 5 light-duty passenger and cargo on-road vehicles ahead of their widespread deployment.

The AVSC will:

- Develop and prioritize a roadmap of pre-competitive topics;
- Establish working groups to address each of the topics;
- Engage the expertise of external stakeholders;
- Share output/information with the global community;
- Initially focus on fleet service applications.

9. Contact Information

To learn more about the Automated Vehicle Safety Consortium™, please visit <https://avsc.sae-itc.org>.

Contact: AVSCinfo@sae-itc.org

10. Acknowledgements

The Automated Vehicle Safety Consortium™ would like to acknowledge the contributions of the member organizations during the development of this document:

Daimler, Ford, General Motors, Honda, Lyft, Toyota, Uber ATG, and VW.

11. Abbreviations

ADS - Automated Driving System

ADS-DV - Automated Driving System-Dedicated Vehicles

AVSC - Automated Vehicle Safety Consortium™

DDT - Dynamic Driving Task

MaaS - Mobility as a Service

MRC - Minimal Risk Condition

ODD - Operational Design Domain

PEC - Passenger-Initiated Emergency Call

PES - Passenger-Initiated Emergency Stop

SA - Situation Awareness

SAE ITC® - SAE Industry Technologies Consortia

Appendix A. Best Practice Quick Look

Passenger-Initiated Emergency Trip Interruption

Trip Interruption Typology (4.0). Trip interruptions can be described by those initiated by the ADS or those initiated by passengers; of passenger-initiated interruptions there are emergency and non-emergency interruptions to the trip ([Figure 1](#)). **ADS-DVs should be equipped with a PES function, a PEC function, or both.**

- **Passenger-Initiated Emergency Stop (PES) (5.1).** A passenger's command to bring an ADS-DV to a controlled stop in response to the passenger's perceived emergency on board or in the vicinity of the vehicle. The PES function should **always bring the vehicle to a controlled stop**.
- **Passenger-Initiated Emergency Call (PEC) (5.2).** Vehicle-based communication from a passenger to fleet operations in response to the passenger's perceived emergency on board or in the vicinity of the vehicle. Humans must be available to field PECs during all trips whenever passengers are on board the vehicle. The PEC **may stop** the vehicle, or it **may reroute** the vehicle or result in some **other action without stopping** the vehicle such as cancelling the emergency call. Minimal available information available to PEC call takers:
 - Vehicle location
 - Visual and audio information from inside the vehicle cabin
 - Vehicle and ADS status
 - Perception data of the environment around the vehicle

Common Attributes and Considerations for PES and PEC (6.0). Passenger-initiated emergency trip interruption interfaces should be **easily recognizable, reasonably accessible, and always available**. They should be easily identifiable but clearly distinguishable from one another. The **activation of an emergency trip interruption feature should elicit an immediate and predictable response**.

- **Situation Arbitration (6.1).** Features should be designed with the assumption that emergency is taking place (i.e., the ADS or feature is not making that determination).
- **Easily Recognizable (6.2.1).** Passengers should be able to recognize the PES or PEC interface based on visual, tactile, or audio cues.
- **Reasonably Accessible (6.2.2).** Ninety-five percent (95%) of the mean distribution of expected adult passengers should be able to actuate the passenger-initiated emergency trip interruption interface.
- **Always Available (6.2.3).** PES and PEC should be active during all passenger trips.
- **Considerations for Mitigating Potential Misuse and Abuse (6.2.4).** Educational messages should reinforce the fact that passenger-initiated emergency trip interruption features are for emergency purposes only.
- **Acknowledgement (of Function Initiation) (6.3.1).** Passengers should be provided an immediate audible acknowledgement that the emergency command was received and at least one other aspect of the human sensory system to acknowledge the initiation of the emergency trip interruption.
- **Enhanced Diagnosis and Interior Illumination (6.3.2).** The interior of the cabin should be illuminated and controllable ambient sound should be reduced once PEC or PES is initiated.
- **Emergency Communication Outside the Vehicle (6.4).** Other road users should be alerted that an emergency maneuver may be taking place and fleet operations should always be contacted (for both PES and PEC features).
- **Post-Stop Actions (6.5).** Post-stop actions apply to PES and PEC if the PEC results in a stop. Passengers and fleet operations should be alerted once the stop maneuver has been completed; the vehicle should not restart or resume driving until authorized by fleet operations personnel; and passengers should be reminded to observe their surroundings and be aware of potential hazards in the environment.