Stakeholder Meeting: FMVSS Considerations for Automated Driving Systems

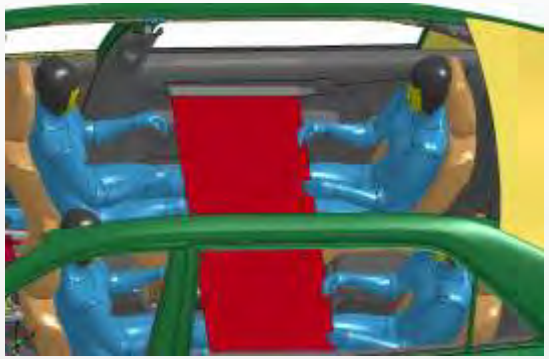
200-Series Breakout Sessions

200-Series Breakout Session Focus

		Phase 1.1						Phase 1.2								
Panel	**Themes**	**201**	**202a**	**203**	**204**	**205**	**206**	**207**	**208**	**210**	**214**	**216a**	**219**	**222**	**225**	**226**
1	Driver (Operator)	X	X	X		X	X	X	X		X	X		X	X	X
	Driver/Passenger Seating Position(s)	X	X				X	X	X		X	X		X	X	X
	Equipment to Be Tested May Not Be Present			X	X											
2	Telltales						X		X							X
3	Assumes Front Row Is Preferred Seating Position	X	X	X	X		X		X		X					
4	Front/Rear of Vehicle (“Forward” and “Forward-Facing” References)	X	X				X	X	X		X	X	X	X	X	X
	Dummy Positioning	X	X						X		X					

Conventional vs. Unconventional Seating

Phase 1:
Conventional Seating



Phase 2:
Unconventional Seating

Panel 1
Driver References

FMVSS 208 Translation Discussion

200-Series Breakout Session Focus

		Phase 1.1						Phase 1.2								
Panel	**Themes**	**201**	**202a**	**203**	**204**	**205**	**206**	**207**	**208**	**210**	**214**	**216a**	**219**	**222**	**225**	**226**
1	Driver (Operator)	**X**	**X**	X		X	X	X	**X**		X	X		X	X	X
	Driver/Passenger Seating Position(s)	X	X				X	X	X		X	X		X	X	X
	Equipment to Be Tested May Not Be Present			X	X											
2	Telltales						X		X							X
3	Assumes Front Row Is Preferred Seating Position	X	X	X	X		X		X		X					
4	Front/Rear of Vehicle (“Forward” and “Forward-Facing” References)	X	X				X	X	X		X	X	X	X	X	X
	Dummy Positioning	X	X						X		X					

Supporting Definitions

Panel 1

Candidate Driver Definition (Part 571.3)

Option	Translation	Considerations/Challenges
Current Text	*Driver means the occupant of a motor vehicle seated immediately behind the steering control system.*	
Option 1	*Driver means:* *1. the occupant of a motor vehicle seated in the driver's designated seating position (human driver), or* *2. the ADS (ADS driver), for ADS-equipped vehicles when the ADS is operational. When the ADS is not operational, the definition in paragraph (1) applies.*	*Approach: "Driver" would be used when referring to both human driver and ADS and "human driver" when only (1) applies and "ADS driver" when only (2) applies.*
Option 2	*Driver means the occupant of a motor vehicle seated immediately behind the steering control system.*	*Approach: "Driver" would be used when referring to human driver. "ADS" would be used when referring to the ADS controlling the driving task.*

Candidate Driver Definition (Part 571.3)

Automated Driving System (ADS) Translation Add (as defined in SAE J3016 Sept 2016):

ADS means 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.

Candidate Driver Seating Position Definition (Part 571.3)

Option	Translation
Current 571.3	*Current Designated Seating Position definitions provide method for calculating the number of seating positions based on the width of the seat.*
Option 1	*Driver's Designated Seating Position (driver's seat) means a designated seating position immediately behind the manual driving controls positioned at which a human driver can operate one or more manual driving controls, regardless of whether he or she is in active control of the vehicle. (Set 1)*
Option 2	*Driver's (designated) seating position (driver's seat) means a designated seating position providing immediate access to manual-operated driving controls. (Set 2)*

Candidate Passenger Seating Definition (Part 571.3)

Passenger's Seating Position Translation Add (Passenger's Seat)

Passenger's Seating Position (passenger's seat) means any designated seating position other than the driver's designated seating position.

Candidate Manual Driving Control Definition (Part 571.3)

Option 1 (Set 1):

Manual-operated driving control means the system used by a human driver to manually operate the motor vehicle's lateral (steering) and/or longitudinal (acceleration and deceleration) motion in real-time.

Option 2 (Set 2):

Manual-operated driving controls means: (a) the system used by a human driver for real-time, sustained, manual manipulation of the motor vehicle's heading (steering) and/or speed (accelerator and brake); (b) positioned such that they can be used by the human driver; (c) regardless of whether the driving controls are active.

Panel 3

Driver Reference

FMVSS 208 Occupant Crash Protection

208 Driver References Example

FMVSS 208 : Scope (S1) and Purpose (S2)

Scope: The purpose of this standard is to reduce the number of deaths of vehicle occupants, and the severity of injuries, by specifying vehicle crashworthiness requirements in terms of forces and accelerations measured on anthropomorphic dummies in test crashes, and by specifying equipment requirements for active and passive restraint systems.

Purpose: This standard specifies performance requirements for the protection of vehicle occupants in crashes.

Candidate 208 Definitions Simplify Translation

Example: Reference to a Driver or the Driver Position

208 S25: Requirements using an out-of-position 5th percentile adult female dummy at the driver position

Translation Options			
Option	Translation	Considerations	Challenges
1	Requirements using an out-of-position 5th percentile adult female dummy at the **Designated Seating Position for a Human Driver Using Manual Controls**	No further translation necessary in this section for vehicles with manual controls	New section may be needed for vehicles without manual steering controls (though seating for left front passenger will likely be the same as for the right front passenger, so could just direct to already written right front passenger section)
2	Requirements using an out-of-position 5th percentile adult female dummy at the **Left Front Outboard** Position	More encompassing and erases driver/passenger references	Does not address presence of manual steering controls so further translation of this section would be necessary
3 (new)	Requirements using an out-of-position 5th percentile adult female dummy at the driver position	No translation needed	

Candidate 208 Definitions Simplify Translation

FMVSS 208 S10.6 [Dummy Foot Positioning, Section Headings]

S10.6.1 Driver's Position; S10.6.2 Passenger's Position

Translation Options			
Option	Translation	Considerations	Challenges
1a	S10.6.1 DSP for a Human Driver Using Manual Controls	More encompassing; erases driver/passenger DSP references; considers absence/presence of manual steering controls (chief difference between driver/passenger DSPs); requires little to no further translation of text in the section bodies	
1b	S10.6.2 Front Passenger DSP for a Vehicle with Manual Driving Controls, or Front Left and Right Outboard DSP for a Vehicle Without Manual Driving Controls		
2a	S10.6.1 Front Left Outboard Position		Does not address presence of manual steering controls; requires further translation of the front left outboard sections
2b	Front Right Outboard Position		
3a (new)	S10.6.1 Driver dummy position	No need to reference manual controls. Only applies to driver DSP (if present).	
3b (new)	S10.6.2 Front outboard passenger dummy position	Encompasses both RFP as before plus LFP in an ADS-DV	

Panel 1
Equipment to be Tested may not be Present

FMVSS 203 and 204 Translation Discussion

Candidate Steering Control Definition (Part 571.3)

Driver's designated seating position supporting definitions:

Option 1 (Set 1):

"Steering control (wheel) means the manual-operated driving control positioned such that it can be used by the human driver to control the vehicle heading, regardless of whether they are in active control."

Option 2 (Set 2):

Steering control (e.g., wheel) means the manual-operated driving control used to control the vehicle heading.

Candidate Steering Control System Definition (Part 571.3)

Driver's designated seating position supporting definitions:

Current Text

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 mechanism control and its associated trim hardware, including any portion of a steering column assembly that provides energy absorption upon impact.

200-Series Breakout Session Focus

		Phase 1.1						Phase 1.2								
Panel	**Themes**	**201**	**202a**	**203**	**204**	**205**	**206**	**207**	**208**	**210**	**214**	**216a**	**219**	**222**	**225**	**226**
1	Driver (Operator)	X	X	X		X	X	X	X		X	X		X	X	X
	Driver/Passenger Seating Position(s)	X	X				X	X	X		X	X		X	X	X
	Equipment to Be Tested May Not Be Present			**X**	**X**											
2	Telltales						X		X							X
3	Assumes Front Row Is Preferred Seating Position	X	X	X	X		X		X		X					
4	Front/Rear of Vehicle (“Forward” and “Forward-Facing” References)	X	X				X	X	X		X	X	X	X	X	X
	Dummy Positioning	X	X						X		X					

203 Equipment Not Present Example

FMVSS 203 Purpose and Scope

Purpose and Scope (S1) - This standard specifies requirements for steering control systems that will minimize chest, neck, and facial injuries to the driver as a result of impact.

Translation Option – This standard specifies requirements for steering control systems that will minimize chest, neck, and facial injuries to the human driver as a result of impact.

Note: FMVSS 200-series does not require a steering control system.

204 Equipment Not Present Example

FMVSS 204 Purpose and Scope

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.

Candidate Steering Control Definition:

"Steering control (wheel) means the manual-operated driving control positioned such that it can be used by the human driver to control the vehicle heading, regardless of whether they are in active control."

<u>Translation: None needed as only applies to human drivers</u>

Thank You for Your Participation

200-Series Breakout Sessions

Stakeholder Meeting: FMVSS Considerations for Automated Driving Systems

FMVSS 206 and 208 Translation Discussion

200-Series Breakout Session Focus

		Phase 1.1						Phase 1.2								
Panel	**Themes**	**201**	**202a**	**203**	**204**	**205**	**206**	**207**	**208**	**210**	**214**	**216a**	**219**	**222**	**225**	**226**
1	Driver (Operator)	X	X	X		X	X	X	X		X	X		X	X	X
	Driver/Passenger Seating Position(s)	X	X				X	X	X		X	X		X	X	X
	Equipment to Be Tested May Not Be Present			X	X											
2	Telltales						X		X							X
3	Assumes Front Row Is Preferred Seating Position	X	X	X	X		X		X		X					
4	Front/Rear of Vehicle (“Forward” and “Forward-Facing” References)	X	X				X	X	X		X	X	X	X	X	X
	Dummy Positioning	X	X						X		X					

Panel 2

FMVSS 206 Telltales Example

Example: FMVSS 206 Telltale

FMVSS 206: Scope and Purpose

This standard specifies requirements for door locks and door retention components including latches, hinges, and other supporting means, to minimize the likelihood of occupants being thrown from the vehicle as a result of impact.

Crosscutting Theme: Telltales

- FMVSS 206 requires a door closure warning system for vehicle doors. The door closure warning system shall be located where it can be clearly seen by the driver.

- The current FMVSS does not specify how a door-not-latched warning should be communicated to an ADS, or what actions the ADS should take in this event.

Telltales: 206 Translation Example

Current Text:

S4.1.2.3 – 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. The door closure warning system shall be located where it can be clearly seen by the driver.

Telltales: 206 Translation Example

Option	Translation	Considerations / Challenges
Current Text	*The door closure warning system shall be located where it can be clearly seen by the driver.*	
Option 1	*"….clearly seen from the front left outboard designated seating position."*	No occupant may be seated at this DSP
Option 2	*"….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."*	Maintains the front seat bias of FMVSS
Option 3	*"…clearly seen from any designated seating position for vehicles not being operated by manual driving controls."*	Includes all occupants

Telltales: 206 Translation Considerations

- FMVSS 206 translations only warn vehicle occupant of unlatched doors.
- Is the implicit assumption that driver is responsible for latching the doors? What if there is no driver?
- Should ADS-DV be notified? If so, what actions should ADS-DV action take?
- How should telltales be communicated to the visually impaired?

Panel 2

Telltales

FMVSS 208 Occupant Crash Protection

208 Translation Example

FMVSS 208 Purpose and Scope

Purpose: This standard specifies performance requirements for the protection of vehicle occupants in crashes.

Scope: The purpose of this standard is to reduce the number of deaths of vehicle occupants, and the severity of injuries, by specifying vehicle crashworthiness requirements in terms of forces and accelerations measured on anthropomorphic dummies in test crashes, and by specifying equipment requirements for active and passive restraint systems.

208 Translation Example

Crosscutting Theme: Telltales

S7.3 (a) A seat belt assembly provided at the driver's seating position shall be equipped with a warning system that …. activates a continuous or intermittent audible signal for a period of not less than 4 seconds and not more than 8 seconds and that activates a continuous or flashing warning light visible to the driver displaying the identifying symbol for the seat belt telltale …"

Example of 208 Telltale Translation:
What should trigger the warning?

Option	Translation	Considerations / Challenges
Current Text	*"A seat belt assembly provided at the driver's seating position shall be equipped with a warning system …"*	
Option 1	*"A seat belt assembly provided at the left front outboard position shall be equipped with a warning system…"*	No occupant may be seated at this DSP
Option 2	*"A seat belt assembly provided at the driver's seating position or any designated seating position, if no driver's seating position is occupied or present, shall be equipped…"*	Includes all occupants

Example of 208 Telltale Translation: Who should be warned?

Option	Translation	Considerations / Challenges
Current Text	*"…activates a continuous or flashing warning light visible to the driver displaying the identifying symbol for the seat belt telltale …"*	
Option 1	*"…activates a continuous or flashing warning light visible to the left front outboard seat displaying the identifying symbol for the seat belt telltale …"*	*No occupant may be seated at this DSP*
Option 2	*"…activates a continuous or flashing warning light visible to the occupant of the driver's seating position or any occupant of a designated seating position, if no driver's seating position is occupied or present, displaying the identifying symbol for the seat belt telltale …"*	*Warn all occupants*

208 Telltales Translation Considerations

- FMVSS 208 only warns human driver if unbuckled.
- FMVSS 208 also warns human driver if air bag fault detected.
- What if there is no driver? Should other occupants be warned?
- Should ADS-DV be notified? If so, what action should ADS-DV action take?
- How should telltales be communicated to persons with a visual or hearing impairment?

Thank You for Your Participation

200-Series Breakout Sessions

Stakeholder Meeting: FMVSS Considerations for Automated Driving Systems

FMVSS 201 and 208 Translation Discussion

200-Series Breakout Session Focus

		Phase 1.1						Phase 1.2							
Panel	**Themes**	**201**	**202a**	**203**	**204**	**205**	**206**	**207**	**208**	**210**	**214**	**216a**	**219**	**222**	**225**	**226**
1	Driver (Operator)	X	X	X		X	X	X	X		X	X		X	X	X
	Driver/Passenger Seating Position(s)	X	X				X	X	X		X	X		X	X	X
	Equipment to Be Tested May Not Be Present			X	X											
2	Telltales						X		X							X
3	Assumes Front Row Is Preferred Seating Position	X	X	X	X		X		X		X				X	
4	Front/Rear of Vehicle (“Forward” and “Forward-Facing” References)	X	X				X	X	X		X	X	X	X	X	X
	Dummy Positioning	X	X						X		X					

Front Seat Bias Background

- Several 200-series crash tests assess occupant protection for the front seat occupants only.
- All telltales present information to the human driver.
- Current vehicles – All current vehicles have a front seat driver. Few occupants sit in the rear seat.
- ADS-DV – If there is not a driving seating position, where will occupants sit? Will they expect equal protection?

Panel 3

FMVSS 201
Front Seat Bias
Example

Example: FMVSS 201 Front Seat Bias

FMVSS 201, S1: Purpose and Scope

This standard specifies requirements to afford impact protection for occupants.

Crosscutting Theme: Front Seat Bias

- FMVSS 201 describes a dynamic vehicle-to-pole test. ATDs are only positioned at the front outboard seating position of the struck side.

201 Vehicle-to-Pole Test Example

Current Text:

S8.28 – The part 572, subpart M, test dummy is initially positioned in the front outboard seating position on the struck side of the vehicle in accordance with the provisions of S12.1 of Standard 214 (49 CFR 571.214), and the vehicle seat is positioned as specified in S8.3.2.1 and S8.3.2.2 of that standard.

Panel 3

Front Seat Bias

FMVSS 208 Occupant Crash Protection

208 Frontal Barrier Crash Test Example

FMVSS 208: Scope (S1) and Purpose (S2)

Scope: The purpose of this standard is to reduce the number of deaths of vehicle occupants, and the severity of injuries, by specifying vehicle crashworthiness requirements in terms of forces and accelerations measured on anthropomorphic dummies in test crashes, and by specifying equipment requirements for active and passive restraint systems.

Purpose: This standard specifies performance requirements for the protection of vehicle occupants in crashes.

208 Frontal Barrier Crash Test Example

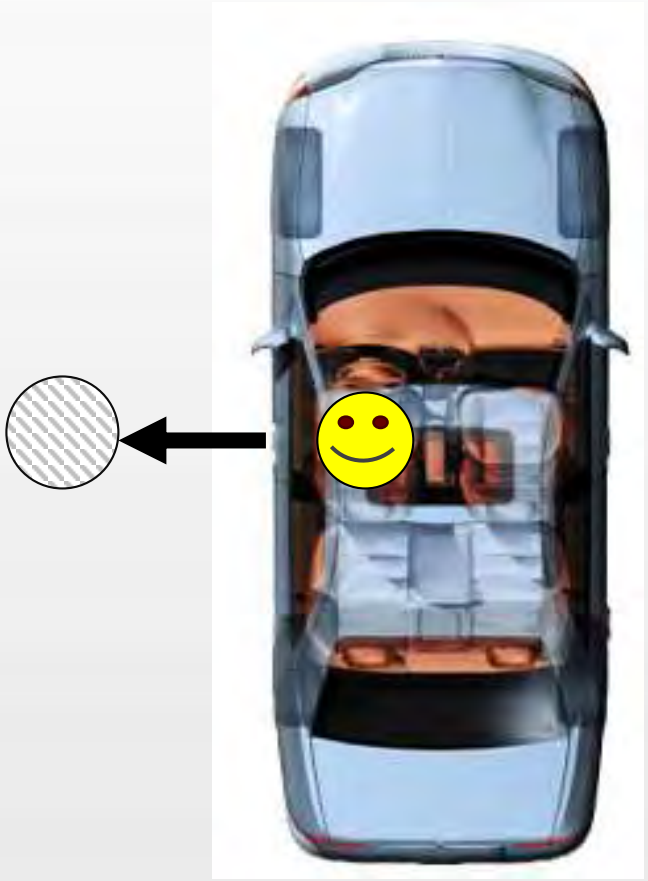
Crosscutting Theme: Front Seat Bias

S5.1.1b.2 (Frontal Barrier Belted Crash Test) "Impact a vehicle traveling longitudinally forward at any speed, up to and including 56 km/h (35 mph), into a fixed rigid barrier that is perpendicular to the line of travel of the vehicle under the applicable conditions of S8 and S10. The test dummy specified in S8.1.8 placed in each front outboard designated seating position shall meet the injury criteria of S6.1, S6.2(b), S6.3, S6.4(b), S6.5, and S6.6 of this standard."

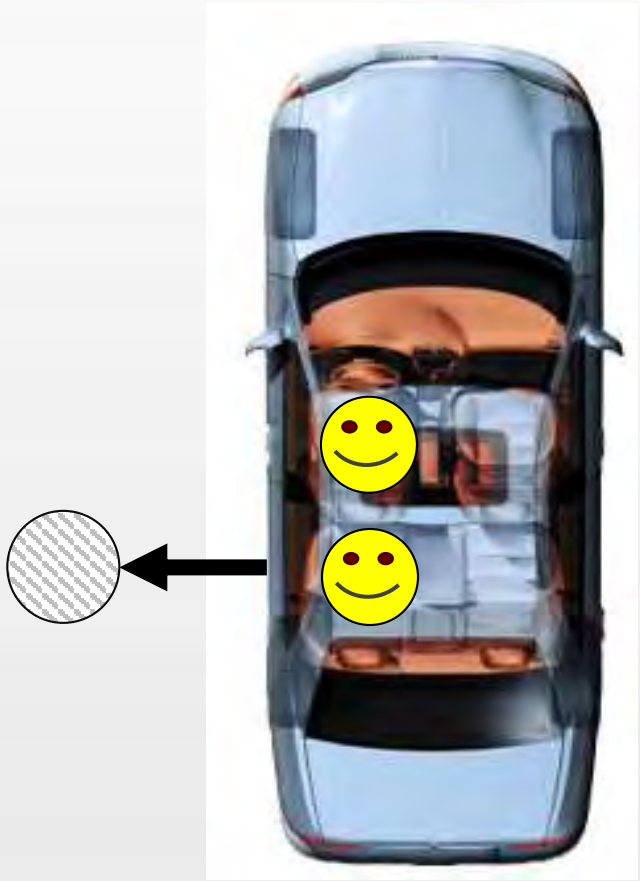
FMVSS Translation Options

- Issue: FMVSS are biased toward tests of the front seat occupants.
- Translation Options:
  - FMVSS 208: Frontal Rigid Barrier test of rear seat occupants using front seat procedures
  - FMVSS 201: Pole test of rear seat occupants using FMVSS 201 pole test
  - FMVSS 214: Pole test of rear seat occupants using FMVSS 214 pole test

FMVSS 201 Vehicle-Pole Test



FMVSS 201
(Current Test)



FMVSS 201
(Additional Test)

- Impact front outboard seating positions (left or right)
- In ADS-DV, preferred seating position may not be front seats.
- Test Procedure dummy alignment assumes forward facing seats

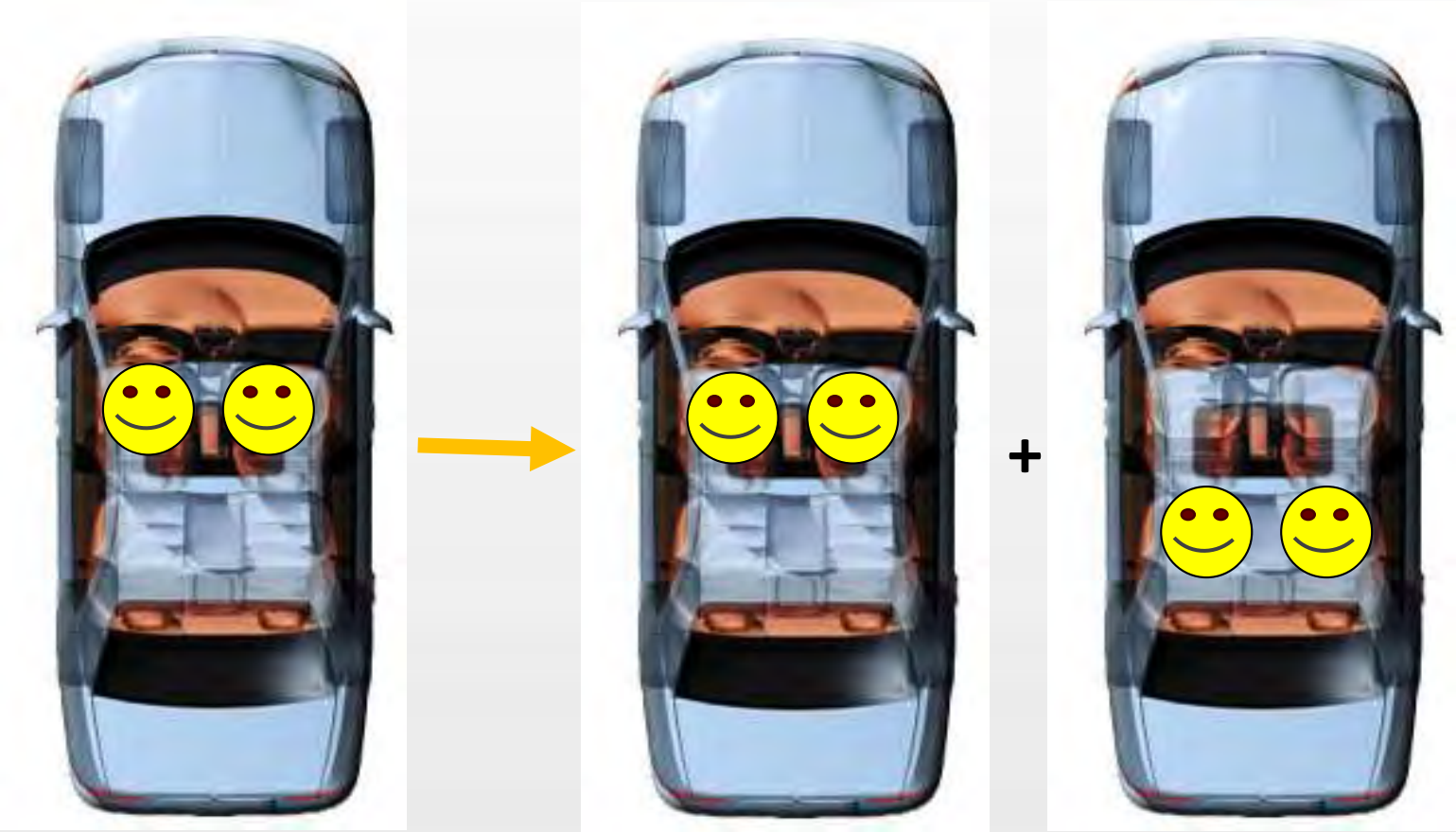
FMVSS 208 Frontal Crash Test – Option 1

FMVSS 208
(current)

FMVSS 208
(Option 1)

- Tests front outboard seating positions
- In ADS-DV, preferred seating position may not be front seats.
- Test-procedure dummy alignment assumes forward-facing seats.

FMVSS 208 Frontal Crash Test – Option 2



FMVSS 208
(current)

FMVSS 208
(Additional Test - Option 2)

- Tests front outboard seating positions
- In ADS-DV, preferred seating position may not be front seats.
- Test-procedure dummy alignment assumes forward-facing seats.

Thank You for Your Participation

200-Series Breakout Sessions

Stakeholder Meeting: FMVSS Considerations for Automated Driving Systems

FMVSS 208 Translation Discussion

200-Series Breakout Session Focus

		Phase 1.1						Phase 1.2							
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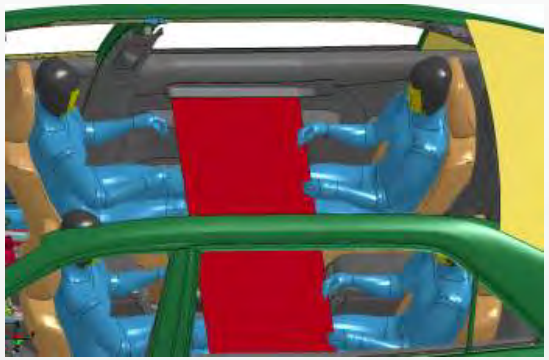
1	Driver (Operator)	X	X	X		X	X	X	X		X	X		X	X	X
	Driver/Passenger Seating Position(s)	X	X				X	X	X		X	X		X	X	X
	Equipment to Be Tested May Not Be Present			X	X											
2	Telltales						X		X							X
3	Assumes Front Row Is Preferred Seating Position	X	X	X	X		X		X		X					
4	Front/Rear of Vehicle (“Forward” and “Forward-Facing” References)	X	X				X	X	✘		X	X	X	X	X	X
	Dummy Positioning	X	X						✘		X					

Forward vs. Rear-facing Seating

Phase 1:
Conventional Seating



Phase 2:
Unconventional Seating

Overview

- **Theme**: Front/Rear of the Vehicle

- **Challenge**: Front and rear of the vehicle is assumed in the standards. Bi-directional vehicles no longer have a traditional front and rear. Occupants will need to be protected regardless of seating direction.

- **Options:**
  1. Define front and rear of vehicle in the context of travel direction
  2. Define bi-directional functionality and clarify requirements in both directions

Proposed Front/Rear Definition (Part 571.3)

Option	Translation	Considerations/Challenges
Option 1	*Front of the vehicle* is defined as the face of the vehicle located in the primary direction of travel and the typical direction of traffic flow for the roadway. *Rear of the vehicle* is defined as the face of the vehicle located opposite the primary direction of travel and the typical direction of traffic flow for the roadway.	The difficulty in the definition of when a vehicle is backing up versus when it direction is reversing.
Option 2	*Bi-directional operation* is an ADS which operates with equal speed and heading control in two or more directions.	Simplifies translations. For Bi-directional vehicles, FMVSS must be met in all directions of travel.

200-Series Breakout Session

Panel 4
Dummy Positioning References

FMVSS 208 Translation Discussion

Example: FMVSS 208 Dummy Positioning

Dummy Positioning References Equipment that may be Nonexistent

FMVSS 208 S10.3 Hands

The palms of the driver test dummy shall be in contact with the outer part of the steering wheel rim at the rim's horizontal centerline. The thumbs shall be over the steering wheel rim and shall be lightly taped to the steering wheel rim so that if the hand of the test dummy is pushed upward by a force of not less than 2 pounds and not more than 5 pounds, the tape shall release the hand from the steering wheel rim.

Translation Options

Option	Translation	Considerations	Challenges
1	Add the phrase "**If manual steering controls are present**, the palms of the front right test dummy..."	covers vehicles with manual steering controls	excludes AVs without manual steering controls; they would still need to be addressed w/ further translation
2	apply front passenger positioning procedures to all front seat occupants in vehicles w/o manual steering controls	can maintain most, if not all, current positioning language	no existing positioning procedures for rear-facing seats (not an immediate issue, but will become paramount in subsequent Phases)

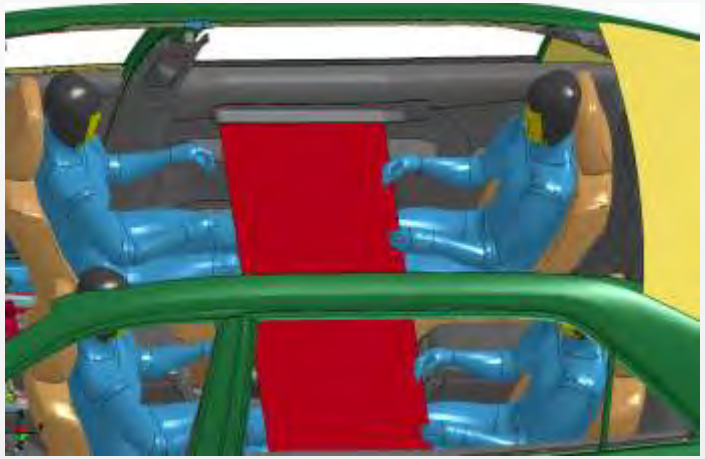
Dummy Positioning in Unconventional Seating Arrangements

- No existing positioning procedures for rear-facing seats.
- Possibly adapt FMVSS 214 rear seating procedure.
- Existing landmarks, e.g., A-pillar for front seat occupants, may no longer be relevant.
- Phase 2 research topic.

Panel 4

Looking Ahead Phase 2: Forward/Rear References

Features of Unconventional Seating



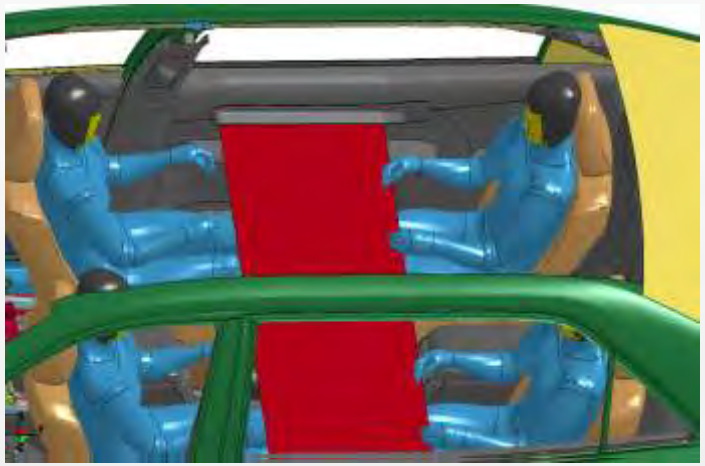
ADS-DV Configuration

- Unconventional seats (rear facing + rotating)
- Maximize occupant compartment space ("car as a living room")

ADS-DV Crash Countermeasures

- Stiff structure (to avoid intrusion)
- Stiff Crash Pulse (75G vs. 40G)
- Seats with integral seat belts (to allow rotation)

Challenges for Unconventional Seating



- Issue: Need to protect occupants in posterior-anterior (PA) loading (rear-facing occupants in frontal crash)
- Limited data on injury mechanisms in high-severity PA loading
- Unknown if current dummies are suitable for severe posterior-anterior loading
- Limited knowledge of injury criteria to measure occupant injury risk

Crash Testing Considerations

Impact Direction

Impact Direction

- Issue: Need to protect occupants in posterior-anterior (PA) loading (rear-facing occupants in frontal crash)
- Option 1: Multiple crash tests
  - Front
  - Rear
  - Tests with seats oriented across range of rotation
- Option 2: Simulation validated by crash tests

Thank You for Your Participation

200-Series Breakout Sessions