

AEBS-HDV-06 industry prep

AEBS-HDV-06

September 21-22, 2021

Support for discussion

1. Paragraph 5.2.1.4 (Conditions (a) to (g) and the *it-is-recognized* paragraph)
2. Vehicle longitudinal centre planes (offset)
3. Different types of vehicles with hydraulic braking
4. Use of R152 as an alternative
5. M2N2 derived from M1N1
6. Scope issue - Specification of the targets
7. Performance (V2C and V2P)

1 5.2.1.4 - Status of current draft

(Skeleton Document after Homework #1_clean.docx)

5.2.1.4. Speed reduction by braking demand

In absence of driver's input which would lead to interruption according to paragraph 5.3.2., the AEBS shall be able to achieve a relative impact speed that is less or equal to the maximum relative impact speed as shown in the following table:

- (a) For collisions with unobstructed and constantly travelling or stationary targets;
- (b) On flat, horizontal and dry roads affording good adhesion;
- (c) No trailer is coupled to the motor vehicle and the mass of the motor vehicle is between maximum mass and mass in running order conditions;
- (d) In situations where the vehicle longitudinal centre planes are displaced by not more than 0.2 m;
- (e) In ambient illumination conditions of at least 1000 Lux without blinding of the sensors (e.g. direct blinding sunlight);
- (f) In absence of weather conditions affecting the dynamic performance or the detection capabilities of the vehicle (e.g. no storm, not below 0° C);
- (g) When driving straight with no curve, and not turning at an intersection

~~(h) In unambiguous situations (not in situations so ambiguous as those encountered in urban areas / different from those typically encountered in urban areas)~~

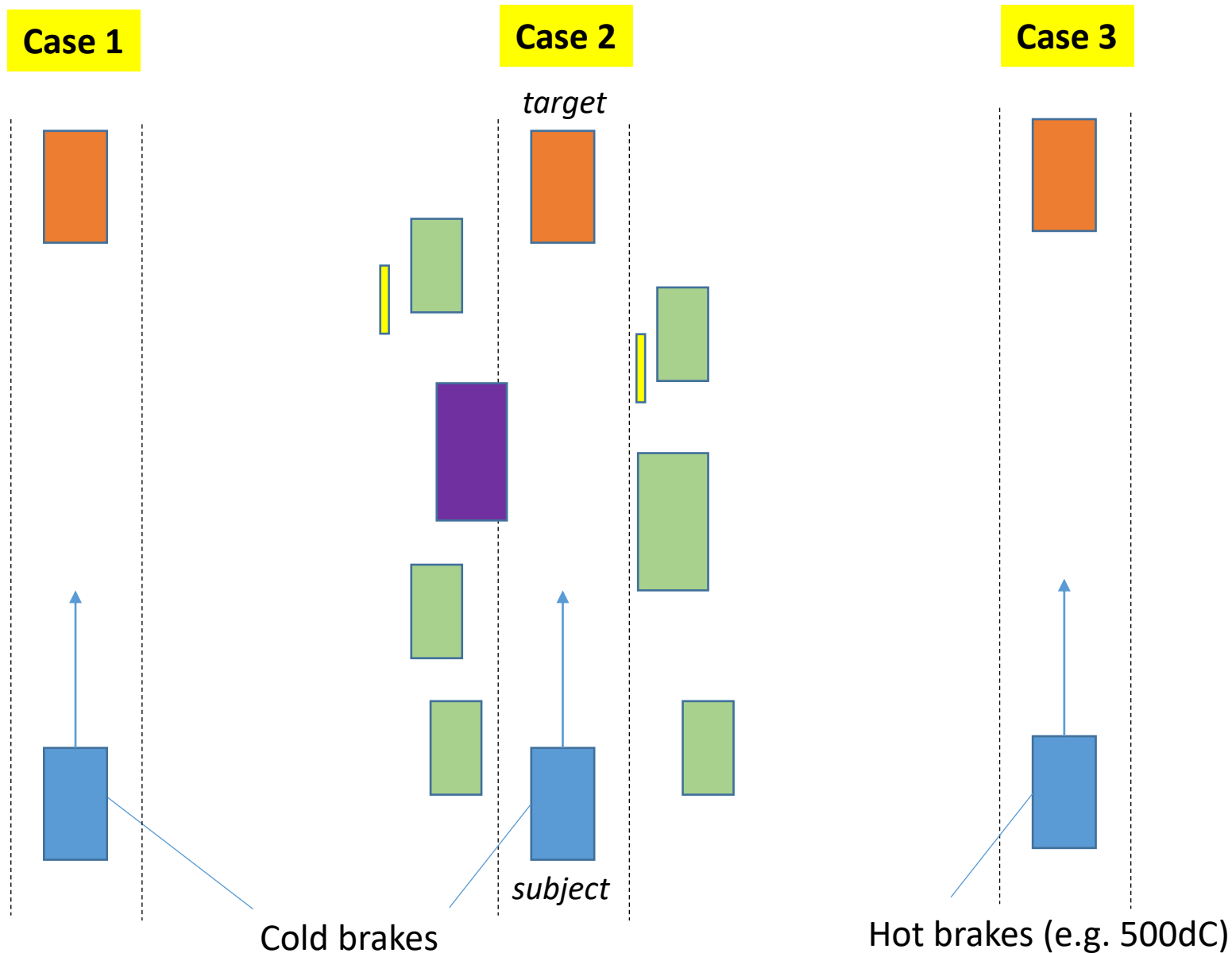
(h) In unambiguous situations (e.g. targets no motorcycle nor bicycle in between rows of vehicles, no laterally waving vehicle in the adjacent lanes)

(i) In absence of conditions resulting from the usage of the vehicle which are directly affecting the braking performance (e.g. brake temperature, severe uneven load distribution)

(j) In absence of conditions directly affecting the detection capabilities of the system (e.g. misleading lane markings, highly reflective environment)

It is recognised that the performances required in this table may not be fully achieved in other conditions than those listed above. However, the system shall not deactivate or unreasonably switch the control strategy in these other conditions. This shall be demonstrated in accordance with Annex 3 of this Regulation.

1 5.2.1.4 - What is the issue?



1. Assuming that in these 3 cases here conditions (a) to (g) are all fulfilled, the system is expected to deliver the required performance.

2. However, it can be easily understood that in cases 2 and 3, the performance will be affected by conditions which are not named in the (a) to (g) list, i.e.

- Complexity of the situation
- Brake temperature

3. The issue is that current wording of 5.2.1.4 does not clearly acknowledge this.

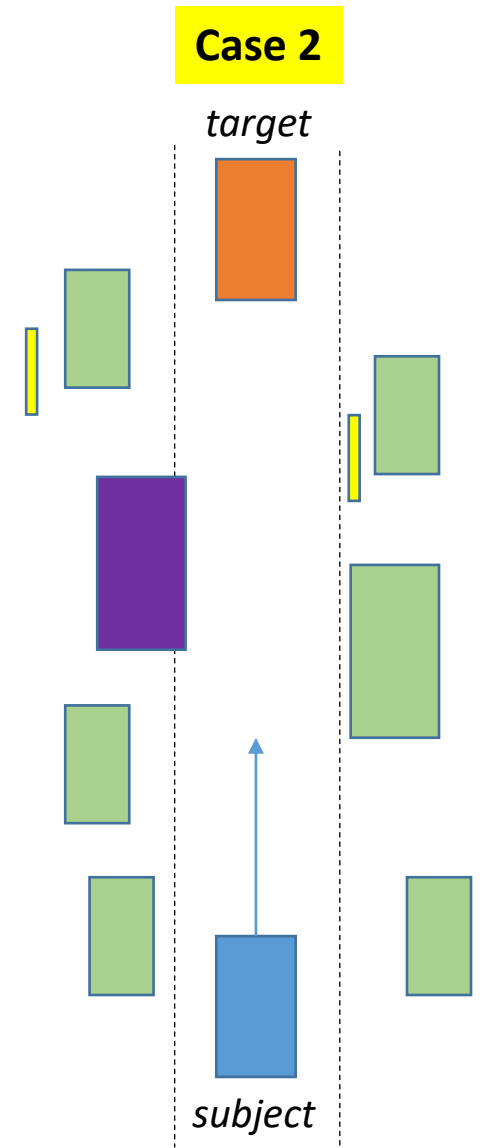
1 5.2.1.4 - Proposal

Proposal to amend 5.2.1.4.

- (h) **In unambiguous situations (e.g. not multiple potential targets ~~no motorcycle nor bicycle in between rows of vehicles, no laterally waving vehicle in the adjacent lanes~~)**

Justification:

- This wording is directly inspired from V2P and V2B paragraphs:
 - 5.2.2.4 (b) In unambiguous situations (e.g. not multiple pedestrians)**
 - 5.2.3.4 (b) In unambiguous situations (e.g. not multiple bicycles)**
- The new requirements are targeting low speed/city use case, where more ambiguous situations are likely to be met by the system (which is currently focused on highway driving). This added paragraph would reflect that such complex situation may affect the performance in some way.



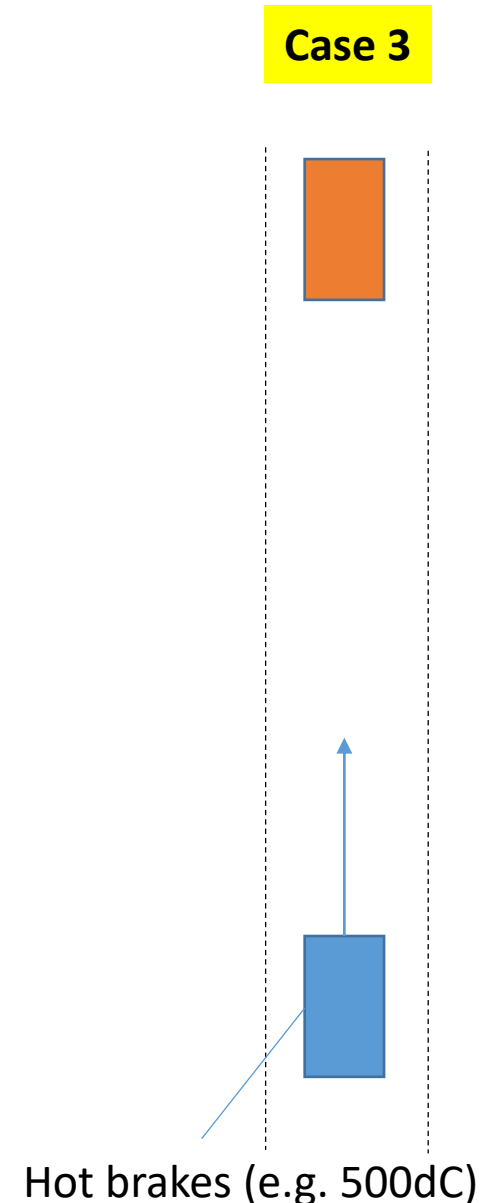
1 5.2.1.4 - Proposal

Proposal to amend 5.2.1.4.

It is recognised that the performances required in this table may not be fully achieved in other conditions than those listed above **or due to parameters not listed above** . However, the system shall not deactivate or unreasonably switch the control strategy in these other conditions. This shall be demonstrated in accordance with Annex 3 of this Regulation.

Justification:

- This modification makes the interpretation of current paragraph more explicit (with regard to **item 2b** of the interpretation below).
- Interpretation of the “it is recognized” paragraph
 1. Items (a) to (g) specify the key parameters where the performance is expected.
 2. The “it is recognized paragraph” refers to the conditions when:
 - a. at least one condition among (a) to (g) is not fulfilled,
 - b. another parameter not listed (named) in (a) to (g) affects the performance**
- With this simple add-on, industry could withdraw their proposals (f), (i) and (j).



2 Vehicle longitudinal centre planes (offset) Proposal

- (d) In situations where the vehicle longitudinal centre planes are displaced by **not more than 0.2 m**;

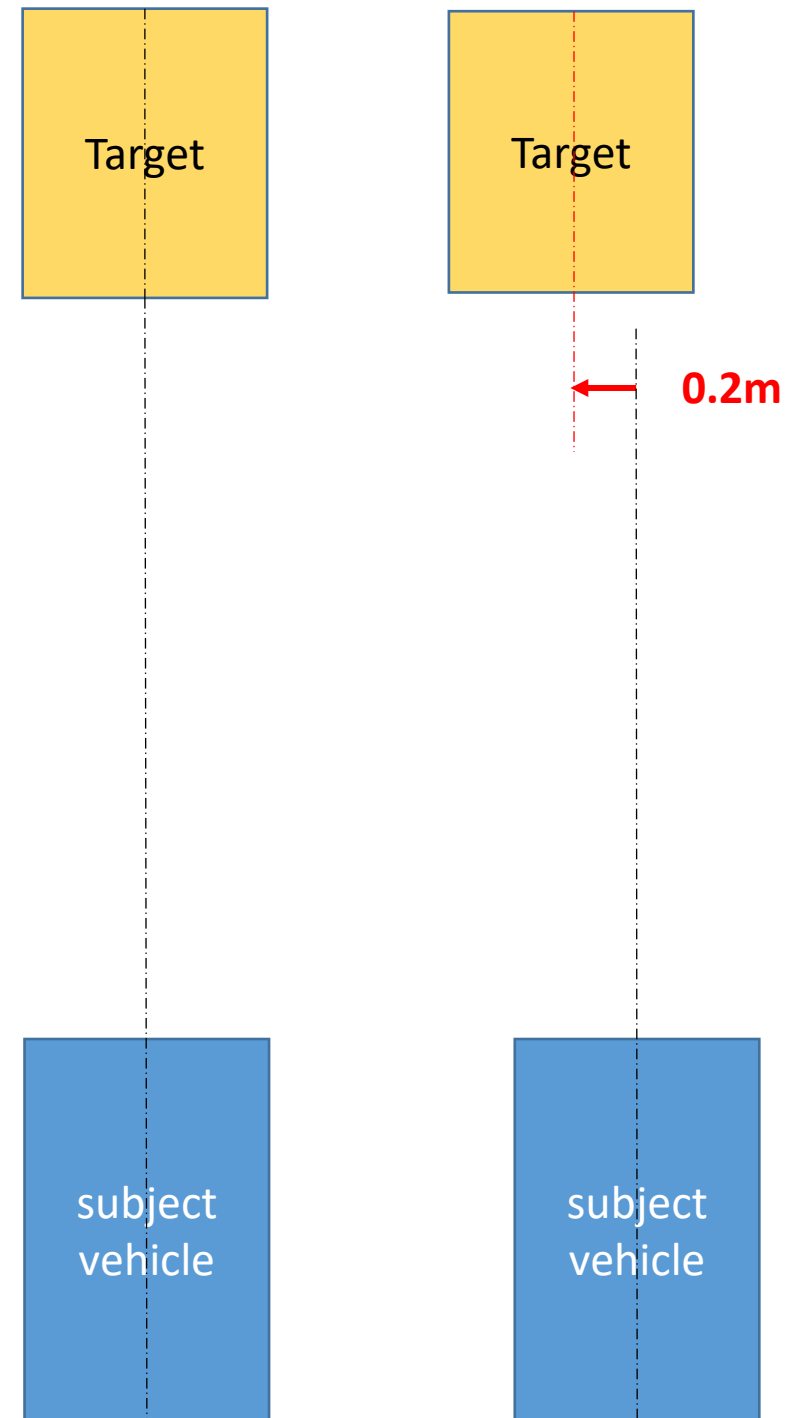
We still believe the current wording is ambiguous. Indeed, if center planes (with plural form) are displaced by 0.2m, it means that both the center plane of the target and of the subject vehicle are displaced by 0.2m (otherwise, why using plural form?).

Proposal to amend:

- (d) In situations where ~~the vehicle longitudinal centre planes are~~ **the anticipated impact point is** displaced by **not more than 0.2 m compared to the vehicle longitudinal centre plane**;

The proposal is to copy the same wording as in 5.2.2.4 and 5.2.3.4 to avoid any possible misunderstanding (and avoid creating a new wording).

*This would then make fully clear the following **interpretation**: “the performance shall be delivered in case the centre plane of the target vehicle is moved by up to 0.2m to the left or to the right”.*



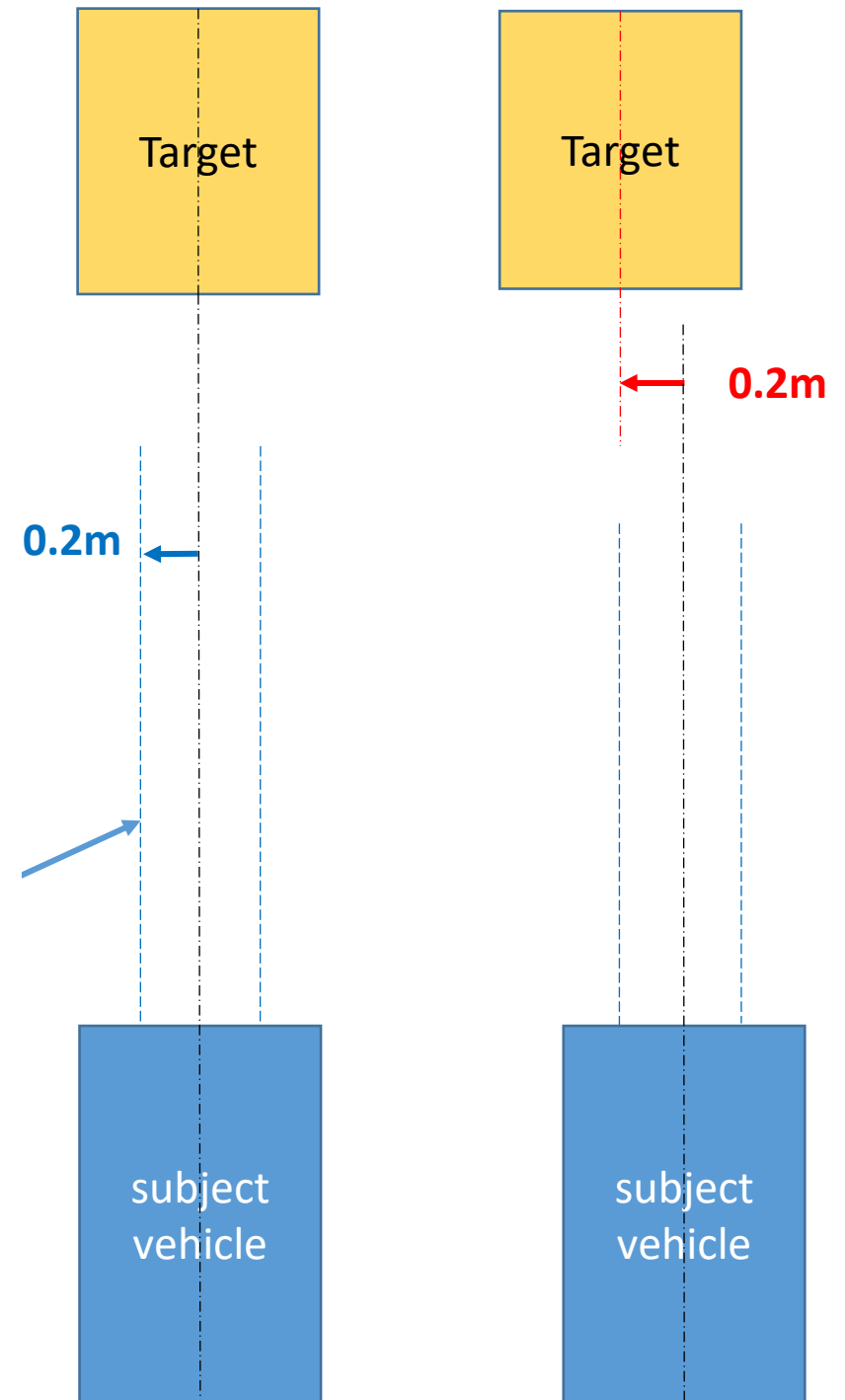
2 Vehicle longitudinal centre planes (offset) Interpretation

Requirement section:

- (d) In situations where ~~the vehicle longitudinal centre planes are the anticipated impact point~~ is displaced by **not more than 0.2 m** compared to the vehicle longitudinal centre plane;

Test section:

- 6.5 The subject vehicle and the moving target shall travel in a straight line, in the same direction, for at least two seconds prior to the functional part of the test. with a subject vehicle to target centreline offset of **not more than 0.2m**.



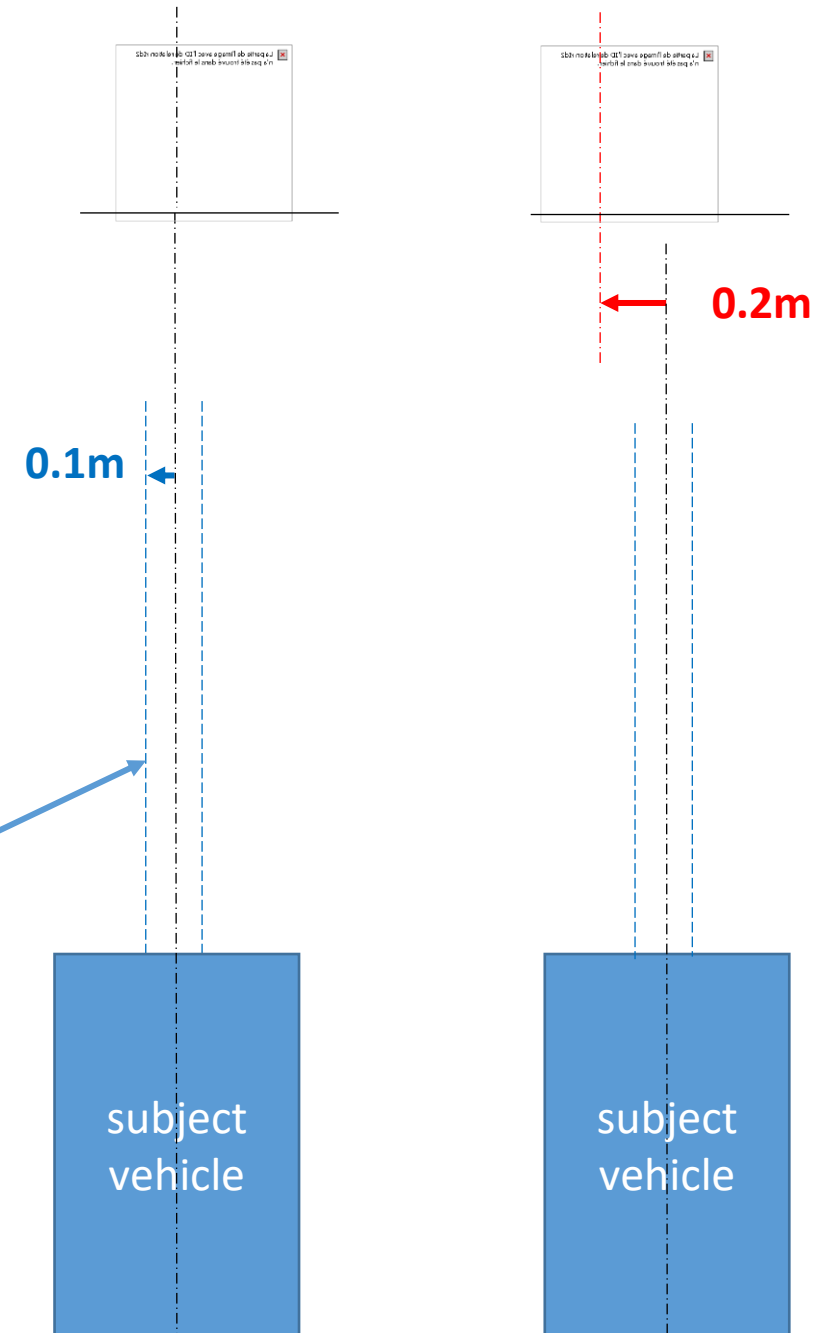
2 Vehicle longitudinal centre planes (offset) Interpretation

Requirement section:

- (e) In situations where the anticipated impact point is displaced by **not more than 0.2 m** compared to the vehicle longitudinal centre plane;

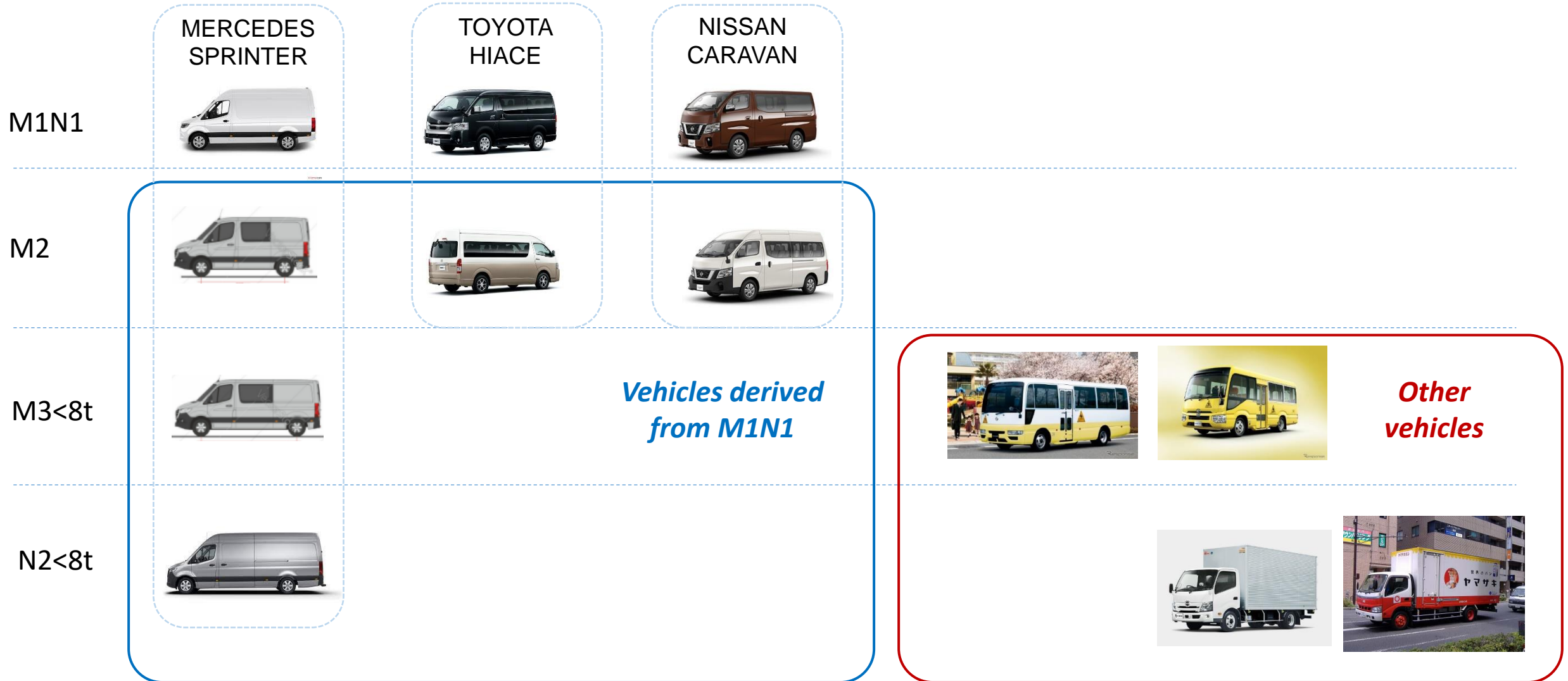
Test section:

- 6.6.1. The subject vehicle shall approach the impact point with the pedestrian target in a straight line for at least two seconds prior to the functional part of the test with an anticipated subject vehicle to impact point centreline offset of **not more than 0.1 m**.



*During the test,
the vehicle shall
stay within a +/-
0.2m corridor*

3 Different types of vehicles with hydraulic braking



4 Use of R152 as an alternative

1. Scope

This Regulation applies to the approval of vehicles of Category M₂, M₃, N₂ and N₃ with regard to an on-board system to

- (a) Avoid or mitigate the severity of a rear-end in lane collision with a preceding vehicle,
- (b) Avoid or mitigate the severity of an impact with a pedestrian,
- (c) Avoid or mitigate the severity of an impact with a bicycle. */

***/ For vehicles of category M2, and for those of category M3/N2 with a maximum weight below or equal to 8t, equipped with hydraulic braking, Contracting Parties that are signatories to both Regulation No. 152 and this Regulation shall recognize approvals to either Regulation as equally valid.**

Justification of changes in blue text:

(extract from AEBS-HDV-06-06-Rev.1)

- ❖ There are M3<8t vehicles which are derived from M1/N1.
- ❖ Restricting the scope of the footnote to vehicles equipped with hydraulic braking is an acceptable compromise for industry.
- ❖ Proposal for footnote to be added to R152 scope:

“This Regulation offers an alternative set of requirements for Category M2 and for M3/N2 with a maximum weight below or equal to 8t to those contained in UN Regulation No. 131. Contracting Parties that are signatories to both Regulation No. 131 and this Regulation shall recognize approvals to either Regulation as equally valid. For vehicles of category M2/M3 and N2 covered in the scope of this regulation, the requirements of category M1 and N1 shall respectively apply.”

5 M2N2 derived from M1N1

Justification of changes in orange text:
(extract from AEBS-HDV-06-06-Rev.1)

Maximum relative Impact Speed (km/h) (regardless whether target stationary or moving)*

Relative Speed (km/h)	<i>M₂, N₂ ≤ 8t, M₃ ≤ 8t</i>			<i>M₃ > 8t, N₃</i>
	<i>Vehicle derived from M1/N1 **</i>	<i>Other vehicles</i>		<i>All load conditions</i>
		<i>Vehicle derived from M3/N3 & pneumatic brake</i>	<i>Vehicle derived from M3/N3 & hydraulic brake</i>	
10	0	0	0	0
20	0	0	0	0
26.5	0	0	0	0

Industry proposes here to adapt the structure of the table to the former proposals made in the group (AEBS-HDV-05-03, AEBS-HDV-04-06-rev.1 etc.)

Industry did not find any specific technical criteria to identify those vehicles derived from M1N1. Probably parameters like dimensions, structure, braking system, AEBS are relevant; still it cannot be specified that “these parameters have to be strictly identical”, or “within a defined tolerance”.

** The vehicle manufacturer shall demonstrate to the technical service that the vehicles are derived one from the other.

We thus propose to leave the vehicle manufacturer demonstrate to the technical service that one vehicle is derived from another.

6 Scope issue - Specification of the targets

1. Scope **R152**
- (a) Avoid or mitigate the severity of a rear-end in lane collision with a passenger car, ...
- 5.2.1. Car to **car** scenario
- 5.2.1.1. Collision warning
- When a collision with a preceding vehicle of Category M₁, in the same lane with a relative speed above that speed up to which the subject vehicle is able to avoid the collision, is imminent, a collision warning shall be provided as specified in paragraph 5.5.1., and shall be triggered at the latest 0.8 seconds before the start of emergency braking.
- 5.2.1.2. Emergency braking
- When the system has detected the possibility of an imminent collision, there shall be a braking demand of at least 4 m/s² to the service braking system of the vehicle...
- 5.2.1.4. Speed reduction by braking demand
- In absence of driver's input which would lead to interruption according to paragraph 5.3.2., the AEBS shall be able to achieve a relative impact speed that is less or equal to the maximum relative impact speed as shown in the following table:
- (a) For collisions with unobstructed and constantly travelling or stationary targets; ...
- It is recognised that the performances required in this table may not be fully achieved in other conditions than those listed above. However, the system shall not deactivate or unreasonably switch the control strategy in these other conditions. ...

The scope covers M1

VS

The scope covers all vehicle categories (M, N, O, motorbikes ...)



This proposal goes beyond the Terms of reference of the HDV informal group, which specifies "Vehicle to Car (V2C)".

Text as per current draft

1. Scope **R131**
- (a) Avoid or mitigate the severity of a rear-end in lane collision with a preceding vehicle, ...
- 5.2.1. Vehicle to vehicle scenario
- 5.2.1.1. Collision warning
- When a collision with a preceding vehicle ~~of Category M₁~~ in the same lane with a relative speed above that speed up to which the subject vehicle is able to avoid the collision (within the conditions specified in paragraph 5.2.1.4), is imminent, a collision warning shall be provided as specified in paragraph 5.5.1., and shall be triggered at the latest 0.8 seconds before the start of emergency braking.
- 5.2.1.2. Emergency braking
- When the system has detected the possibility of an imminent collision, there shall be a braking demand of at least 4 m/s² to the service braking system of the vehicle...
- 5.2.1.4. Speed reduction by braking demand
- In absence of driver's input which would lead to interruption according to paragraph 5.3.2., the AEBS shall be able to achieve a relative impact speed that is less or equal to the maximum relative impact speed as shown in the following table:
- (a) For collisions with unobstructed and constantly travelling or stationary targets; ...
- It is recognised that the performances required in this table may not be fully achieved in other conditions than those listed above. However, the system shall not deactivate or unreasonably switch the control strategy in these other conditions. ...

6 Scope issue - Specification of the targets

Blue and orange changes extracted from AEBS-HDV-06-06-Rev.1

1. Scope **R152**
- (a) Avoid or mitigate the severity of a rear-end in lane collision with a passenger car, ...
- 5.2.1. Car to car scenario
- 5.2.1.1. Collision warning
- When a collision with a preceding vehicle of Category M₁, in the same lane with a relative speed above that speed up to which the subject vehicle is able to avoid the collision, is imminent, a collision warning shall be provided as specified in paragraph 5.5.1., and shall be triggered at the latest 0.8 seconds before the start of emergency braking.
- 5.2.1.2. Emergency braking
- When the system has detected the possibility of an imminent collision, there shall be a braking demand of at least 4 m/s² to the service braking system of the vehicle...
- 5.2.1.4. Speed reduction by braking demand
- In absence of driver's input which would lead to interruption according to paragraph 5.3.2., the AEBS shall be able to achieve a relative impact speed that is less or equal to the maximum relative impact speed as shown in the following table:
- (a) For collisions with unobstructed and constantly travelling or stationary targets; ...
- It is recognised that the performances required in this table may not be fully achieved in other conditions than those listed above. However, the system shall not deactivate or unreasonably switch the control strategy in these other conditions. ...

The simpler would be to change "vehicle" to "passenger car". However, industry may be ready to "play the game" provided the changes in 5.2.1.1. and 5.2.1.4. (or an equivalent wording) would be accepted.

Proposal to stick to current situation in R131, paragraph 5.2.1.1. This proposal already goes beyond the Terms of reference of the HDV informal group, which specifies "Vehicle to Car (V2C)"

Alignment on 5.2.1.1. modification.

This proposal already goes beyond the TORs of the HDV informal group, which specifies "Vehicle to Car (V2C)".

Why excluding light trailers:



1. Scope **R131**
- (a) Avoid or mitigate the severity of a rear-end in lane collision with a preceding vehicle, ...
- 5.2.1. Vehicle to vehicle scenario
- 5.2.1.1. Collision warning
- When a collision with a preceding vehicle of Category M₁ of category **M, N or O is detected** in the same lane with a relative speed above that speed up to which the subject vehicle is able to avoid the collision (within the conditions specified in paragraph 5.2.1.4), is imminent, a collision warning shall be provided as specified in paragraph 5.5.1., and shall be triggered at the latest 0.8 seconds before the start of emergency braking.
- 5.2.1.2. Emergency braking
- When the system has detected the possibility of an imminent collision **with a preceding vehicle of category M, N or O**, there shall be a braking demand of at least 4 m/s² to the service braking system of the vehicle...
- 5.2.1.4. Speed reduction by braking demand
- In absence of driver's input which would lead to interruption according to paragraph 5.3.2., the AEBS shall be able to achieve a relative impact speed that is less or equal to the maximum relative impact speed as shown in the following table:
- (a) For collisions with unobstructed and constantly travelling or stationary **targets vehicles of category M, N, O3/O4**; ...
- It is recognised that the performances required in this table may not be fully achieved in other conditions than those listed above **or due to parameters not listed above**. However, the system shall not deactivate or unreasonably switch the control strategy in these other conditions. ...

7 V2C Performance

(changes to AEBS-HDV-05-03 **in red**)



Vehicle category			CLEPA/OICA	D	J	
M2 M3 ≤ 8t N2 ≤ 8t	derived from M1N1	Hydraulic braking	50	40		R152 as alternative
	Others	Hydraulic braking	35	40		R152 as alternative
		Pneumatic braking	68 (highway) 40 (city)	40		R152 as alternative
N2 > 8t M3 > 8t (except hydraulic braking) N3			68 (highway) 40 (city)	70		



7 V2P Performance

(changes to AEBS-HDV-05-03 **in red**)

Vehicle category			CLEPA/OICA	D	J	
M2 M3 ≤ 8t N2 ≤ 8t	derived from M1N1	Hydraulic braking	26	20		R152 as alternative
	Others	Hydraulic braking	12	20		R152 as alternative
		Pneumatic braking	12.5	20		R152 as alternative
N2 > 8t M3 > 8t (except hydraulic braking) N3			20 → 22.5	20		

Back-up slides



Proposed approach for HDVs

- Whereas:
 - HDV Industry has little experience on VRU and city-AEB;
 - Very few systems are available on the market, e.g. to support IWG discussions with actual measurements (as during the AEBS M1N1 IWG);
 - Available systems does not provide a comparable performance with those of the passenger cars available on the market.
 - **State of the art on one EU vehicle: 20kph collision avoidance**
- Industry proposes to define HDVs requirements **on the base of R152 step 1, and to value the state of the art measurements.**
- The values could be reviewed once practical experience will be available.



LCVs and HCVs – Peak avoidance - Calculations

	M1N1 (step 1)	LCVs (M2 and N2<8t)			HCVs (N2>8t M3 N3)			
		derived from M1N1	derived from / based on “heavies”		4x2T N3		Multi-axles, construction...	
		Hydraulic braking	Hydraulic braking	Hydraulic braking	Pneumatic braking	Pneumatic braking		Pneumatic braking
Vehicle width (m)	2	2	2	2	2.55		2.55	
TTC (s)	0.72	0.72	0.72	0.72	0.92		0.92	
TTC - 0.15s *	-	-	-	0.57	0.77		0.77	
Decel (m/s²)	9	7	6	6	7 (laden)	5.5 (solo)	6 (disc)	5.5 (drum)
T1g (s)	0.6	0.6	2.5 → 1.7s	1	1	1	1	1
Peak avoidance (km/h)	30	26	6 → 12	12.5	22.5	20	21	20
			This column also applies to M3 with hydraulic braking		“Special case” for solo 4x2 tractors		This column does not apply to M3 with hydraulic braking	
		R152 as an Alternative (to the choice of the vehicle manufacturer)						



Proposed approach for HDVs - summary

General approach

- Whereas:
 - HDV Industry has little experience on VRU and city-AEB;
 - Very few systems are available on the market, e.g. to support IWG discussions with actual measurements (as during the AEBS M1N1 IWG);
 - Available systems does not provide a comparable performance with those of the passenger cars available on the market.
 - **State of the art on one EU vehicle: 20kph collision avoidance**
- Industry proposes to define HDVs requirements **on the base of R152 step 1, and to value the state of the art measurements.**
- The values could be reviewed once practical experience will be available.

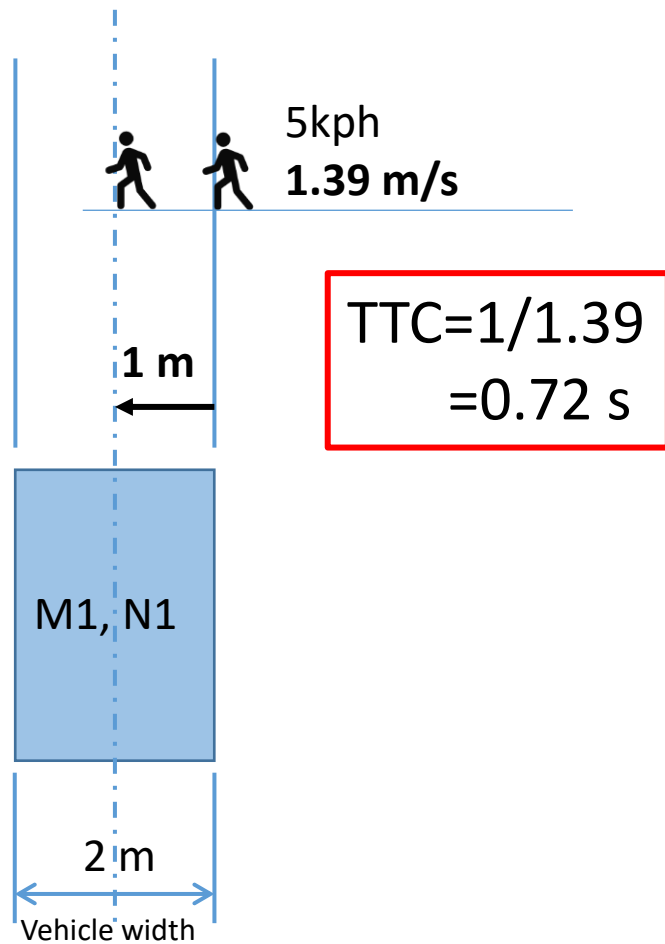
Technical principles

- In order to keep the risk of false positive **identical** to those of M1N1s, HDVs shall **not** be expected to start braking earlier than M1N1s.
- Even with such an assumption, the challenge is already higher for HDVs compared to M1N1s:
- Due to a bigger width, the position of the pedestrian when emergency braking must start is “shifted to the side” (on the sidewalk)
 - The effect of chassis-cab relative movement is unknown.
- The safety zone (defined as the distance needed for a pedestrian to stop at 5kph) is **independent** from the ego vehicle. No vehicle should be expected to start braking before the pedestrian enters that “safety zone”.
- Last but not least, the **lower** braking performance of HDVs vs M1N1’s shall be taken into account in the calculation of the required AEBS performance.

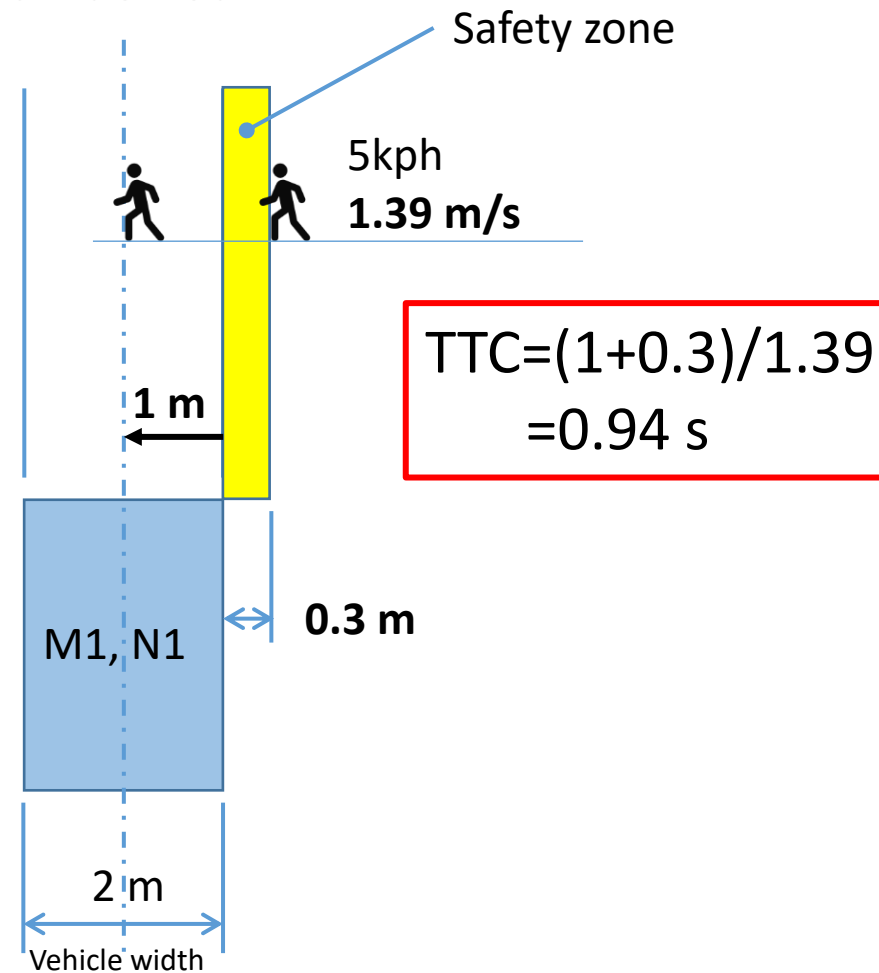


V2P braking time logic in R152

Step 1
00 series

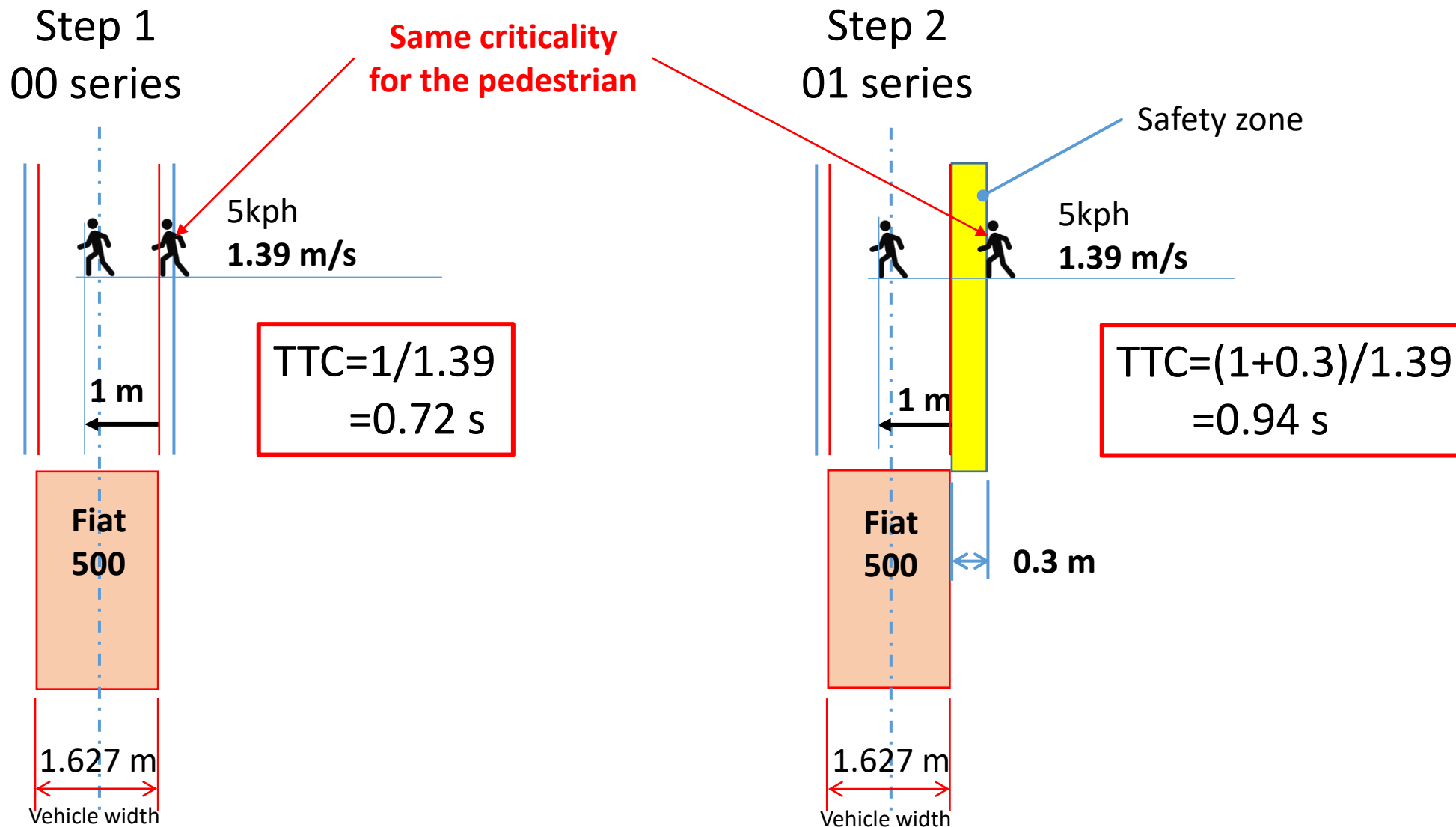


Step 2
01 series



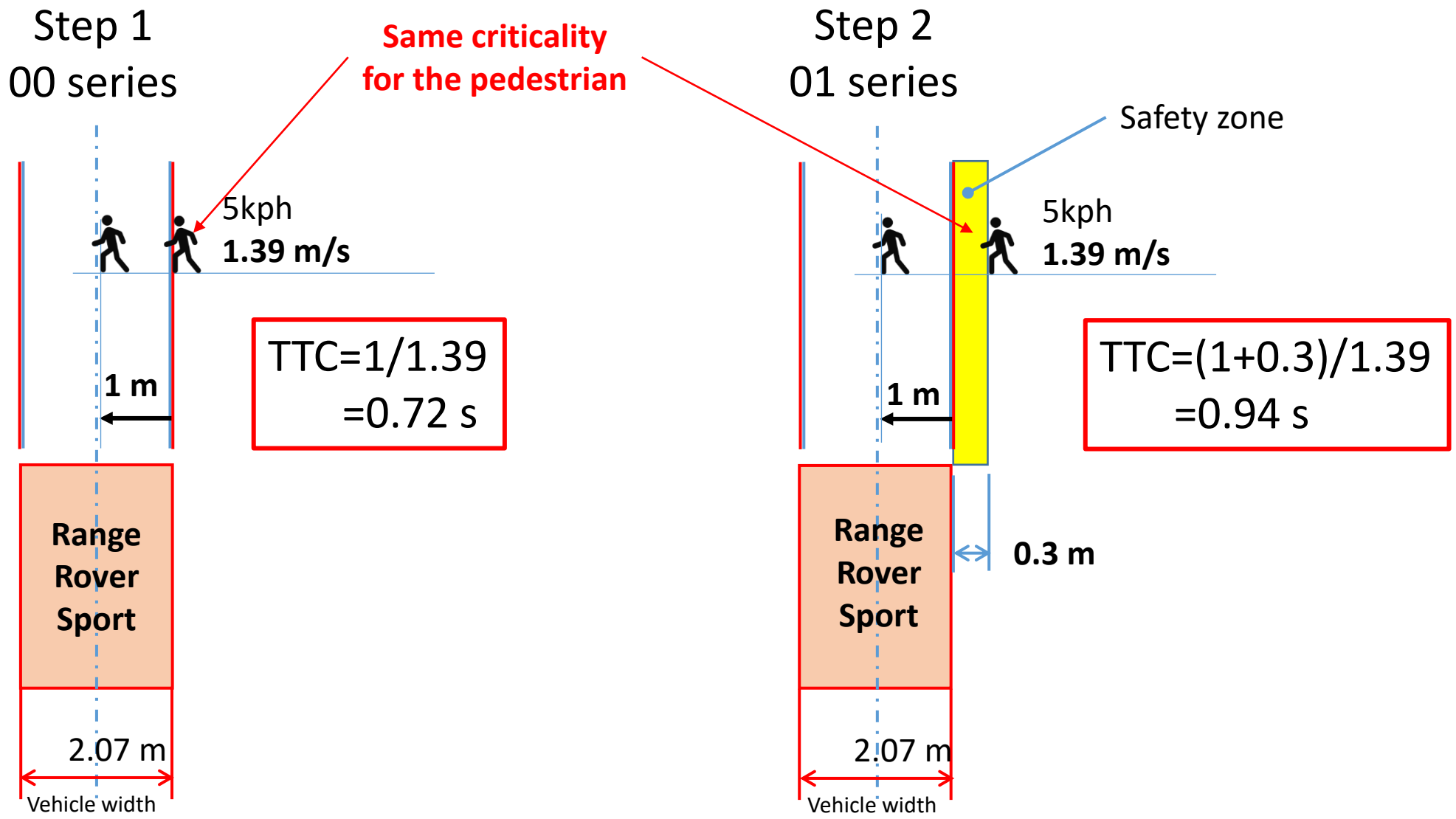


V2P braking time logic applied to a Fiat 500



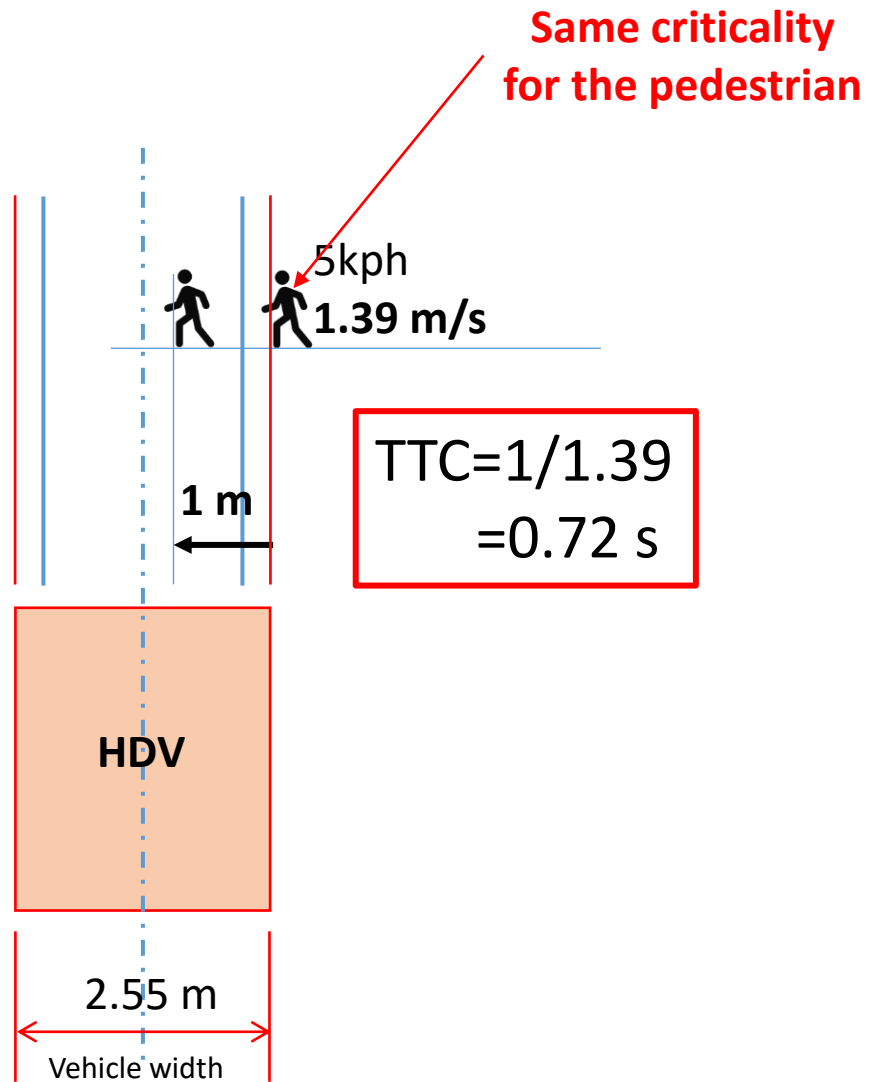


V2P braking time logic applied to a Range Rover Sport





V2P braking time logic applied to a HDV





Summary

- Adopt the principle of an “ISO-criticality” for the pedestrian to HDVs
(No intention to change R152 principles)

- Calculations

- Decel	6m/s ²	7m/s ²
- T1g	1s	1s
- TTC	0.72s	0.72s
- Peak avoidance speed	19 kph	20 kph

- **Conclusion:**

Both approaches are consistent with a peak avoidance speed **around 20kph**, which also reflects the state-of-the-art (of one OEM)