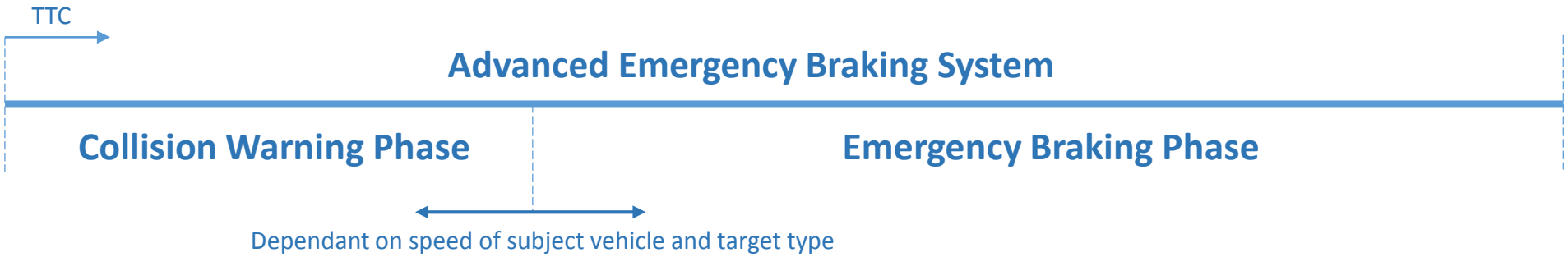
Industry Homework from AEB 02

1. AEBS Definition.
2. AEBS Activation.
3. Minimum 6.4m/s^2 deceleration demand for automatic braking.
4. Justification for not mandating AEBS above 50km/h.
5. Test Scenario Selection
6. Reasons consumers should be able to deactivate AEBS.
7. Method for implementation

AEBS Definition



2.1. **"Advanced Emergency Braking System (AEBS)"** means a system which can automatically detect a potential forward collision, provide the driver with a warning and activate the vehicle braking system to decelerate the vehicle with the purpose of avoiding or mitigating the severity of a collision in the event that the driver does not respond to the warning. The Advanced Emergency Braking System shall include a Collision Warning Phase and an Emergency Braking Phase.

2.2. **"Emergency Braking Phase"** means the phase starting when the AEBS emits an automatic braking demand to the service braking system of the vehicle.

2.3. **"Collision Warning Phase"** means the phase directly preceding the emergency braking phase, during which the AEBS warns the driver of a potential forward collision.

AEBS Activation

The Emergency Braking Phase should be regulated between 10km/h and [50]km/h and should react for vehicle, pedestrian and cyclists. *The first stage of implementation should focus of vehicle detection, and the second stage should focus of pedestrian detection.*

This does not prohibit manufacturers to implement AEBS outside of the speed range or to detect other objects.

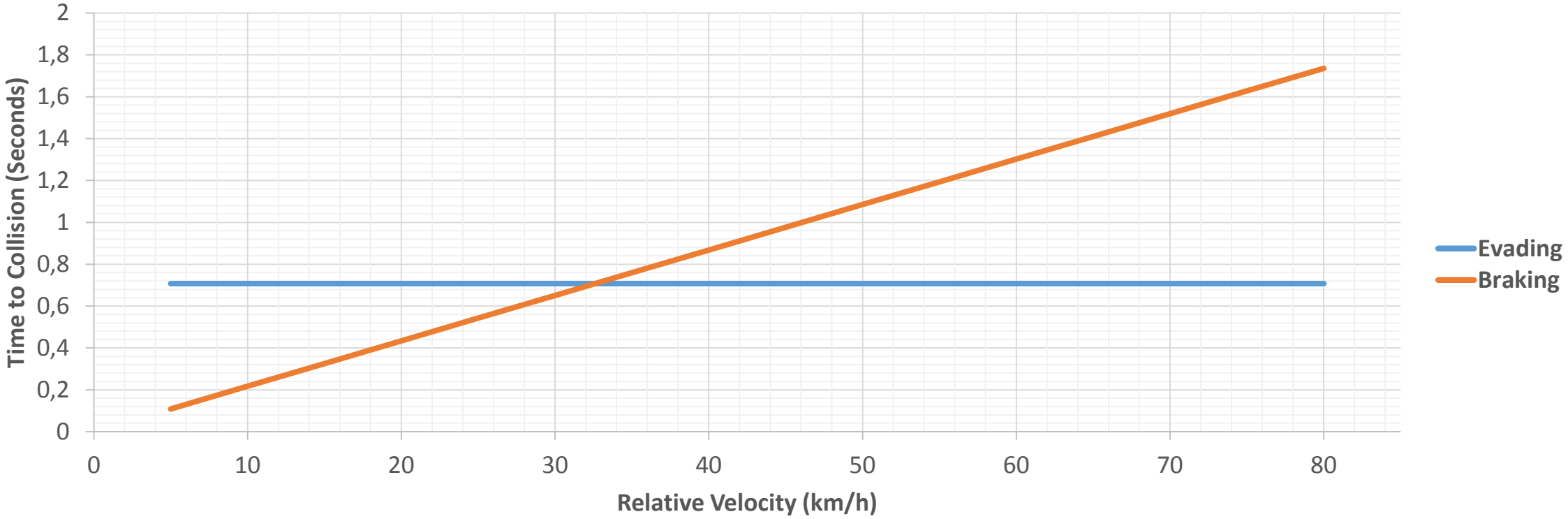
The AEBS must avoid a collision when the Last Point to Steer (LPS) is before the Last Point to Brake (LPB).

- LPS is dependant upon: Time to collision, lateral displacement required to avoid a collision and the maximum lateral acceleration of the subject vehicle which highly depends on road conditions (adhesion, slope), load conditions (loaded/unloaded, in some case the COG height, presence of a trailer) and vehicle maintenance (shock absorbers, tyres).

- LPB is dependent upon: Time to collision and maximum deceleration of the subject vehicle which is also depends on road and vehicle conditions.

AEBS Activation

Calculation Strategy:



Assumptions: *Braking Level = 6.4 m/s²* *Lateral Acceleration = 10 m/s²* *Lateral Offset = 2.5m*

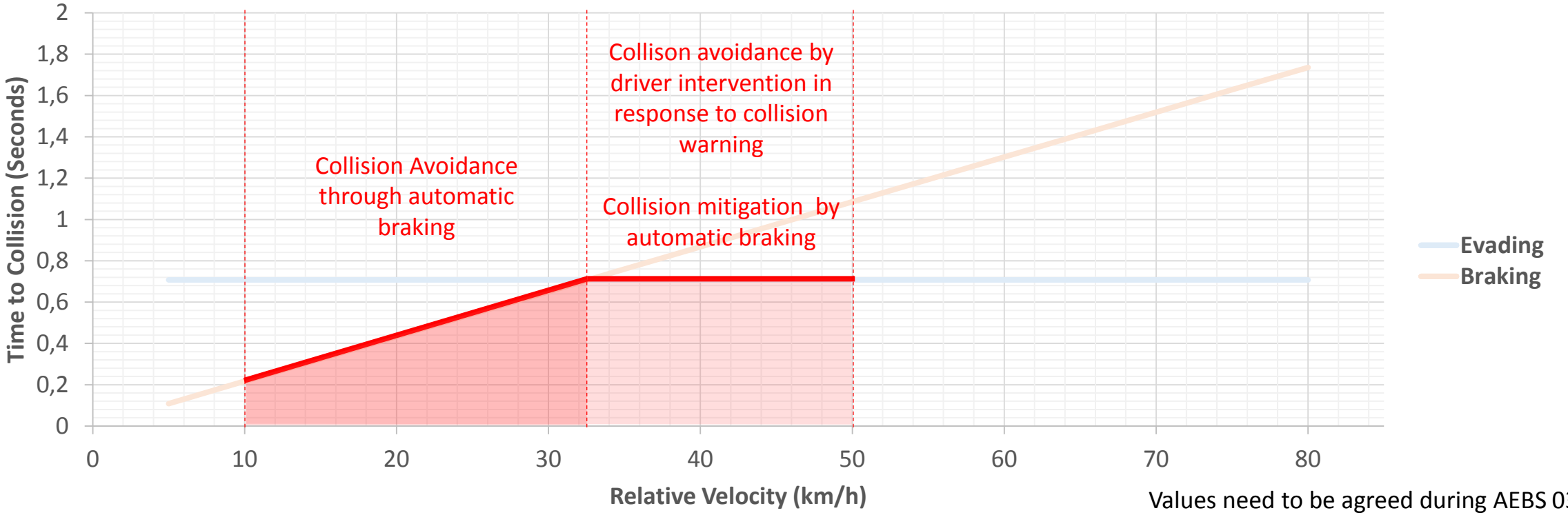
1. Calculate the TTC dependent on the LPS and LPB.

AEBS Activation

Full collision avoidance between 10km/h and [32.6]km/h (LPS = LPB)

Calculation Strategy: 2.

Collision mitigation between [32.6]km/h (LPS = LPB) and 50km/h



Values need to be agreed during AEBS 03

Assumptions: *Braking Level = 6.4 m/s²* *Lateral Acceleration = 10 m/s²* *Lateral Offset = 2.5m*

2. The Emergency Braking Phase of the AEBS shall activate no later than the TTC defined by the minimum of LPS and LPB.

AEBS Activation

Calculation Strategy:

1. Calculate the TTC dependent on the LPS and LPB. Based on (6.4m/s^2 deceleration, 10m/s^2 lateral acceleration, 2.5m lateral offset.

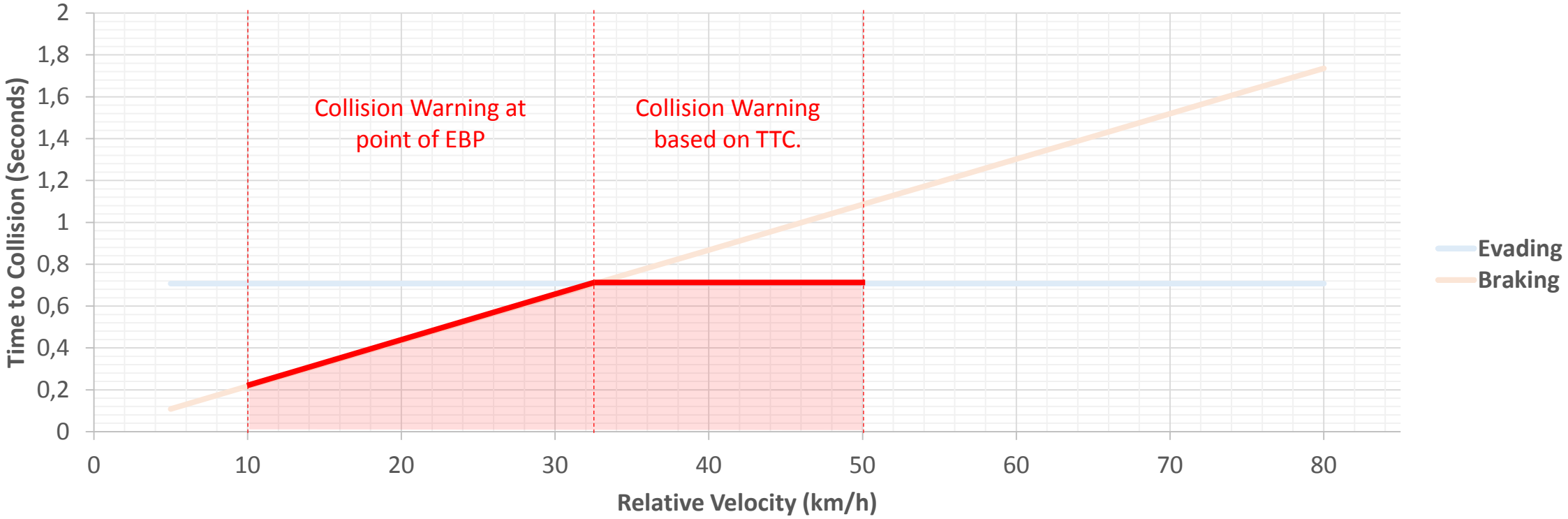
2. The minimum performance requirements for the Emergency Braking Phase of the AEBS shall be determined by applying the designated braking performance (ref. calc 1) at the minimum TTC between LPS and LPB.

3. The collision warning phase shall activate before the Emergency braking phase, this is only applicable at speeds higher than [32.6]km/h (LPS = LPB), below this speed the Collision Warning shall occur at the same time as the Emergency braking phase.

The proposed calculations are used to determine the fixed performance criteria within the Regulation itself and not a dynamic calculation that vehicles make during real world driving.

AEBS Activation

Emergency Braking Phase Performance Requirements



3. The collision warning phase shall activate before the Emergency braking phase, this is only applicable at speeds higher than [32.6]km/h (LPS = LPB), below this speed the Collision Warning shall occur at the same time as the Emergency braking phase.

Minimum [6.4]/[5]m/s^2 deceleration demand for automatic braking

UNECE Regulation No.13-H/R13 the minimum service brake performance of the vehicle (Type 0 with the engine disconnected) is 6.43 or 5m/s^2 for M1 or N1 category vehicles.

The regulation for advanced emergency braking shall not specify any minimum deceleration for the vehicle, since this is already regulated in R13-H

The minimum deceleration values of the vehicle should not be defined within the regulation, but should be implicit by the performance requirements of the AEBS equipped vehicle . i.e. by defining the conditions when a collision shall be avoided or mitigated. The very same principle applies to the performance of the sensors.

The regulation for autonomous emergency braking shall only specify a minimum deceleration demand to the braking system. Depending on the road and load conditions, the vehicle will be able to achieve the demanded deceleration or not.

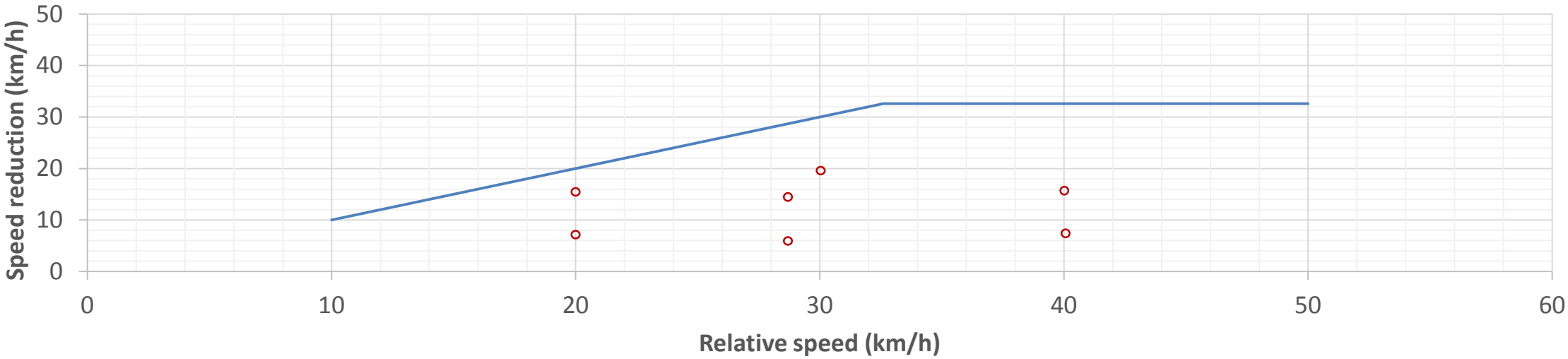
To enable technically neutral requirements for every manufacturer.

Higher values will require amendments for UNECE R13-H (& FVMSS135)

Allows for compatibility between existing AEB test protocols:

Minimum 6.4m/s² deceleration for automatic braking.

Emergency Braking Phase Performance Requirements – compatibility to existing standards



Car-to-car

		Title	System	VUT speed	EVT speed	Conditions	Pass Criteria
IIHS	U.S		AEB	20km/h	0km/h		8km/h for both or 16km/h for one
			AEB	40km/h	0km/h		
			FCW	72km/h	0km/h		>2.1s TTC
			FCW	72km/h	32km/h		>2.0s TTC
			FCW	72km/h	72km/h	0.3g at 30m	>2.4s TTC
ISO	International	FVCMS	AEB	28.8km/h	0km/h		14.4km/h or 7.2km/h speed reduction
			AEB	72km/h	43.2km/h		

Car-to-pedestrian

		Title	System	VUT speed	EVT speed	Conditions	Pass Criteria
ISO	International	PDCMS	AEB	30km/h			20km/h speed reduciton

Justification for not mandating AEBS above 50km/h absolute velocity.

- Accident data suggests that the majority of vehicle collisions with other vehicles in urban environments, therefore AEBS for M1/N1 should be regulated for these scenarios where speed differences more than 50km/h are uncommon.

- At higher speeds the difference in which the last point to steer and last point to brake occur increases linearly, this could lead to a greater possibility of false positives – at higher speeds a false positive will have a greater impact on the road user's safety and traffic flow.

- Greater alignment with voluntary commitment requirements from US manufacturers – ease the development of a GTR.

Test Scenario selection

NCAP vs Type Approval

- Performance determination vs minimum safety standard.

- Designed performance needs to take in account for different conditions in the real world when compared to the test track and designed with safety margin to cover variation in results.

- NCAP selection of vehicle is based on the most common variants available on the market, type approval vehicle selection is based on the worst case vehicle.

- Performance based on Ideal conditions e.g. pre prepared brakes (hot.), weather conditions. Level of braking required for type approval should based on UNECE Regulation R13H. (6.4m/s^2) for regulatory consistency.

Test Scenario selection

EuroNCAP Test Protocol 2018

		Title	System	VUT speed	EVT speed	Impact Postion	Conditions	Pass Criteria
NCAP	Car to Car	CCRs	AEB	10-50km/h	0km/h	50% +/-		
		CCRs	FCW	30-80km/h	0km/h	50% +/-		
		CCRm	AEB	30-80km/h	20km/h	50% +/-		
		CCRm	FCW	50-80km/h	20km/h	50% +/-		
		CCRb	AEB	50km/h	50km/h	50% +/-	2/6m/s2 at 12/40m	
		CCRb	FCW	50km/h	50km/h	50% +/-	2/6m/s2 at 12/40m	
	Car to Pedestrian	CVNA-25	AEB	20-60km/h	5km/h	25%	Day & Night	22 Points
		CVNA-75	AEB	20-60km/h	5km/h	75%	Day & Night	
		CVNC	AEB	20-60km/h	5km/h	50%	Day (Obscured EPT)	
		CVFA	AEB	20-60km/h	8km/h	50%	Day	
		CPLA-25	AEB	20-60km/h	5km/h	25%	Day & night	
		CPLA-50	AEB	25-60km/h	5km/h	50%	Day & night	
		CPLA-50	FCW	50-80km/h	5km/h	50%	Day & night	
	Car to Bicycle	CBNA-50	AEB	20-60km/h	15km/h	50%	Day (Obscured EBT)	22 Points
		CBLA-50	AEB	25-60km/h	15km/h	50%	Day	
		CBLA-25	FCW	50-80km/h	20km/h	25%	Day	

AEBS-02 agreed that the test scenarios and targets should be inspired be EuroNCAP test protocol.

The wholes suite of tests defined in the EuroNCAP 2018 protocol is excessive and pre-mature for type approval. Selection should be based on those scenarios that cover the largest percentage of real world accidents.