Industry Preparation

1. Existing test protocols.

2. System functionality.

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2. System functionality.

Test Protocols: Scenarios

UNECE Regulation No.131

- Test vehicle 80km/h, with target vehicle @ 0, 12 and 67 km/h.
- Annex of regulation determines the minimum performance depending on category of test vehicle and speed of target vehicle.
- Additional system functionality tests i.e. failure detection, deactivation test and false reaction test.

Test Protocols: Scenarios

United States

- US DOT and IIHS announced a voluntary commitment by 20 automakers to make AEB systems a standard feature on virtually all new vehicles.
  - For light duty vehicles and trucks below 3,855kg and manufactured after 2022.
  - For light duty vehicles and trucks between 3,855kg and 4,535kg and manufactured after 2025.

Feature	Test	Pass Criteria
Forward Collision Warning (FCW) *(NHTSA FCW Test)*	Test 2 –Subject Vehicle encounters decelerating Principal Other Vehicle (LVD)	FCW alert issued when TTC is at least 2.4 seconds
	Test 3 –Subject Vehicle encounters slower Principal Other Vehicle (LVM)	FCW alert issued when TTC is at least 2.0 seconds
Crash Imminent Braking (CIB) *(IIHS AEB Test)*	Option A –12 or 24 mph tests involving a stationary lead vehicle *OR* Option B –Both 12 and 24 mph	Option A –Average speed reduction > 10 mph in the 12 or 24 mph tests *OR* Option B –Average speed reduction > 5 mph in both the 12 and 24 mph tests (5 repeated tests)

Test Protocols: Scenarios

ISO

- ISO 15623: Forward Vehicle Collision Warning System (Released in 2013)
- ISO 22839: Forward Vehicle Collision Mitigation System (Released in 2013)
- ISO 19237: Pedestrian Detection Collision Mitigation System (Draft International Standard)
- ISO 22078: Bicyclist Detection Collision Mitigation System (New Work Item Proposal)

Test Protocols: Scenarios

Euro NCAP Test Protocol

- Static target test: Test vehicle 0-50km/h, target 0km/h
- Constant speed moving target test: test vehicle 30-80km/h, target 20km/h
- Braking target test: Test vehicle 50km/h, target 50km/h @ 12 or 40m headway and 2 or 6m/s² deceleration.
- Vulnerable Road User test: test vehicle 20-60km/h, target 5 or 8km/h @ different impact positions.

Test Protocols: Impact targets

ISO 19206-1: 2D vehicle target
Draft International Standard

Static
Cost £15k
Max impact speed 50km/h

Moving
Cost £30k + tow vehicle
Max impact speed 50km/h
Max towing speed 80km/h

Comments
- Use in NCAP protocols from 2014, not allowed in ENCAP from 2018.
- RADAR/camera behaviour at offset/angle.

ISO 19206-3: 3D vehicle target
Working Draft

Static and Moving
Cost £30k + £300k + £150k
Max impact speed 80km/h

Comments
- Use in NCAP protocols from 2018
- Requires significant resources for operation.
- Self propelled.
- Still under development

ISO 19206-2: Pedestrian target
Draft International Standard

Cost £50k + SR robot (£100k)
+ 3-5k/dummy
Max impact speed 60km/h

Comments
- Require precise equipment
- Use in NCAP protocols from 2016
- Moving and Static?
- Articulated?
- Adult or child?

ISO 19206-4: Bicyclist target
Working Draft

Cost £50k + SR robot (£100k)
10k/cyclist
Max impact speed 60km/h
Cyclist speed 35k

Comments
- Use in NCAP protocols from 2018
- Require precise equipment.

Test Protocols: Summary

AEB vehicle detection tests are currently defined through UNECE, NCAP, ISO and U.S National Standards.

- Relative test speeds for U.S and ISO standards range from 20km/h - 40km/h
- Required speed mitigation for U.S and ISO standards range from 7.2km/h - 16km/h

AEB Pedestrian detection test is currently only defined through NCAP.

Vehicle balloon target (EVT) and pedestrian targets (EPTc and EPTa) are defined through ISO draft international standards.

- EVT has a maximum impact speed of 50km/h
- EPTa and EPTc have a maximum impact speed of 60km/h

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2. **System functionality.**

Advanced Emergency Braking Systems – Low Speeds

Characteristics:

- Low speeds = typical city driving environment
- Typically situation gives driver not enough reaction time on a collision warning to avoid accident
- Last point to steer is before last point to brake
- Typical system solution:
    - Automatic intervention only (i.e. no warning)

Advanced Emergency Braking Systems – High Speeds

Characteristics:

- High speeds = typical rural road or highway driving environment
- Typically situation gives enough time for reaction of driver on collision warning in order to avoid accident
- Last point to steer is after last point to brake
- Most systems are designed to support drivers who are inattentive or do brake insufficiently
- Very early warnings should be avoided (regarded as “false warnings” by most drivers)
- Typical system solution:
  - Warning cascade (acoustic, optic, haptic) to bring driver in the loop
  - If driver reacts by braking: Brake support
  - Automatic intervention late, for collision mitigation only

    (as automatic intervention is after last point to steer)
  - Driver override always possible (e.g. by steering)

Last point to steer vs Last point to brake

Two points need to be considered when defining the speed at which AEB is activated:

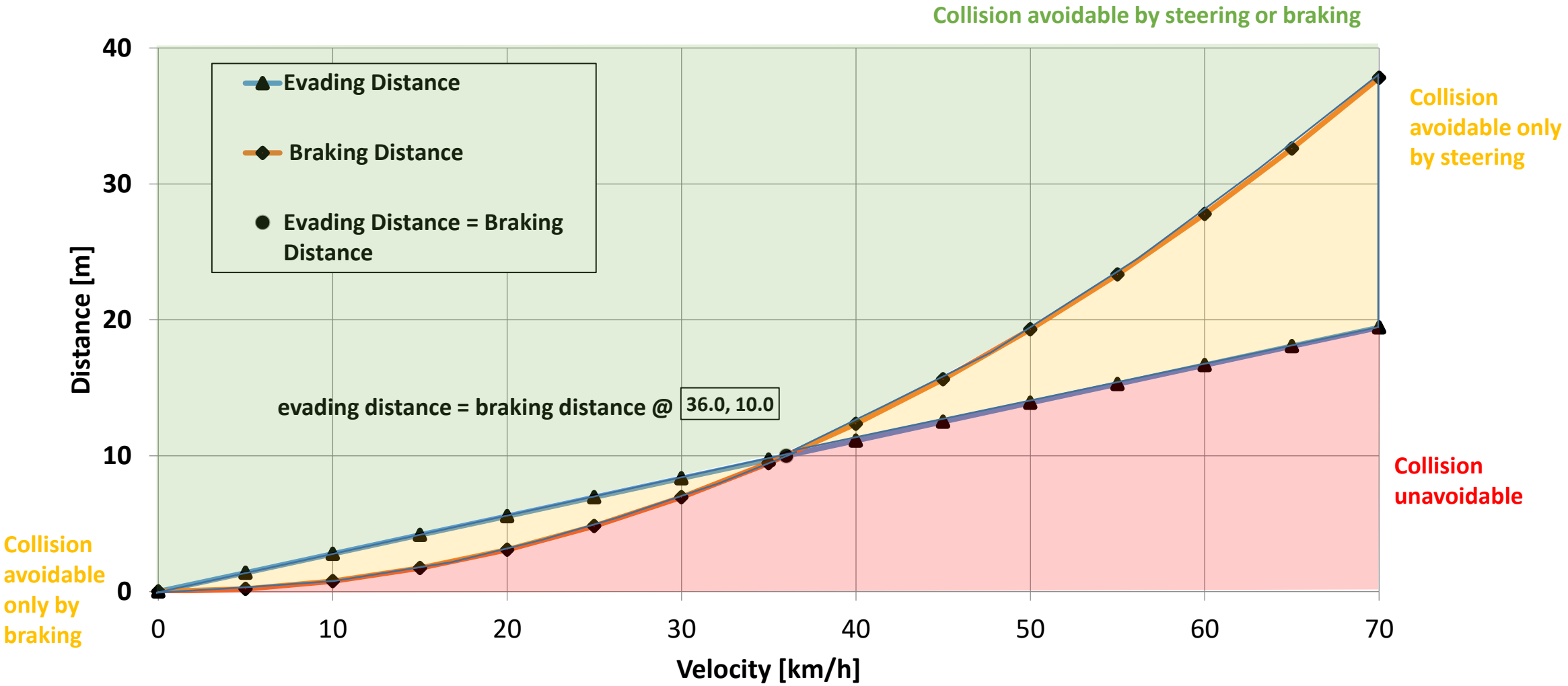
- The last point to steer to avoid a collision.
- The last point to brake to avoid a collision.

Automatic brake intervention should not activate before the last point to steer.

- There are many scenarios in the real world where AEB may be triggered while the driver is in full control of the vehicle and aware of the environment:
  - Overtaking slow/static vehicle on motorway.
  - Moving to adjacent lane because of temporary traffic lights.
  - Urban road with parked cars on either side, with oncoming traffic.

- Initiating a braking manoeuvre before the last point to steer will reduce the steering performance of the vehicle.

Last point to steer vs Last point to brake



Braking deceleration = -**5m/s²**, Lateral Acceleration = **5m/s²**, Lateral offset = **2.5m**

System functionality: Summary

Advanced Emergency braking does not just include automatic braking.

Different system strategies can be used for low and high speed interventions.

To prevent false positives Advanced Emergency Braking tends to not activate when the last point to steer is before the last point to brake.

Trigger thresholds are sometimes included to prevent activation below 10km/h during low speed manoeuvre/parking.

Forward Collision Warning and Brake Assist Systems could be more effective than AEB at higher speeds.