Automatic Emergency Braking Systems (AEBS)

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"Automatic Emergency Braking Systems (hereafter AEBS)"

A) AEBS has functions of the collision warning and the emergency event preparation to the driver in case of occurrence of a danger of collision with a forward obstacle.

B) AEBS has a function of the braking control for mitigating the damage of vehicle collision with a forward obstacle in case of that collision is judged imminent or unavoidable.
1. Definition of AEBS

1st Stage
Collision Warning
Emergency Event Preparation

2nd Stage
Braking Control for Damage Mitigation

Braking Control for Damage Mitigation or Collision Avoidance

Damage Mitigation or Collision Avoidance
2. Speed Range

**Speed Range**
The system need not to start the braking control in the following speed ranges.

(a) The vehicle speed is exceeding a maximum speed.
(b) The absolute speed of the vehicle is equal to or less than 15 km/h.
(c) The relative speed of the vehicle is equal to or less than 15 km/h.
(d) In case of vehicle malfunctions.
3. Timing of Braking Control

The braking control shall be activated. The braking control may be used. The braking control shall not be activated.

The most of driver operates the braking or the steering in the normal driving.

The most of driver has already operated the braking or the steering in the emergency situation.

A driver can’t avoid the collision, even if a driver operates the braking or the steering with the maximum vehicle dynamic performance.
If AEBS activates in the normal driving condition, a driver has nuisance feeling.
• A driver may use off-control.
• A driver may have distrust to AEBS.
And then, AEBS might not activate efficiently in the emergency situation.

Consideration of driver acceptance is important for the effect of AEBS. Therefore, the timing of the braking control is prescribed in this draft.
3. Timing of Braking Control

Operational Range Based on Physical Avoidance Limit

Operational range based on physical avoidance limit

The timing of the braking control is called **collision judgment line** in this draft.

**Collision judgment** means a state of a judgment that a collision cannot be avoided physically by operating either the braking or the steering.

**The braking control shall be activated.**
3. Timing of Braking Control

Driver operates either the braking or the steering for the purpose of avoiding the collision.

The timing of braking control is prescribed in this draft based on considering the operation of both the braking and the steering.
Braking: Braking performance of each vehicle is different. Therefore, this line is changed by each vehicle.

Steering: TTC = 0.6 (s) fixed value is used for all large trucks.

Collision Judgment Line

Collision avoidable limit line by braking is TTC which is calculated by minimum stopping distance with the braking test.

Collision avoidable limit line by steering is TTC which is calculated by minimum lateral displacement with the steering test.
5. Requirement of Braking Deceleration

Requirement of automatic braking:
Braking control shall be activated with average deceleration of 6.0 m/s² or more.
6. Enhance Damage Reducing Effect
Operational Range Based on Driver’s Normal Maneuvers Limit

Operational range based on driver’s normal maneuvers limit

The timing of the braking control is called collision risk judgment line in this draft.

Collision risk judgment means a state that has a risk of a collision. The most of driver has already operated the braking or the steering in the emergency situation.

The braking control may be used by manufacture.
6. Enhance Damage Reducing Effect
Operational Range Based on Driver’s Normal Maneuvers Limit

- Expanded range
  - The most of driver has already operated the braking and the steering in the emergency situation.

- Time to collision (TTC)
- Relative velocity

- Collision risk judgment line
- Collision judgment line
- Lower limit line for collision avoidance by normal steering
- Collision avoidable limit line by steering

- Expanded range
- Collision risk area

- The most of driver operates the braking and the steering in the normal driving. (Normal driving area)

- A driver can’t avoid the collision, even if a driver operates the braking and the steering with the maximum vehicle dynamic performance. (Collision area)

- Braking control may start functioning in the collision risk area.
Collision risk judgment line is **the lowest limit of drivers’ normal avoiding maneuver.**

Braking: \( \text{TTC} = 0.0167 \times R_v + 1.00 \)  \( R_v : \) Relative velocity

Steering: \( \text{TTC} = 0.0167 \times R + 1.13 \) (s) \( R : \) Ovelapping ratio
6. Enhance Damage Reducing Effect

Collision Risk Judgment Line

Overlapping Ratio

Lateral Distance for Collision Avoidance (B) = Overlapping Ratio \times \text{Vehicles Overall Width (A)}

Steering: \text{TTC} = 1.4 \text{ (s)}

Overlapping Ratio = \frac{B}{A}

If the AEBS can detect the overlapping ratio, TTC can be increased by the overlapping ratio.
6. Enhance Damage Reducing Effect

Requirement of Braking Deceleration

From collision risk judgment line:
Braking control may be activated.

![Graph showing the relationship between relative velocity and TTC time to collision, indicating the range in which braking control may be activated.](image-url)
7. Emergency Event Preparation and Collision Warning

“Collision Warning” means a function that alerts the driver to a risk of collision in advance and prompts him/her to make an avoiding action.

“Emergency Event Preparation” means a function that notices the driver in advance that the system detects an unavoidable collision and starts controlling the brake system.

“Collision Warning Braking” means a function that alert the driver a risk of collision by the braking. Warning braking have a limitation of deceleration that shall not exceed 6.0 m/s².
8. Other Principal Requirements

- **“AEBS Off” control**
  The vehicle may equip with a means to manually deactivate the AEBS. If the vehicle may equip with a means to manually deactivate the AEBS, a deactivation warning shall be given when the system is deactivated.

- **Fail safe function**
  The system shall have a function to monitor the operating state of the system, and shall detect failures by means of this function.
  
  If any failure has occurred in the system, the operation of the system shall stop safely and the system shall return to its basic (manual) braking function as a brake system.

- **Malfunction tell-tale**
  If any failure occurs with the system, a warning shall be given.

- **Indication of over limit of function**
  If AEBS recognizes an unfavorable situation which precludes its operation, such as when the system detects contamination on the forward obstacle sensor, the driver in the driver’s seat shall be warned by an optical warning indicating that AEBS is not able to function.