

AUTONOMOUS EMERGENCY BRAKING SYSTEM [CAR-TO-CAR] PERFORMANCE TESTING METHOD

Created: 2014/4/1
Revised: 2018/3/20

1. Effective Dates:

This testing method will be put into operation starting April 1st, 2014. However, the new regulations set on March 20th, 2018 will go into effect starting April 1st, 2018.

2. Scope of Application:

This test procedure applies exclusively to the "Autonomous Emergency Braking System [car-to-car] Performance Test" (AEBS) of passenger vehicles with 9 occupants or less and commercial vehicles with a gross vehicle mass of 2.8 tons or less conducted by the National Agency for Automotive Safety and Victims' Aid (hereinafter referred to as "NASVA") in the new car assessment program information supply project.

3. Definition of Terms:

The terms used in this testing method are defined as follows.

1. **"AEBS (Autonomous Emergency Braking System)"**: Automatically manipulates the brakes to help avoid frontal collisions and to reduce collision speed.
2. **"FCWS (Forward Collision Warning System)"**: A warning system that assesses frontal collision risk and prompts the driver to use the brakes either with audible/visual warning or audible/tactile warning.
3. **"Vehicle Target (VT)"**: A testing system shown in Appendix A that simulates the front of a car.
4. **"TTC (Time To Collision)"**: The time remaining until a collision when the test vehicle and the VT's speeds are kept constant.
5. **"T_{AEBS}"**: The time at which deceleration via AEBS first crosses 0.3m/s^2 .
6. **"T_{FCWS}"**: The time at which the warning system of the FCWS first gives off an audible warning.
7. **"Collision"**: The state at which the distance between the test vehicle and the VT becomes 0.
8. **"V_{impact}"**: The speed at which the test vehicle collides with the VT.
9. **"V_{rel_impact}"**: The relative speed at which the test vehicle collides with the VT.
10. **"Initial Velocity Difference"**: The relative velocity of the test vehicle and the VT at T_{AEBS} for the AEBS test, and at T_{AEBS} or at T_{FCWS} whichever the earlier point in time for the FCW test
11. **"Velocity Reduction Amount"**: Subtracts the speed at the time of collision from the initial speed.
12. **"Velocity Reduction Rate"**: The Deceleration Rate divided by the Initial Speed Difference.
13. **"Standard Track"**: A target test course that allows the test vehicle and the VT to run in the same straight line.

14. **"Lateral Error"**: The lateral distance between the center-front of the test vehicle and the center-rear of the Standard Track. (Fig. 1)
15. **"Lateral Offset"**: The difference between the test vehicle's Lateral Errors and the VT. (Fig. 1)
16. **"Brake Pedal Stroke"**: The amount of depression applied on the test vehicle's brake.
17. **"Accelerator Stroke"**: The amount of depression applied on the test vehicle's accelerator.
18. **"CCRs"**: A test scenario where the VT is stationary.
19. **"CCRm"**: A test scenario where the VT is being towed at a constant speed.
20. **"Mass at Vehicle Delivery "**: The test vehicle's condition when fully loaded with fuel, lubricants, coolants, etc. in the engine and fueling system, and equipped with onboard tools, spare tire, and standard accessories.
21. **"Pre-Braking Brake Temperature"**: The higher of the average temperatures of left and right wheels of each axle pursuant to the procedures of JIS D 0210 when the temperature of the brake lining or pad of each wheel is measured immediately before the start of each running for braking with the vehicle in fixed position.
22. **"Brake Temperature Check Unit"**: A device to check the brake temperature by thermocouple measurement before the test vehicle's brakes is used.

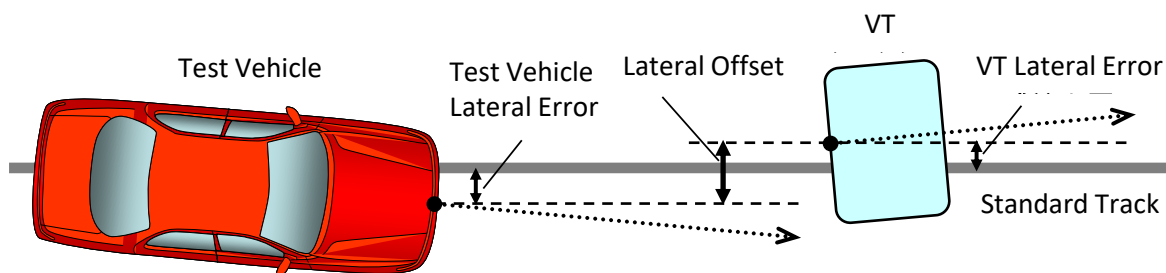


Figure 1: Lateral Error and Lateral Offset

4. Test Conditions

4.1 Provision of Data from Vehicle Manufacturer

Vehicle manufacturers, etc. shall provide NASVA with the following data required for test preparation (Appendix 1). Additionally, they will be able to record the results (referred hereinafter as "pre-data") of these tests into the Appendix 3 and send it to NASVA.

*If all of these test's conditions are not carried out at a satisfactory rate, the pre-data will not be applicable. To avoid confusion, leave said testing rate's column on Table 3 blank.

Furthermore, data cannot be submitted for reference.

4.2 Test Vehicle's Condition

The test vehicle's condition shall be as follows:

- (1) **Load Condition**: The mass of the test vehicle with one driver (including the measurement equipment) shall be the Mass at Vehicle Delivery + 200kg ($\pm 1\%$). Front axle/rear axle weight

distribution (%) shall be on a par ($\pm 5\%$) with that of the Mass at Vehicle Delivery.

If the preceding requirement is not met, parts may be removed or installed as long as the performance is not adversely affected. Weight-increasing parts should be securely fitted.

- (2) **Tires:** The tires installed at the time of purchase of the test vehicle shall be used. The breaking-in of the tires shall be done in conjunction with the brake conditioning of the following items. Additionally, the tire air pressure shall be set before running (normal temperature) on a level surface, at the value for ordinary run as described in the specification sheet.
- (3) **Brake system:** The brake discs, drums and linings that are installed at the time of the test vehicle's purchase shall be used after taking the steps prescribed in Item 4.1 "Brake Conditioning". The brake system shall be adjusted properly without any impact of abnormal heat history, getting wet, etc.
- (4) **Drive axis:** When the drive axis may be selected, choose the default.
- (5) **AEBS and FCWS setup:** If the driver can set up the activation timing of AEBS and/or FCW, use the median of the allowed scope. If there is no median (when the setup options are an even number), choose the value closest to the median on the side on which the timing of activation start will be later.
- (6) **Protection devices:** If passenger or pedestrian protection devices are installed, set such devices not to be activated.

4.3 Test Track

The test track shall meet the following requirements:

- (1) The test track shall be a flat, dry, and clean paved road surface without any leaves, dirt, etc.
- (2) The test track shall have a friction coefficient of about 0.9 under dry conditions. The measurement procedure shall comply with ASTM E1337. The test tires: ASTM E1136, the test load: $4586 \pm 67\text{N}$, the tire air pressure: $241 \pm 3\text{kPa}$, and the speed: $64 \pm 0.8\text{km/h}$.
- (3) During testing, there shall be no obstacles within a lateral distance of 3.0m to either side of the Standard Track and with a longitudinal distance of 30m ahead of the test vehicle when the test ends. Additionally, at the points where AEBS activation or deceleration by post-FCWS braking is expected to take place, there shall no road paint or markings.

4.4 Weather Conditions

- (1) The temperature during testing shall be $0^{\circ}\text{C} \sim 40^{\circ}\text{C}$.
- (2) The average wind speed during testing shall be 5m/s or less.
- (3) Visibility during testing shall be at least 1km.
- (4) A declaration by a vehicle manufacturer might allow the following tests under sunlight conditions to be avoided:
 - Illumination during testing is 2000Lux or less
 - A dark shadow from a source other than the test vehicle or VT near the Standard Track
 - Direct sunlight on the test vehicle from the front or the rear

- The temperature during testing is under 5°C

4.5 Measurement Items

The items of the test shall be measured as described below and the sampling frequency shall be 100Hz or more. Furthermore, for yaw rate and longitudinal acceleration, the high-frequency component shall be eliminated at a cutoff frequency of 10Hz.

- (1) T_{AEBS}
- (2) T_{FCWS}
- (3) Collision time
- (4) Test vehicle and VT positions
- (5) Test vehicle and VT speeds
- (6) Test vehicle and VT yaw rate
- (7) Test vehicle and VT longitudinal acceleration
- (8) Test vehicle steering velocity
- (9) Brake Pedal Stroke
- (10) Accelerator Stroke
- (11) Pre-Braking Brake Temperature

4.6 Measurement Equipment

The following measuring equipment for testing shall be capable of smoothly handling the data of the measurement items covered in Section 3.5. Additionally, before conducting the test, the vehicle position shall be verified. As for the other measurement equipment, accuracy shall be checked based on the results of calibration by the measurement equipment manufacturer.

- (1) Vehicle position measurement device: Accuracy of vehicle position for each test shall be $\pm 0.03\text{m}$.
- (2) Vehicle speed measurement device: Accuracy of test vehicle speed for each test shall be $\pm 0.1\text{km/h}$.
- (3) Yaw rate measurement device: Accuracy of yaw rate for each test shall be $\pm 0.1^\circ/\text{s}$.
- (4) Longitudinal acceleration measurement device: Accuracy of longitudinal acceleration for each test shall be $\pm 0.1\text{m/s}^2$.
- (5) Steering wheel velocity measurement device: Accuracy of steering wheel velocity for each test shall be $\pm 1^\circ/\text{s}$.
- (6) Brake pedal stroke measurement device: Accuracy of brake pedal stroke for each test shall be $\pm 1\text{mm}$.
- (7) Accelerator stroke measurement device: Accuracy of accelerator stroke for each test shall be $\pm 1\%$.
- (8) Brake Temperature Check Unit: Accuracy of temperature of each test shall be $\pm 3\%$.

5. Test Procedure

5.1 Brake Conditioning

To condition the brake discs, drums and linings of the test vehicle, (excluding the conditioning of that was carried out in other tests), the process of accelerating to 64km/h and braking to the result in deceleration of 3.7m/s² and vehicle stop shall be repeated 200 times. The interval between the initial and second braking shall be either the time required to reduce the brake temperature to 110°C~132°C or the distance of 1.6km, whichever occurs earlier. After every stop, the vehicle shall be accelerated to 64km/h and keep that speed until the next braking. (Brake Conditioning is equivalent to that provided in FMVSS105 S7.4.1.1.)

Furthermore, if the vehicle manufacturer requests it, the test vehicle is allowed to run up to 100km on ordinary roads to initialize sensor units. As long as the conditions required for initialization are met, the initialization work may be performed in conjunction with the above conditioning run.

5.2 Warm-up Run

Before starting the test, repeat the process of Item 5.1 at least 35 times for re-conditioning. Furthermore, if the conditioning in 5.1 was carried out more than two weeks before the test, the test vehicle can be reconditioned up to 50 times, depending on the braking system's condition.

5.3 Testing Methods

(1) Test scenario: Two types of tests shall be conducted for each of the AEBS and FCWS evaluation tests: CCRs with stationary VT and CCRm with VT towed at speed of 20km/h. (See Figure 2)

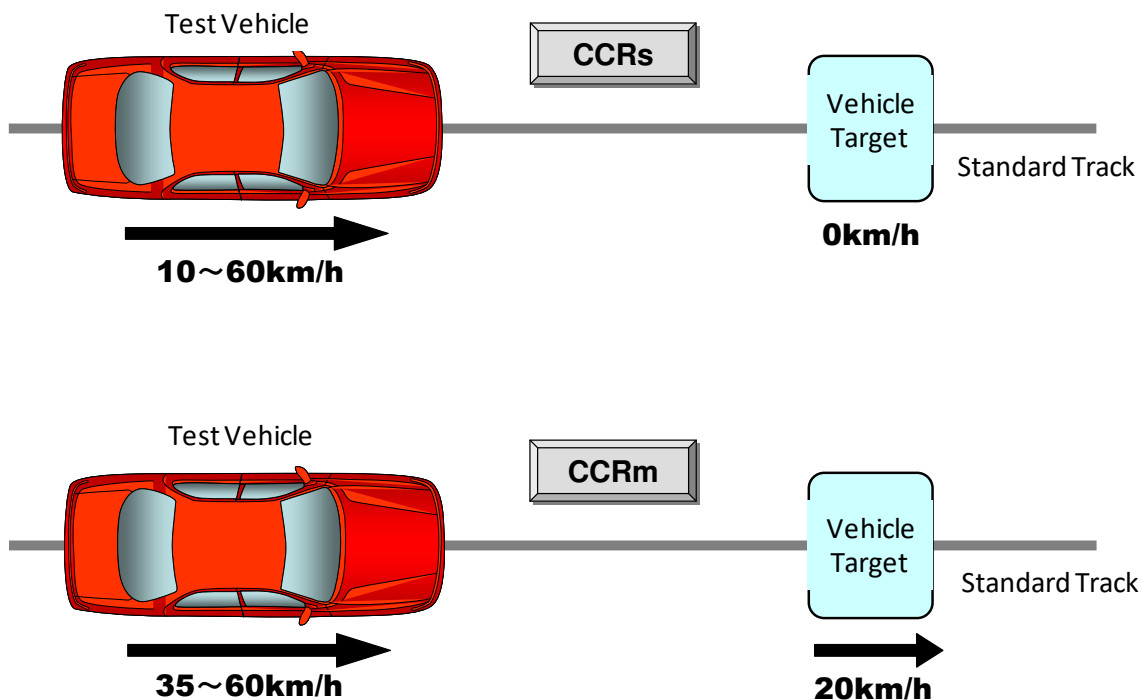


Figure 2: Test Scenario

(2) Test Vehicle Speed: The test vehicle's speed shall be within the parameters as described in Table 1, and the test will be performed by starting at the lowest speed and increasing it in increments of 5km/h or 10km/h. Furthermore, the vehicle's starting speed may be increased or decreased upon declaration of a vehicle manufacturer. In either case, however, results for the speeds not tested shall be handled in the same way as no activation of systems.

Table 1: Test Vehicle Speed

	AEBS Test	FCWS Test
CCRs Scenario	10~60km/h	10~60km/h
CCRm Scenario	35~60km/h	35~60km/h

(3) Transmission: For test vehicles with automatic transmissions, use the D-range. For vehicles with manual transmissions, use the highest gear where the engine's RPM will be at least 1500 at the test speed, and do not disengage the clutch during testing.

(4) Test Measurement Sections: Measurements shall start when the test vehicle approaches the VT and the TTC reaches 4.0 sec. Measurements shall finish when any of the following conditions are reached:

- a. The test vehicle is stopped
- b. The test vehicle's speed becomes lower than the VT speed
- c. The test vehicle collides with the VT

(5) Requirements for Successful Completion of Test: In the time between the initial measurement and the moment when the initial speed gap is obtained (until T_{AEBS} for the AEBS test, and at T_{AEBS} or T_{FCWS} for the FCWS test, whichever happens first), if the prescribed measurement items deviate from the permissible range shown in Table 2, the attempted test shall be deemed invalid (foul) and shall not be counted in the number of tests.

Table 2: Permissible Errors in Test Conditions

Test Condition	Permissible Range
Test Vehicle Speed	Test Vehicle Speed + 1.0 km/h or less
VT Speed	20.0 ± 1.0 km/h or less
Lateral Offset	± 0.20 m or less
Yaw Rate	± 1.0°/s or less
Steering Wheel Velocity	± 15.0°/s or less
Brake Temperature before braking	65-100°C

(6) Number of Tests: The tests shall be performed once for each test vehicle speed. However, if the vehicle manufacturer provides pre-data that shows a deviation of more than 5km/h in the descending speed between median value of pre-data and official test result, the test shall be conducted three times. Additionally, the third test can be omitted if the following conditions occur:

- A collision is avoided twice in a row
- The velocity reduction rate is same twice in a row

Furthermore, the number of pre-data tests is once in case collision avoided in each test speed. (or three times if it's not avoided) if it falls under the above 2 conditions. The third test can be omitted.

(7) Test Implementation Procedures: For both the CCRs and the CCRm, the tests shall be started at the lowest speed condition or the speed condition declared by the vehicle manufacturer. The test vehicle's speed shall be increased in increments of 5km/h; however, when collisions are avoided more than 2 times out of 3 tests, the test vehicle speed may be raised by 10km/h (the 5km/h increment will be passed). When collisions are avoided under a condition of 10km/h higher as well, collisions are deemed to be avoided for passed 5km/h increment. However, when collisions could not be avoided 2 times or more out of 3 tests, the test vehicle speed shall lowered by 5km/h and the test for passed 5km/h increment must also be performed.

Subsequently, take the same procedures to conduct tests up to the highest speed condition or the one declared by the vehicle manufacturer, etc. However, the test will be ended when the Velocity Reduction Amount becomes less than 5km/h or Vrel_impact becomes 50km/h or more for 2 times or more out of 3 tests. This result shall be recorded.

Additionally, when the CCRs' FCWS test speed is 55 or 60km/h, when the FCWS does not operate due to the TTC falling below 1.2 seconds, the driver will be able to avoid or alleviate

the collision by manually using the brakes. In this case, it will be recorded as the FCWS is not activated, and those test results will be invalid.

- (8) Accelerator Operation during the AEBS Test: During the measurement section, the accelerator stroke shall be held constant so as not to cause any impact on the activation of AEBS. Further, for those test vehicles on which the accelerator is controlled when AEBS is activated, upon consultation with the vehicle manufacturer, the accelerator stroke during AEBS activation may be adjusted.
- (9) Accelerator/Brake Operation during the FCWS Test: The test vehicle accelerator shall be released 1.0 seconds after T_{FCWS} . The brake pedal shall be pressed down 1.2 seconds after T_{FCWS} , taking 0.2 seconds to reach the point where deceleration under non-threat situation of $4.0 (+0.25)m/s^2$ is generated (however, maximum pedal application rate is at 400mm/s), and prescribed pedal force shall be maintained. For these brake operation setup values (Brake Pedal Stroke, application rate and pedal force), the value declared by the vehicle manufacturer shall be used. When the vehicle manufacturer submits no setup values or when the deceleration under non-threat situation exceeds the permissible range ($4.00\sim 4.25m/s^2$), the setup shall be performed by NASVA in accordance with the steps described in Appendix B.
- (10) When it is obvious that the same results with the AEBS test will be obtained from the FCWS test, the results of the AEBS test may be deemed the result of the test.

5.4 Measurement Data and Recording

- (1) Confirmed Completion of Testing: For each test, confirm whether the test conditions meet the permissible range of Table 2.
- (2) Collision Avoided Yes/No: For each test, confirm whether collisions were avoided, and record collisions in Appendix 2. Also, in case of collisions, record measurement data in the following page onward.
- (3) Initial Velocity Difference: Read the relative velocity, in units of 0.1km/h, of the test vehicle and the VT at T_{AEBS} for the AEBS test, and at T_{AEBS} or at T_{FCWS} - whichever the earlier point in time for the FCWS test, and record the Initial Velocity Difference.
- (4) Velocity Reduction Amount: From the above Initial Velocity Difference, deduct V_{rel_impact} read in units of 0.1km/h, and record the Velocity Reduction Amount obtained.
- (5) Velocity Reduction Rate: Divide the Velocity Reduction Amount by the Initial Velocity Difference, rounding off to two decimal places, and record the Velocity Reduction Rate obtained.

5.5 Recording Footage of the Tests

- (1) Images inside the vehicle: Images of front of the test vehicle, near the driver's seats and FCWS activation status shall be recorded by a video camera installed in the test vehicle interior. (Filming can be canceled in consultation with the vehicle manufacturer if poor lighting conditions hinder the quality of these images.)
- (2) Images outside the vehicle: Images of the test vehicle running and the status of collision or avoidance with the VT shall be recorded by a video camera installed by the test track. In these cases, the video camera shall be installed at a spot where the test vehicle and VT are expected to collide.

6. Organizing Test Results

6.1 Recording Test Conditions

The test conditions, the test vehicle specification, the test date, weather conditions during testing and the like shall be recorded in Appendix 2.

6.2 Test Results

- (1) Velocity Reduction Rate: The Velocity Reduction Rate of each test shall be either the most effective test result, or the median of 3 effective test results from pre-data. However, the Velocity Reduction Rate of the condition when collisions are avoided shall be 1.00. Furthermore, if only 2 tests are conducted, as per the provisos in 5.3 (6) and (7), use the velocity reduction rate for 5.3 (6), and use the lower result from the tests in 5.3 (7).

For each test, enter the Test Vehicle Speed and the Velocity Reduction Rate in the Test Result column of Appendix 2

- (2) Performance Evaluation: Based on the test subject (AEBS or FCWS), the test scenario (CCRs or CCRm) and the table of point allocation by test vehicle speed prescribed separately, the test vehicle evaluation shall be performed by applying the above Velocity Reduction Rate.

Supplementary Provision

For the AEBS test vehicle speed (5.3, (2) Table 1), in light of the safety of testing, tests will be performed at the following speeds; (60km/h→50km/h on CCRs scenario).

5.3 The Tests

(2) Test Vehicle Speed

Table 1: Test Vehicle Speed

	AEBS Test	FCWS Test
CCRs Scenario	10~50km/h	10~60km/h
CCRm Scenario	35~60km/h	35~60km/h

**APPENDIX 1: COLLISION DAMAGE MITIGATION PERFORMANCE [CAR-TO-CAR] TEST
CONDITIONS AND TEST VEHICLE SPECIFICATION**

[To be filled in by Vehicle Manufacturer]

1. Test Vehicle Specification

(1) Make/Model (Model name): _____

(2) Sensor System: _____

(3) Installed Tires

	Front	Rear
Size		
Brand/Type		
Air Pressure (kPa)		

2. Declarations by Vehicle Manufacturer

(1) AEBS Activation Lower Limit Speed (vehicle speed at test start) CCRs: _____ km/h
CCRm: _____ km/h

(2) AEBS Activation Upper Limit Speed (vehicle speed at test end) CCRs: _____ km/h
CCRm: _____ km/h

(3) FCWS Available or Not (FCWS test needed or not): Available / Not available

(4) FCWS Activation Lower Limit Speed (vehicle speed at test start) CCRs: _____ km/h
CCRm: _____ km/h

(5) FCWS Activation Upper Limit Speed (vehicle speed at test end) CCRs: _____ km/h
CCRm: _____ km/h

(6) FCWS specifications: Specifications of "audible/visual" or "audible/tactile" information, and document describing the position where such information is provided

(7) FCWS Test Brake Operation Setup Values

Brake Pedal Stroke: _____ mm Application rate: _____ mm/s Pedal force: _____ N

Accelerator/brake force (pre-data): Automated Driving System / Driver

(8) Timing Manual Setup at Activation Start?: Yes (_____)
No

(9) Limitations of sunlight conditions during testing: Applicable / NA (no need to consider daytime/nighttime, shadows, backlight, etc)

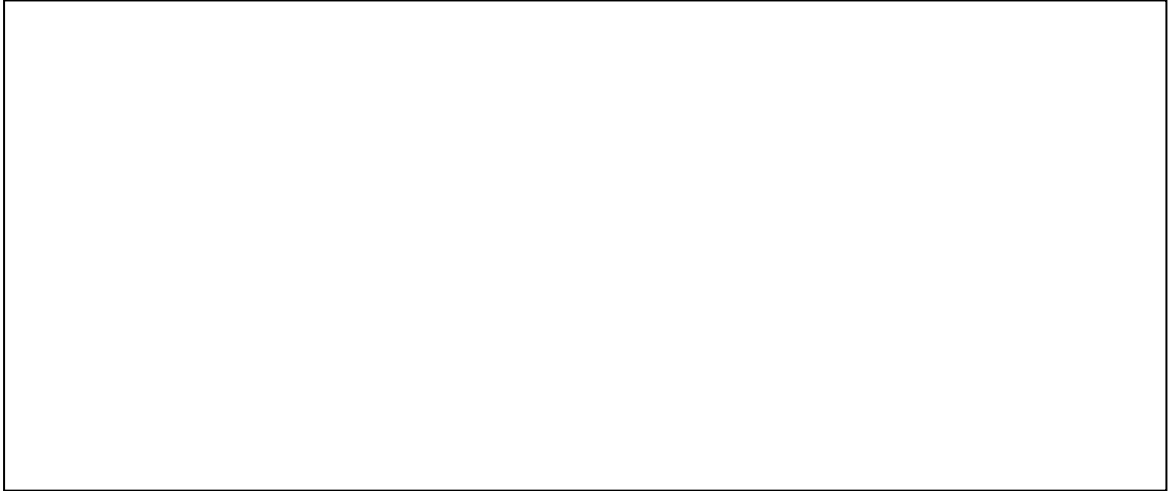
(10) Limit on number of AEBS activations: Applicable (up to _____ times per run) / NA

(11) Protection device: Document describing how to deactivate the passenger protection device

and pedestrian protection device, or document describing brief overview of the modification for deactivation

(12) Test results from the vehicle manufacturer: The vehicle manufacturer or importer shall attach the test results in Appendix 3 under "Pre-Data", as necessary.

(13) Notes

A large, empty rectangular box with a thin black border, intended for the user to provide notes as required by item (13).

3. Functions, Cautions, etc. of Systems to Support Users (HMI)

Documents shall be attached relating to the idea of the subjects and conditions of activation, and functions of systems, as determined by the vehicle manufacturer.

**APPENDIX 2: COLLISION DAMAGE REDUCTION SYSTEM [CAR-TO-CAR] PERFORMANCE
TEST RESULTS**

[To be filled in by Testing Institute]

Testing Date: (dd/mm/yyyy) _____ Location: _____ Overseer: _____

1. Test Vehicle Specifications

(1) Make/Model (model name): _____

(2) Frame number: _____

(3) Sensor system: _____

(4) Installed tires

	Front	Rear
Size		
Brand/Type		
Air pressure (kPa)		

(5) Test Vehicle Load Allocation

		Left	Right	Subtotal	Grand total	Pre/post allocation
Load distribution at vehicle delivery (daN)	Front					%
	Rear					%
Load distribution at the time of the test (daN)	Front					%
	Rear					%

(Note) Describe 1daN as 1kgf

2. Declarations by Vehicle Manufacturer

(1) AEBS Activation Lower Limit Speed (vehicle speed at test start) CCRs: _____ km/h CCRm: _____ km/h

(2) AEBS Activation Upper Limit Speed (vehicle speed at test end) CCRs: _____ km/h
CCRm: _____ km/h

(3) FCWS Available or Not (FCWS test needed or not): Available / Not available

(4) FCWS Activation Lower Limit Speed (vehicle speed at test start) CCRs: _____ km/h

CCRm: _____ km/h

(5) FCWS Activation Upper Limit Speed (vehicle speed at test end)CCRs: _____ km/h

CCRm: _____ km/h

(6) FCWS specifications: audible/visual information / audible/tactile information

(7) FCWS Test Brake Operation Setup Values

Brake Pedal Stroke: _____ mm Application rate: _____ mm/s Pedal force: _____ N

(8) Timing Manual Setup at start: Set up (_____) / NA

3. Environmental Conditions

Day 1 Testing Date: (dd/mm/yyyy)_____ Location:_____ Overseer_____

Test start time:_____ Weather:_____ Temp.:_____ Wind Speed:_____

Test end time:_____ Weather:_____ Temp.:_____ Wind Speed:_____

Remarks:_____

Day 2 Testing Date: (dd/mm/yyyy)_____ Location:_____ Overseer_____

Test start time:_____ Weather:_____ Temp.:_____ Wind Speed:_____

Test end time:_____ Weather:_____ Temp.:_____ Wind Speed:_____

Remarks:_____

Day 3 Testing Date: (dd/mm/yyyy)_____ Location:_____ Overseer_____

Test start time:_____ Weather:_____ Temp.:_____ Wind Speed:_____

Test end time:_____ Weather:_____ Temp.:_____ Wind Speed:_____

Remarks:_____

4. Test Results

(1) CCRs Scenario AEBS Test (a) (b) (c) = (a)-(b) (d) =(c)/ (a)

Vehicle Speed	Test #	Collision Avoided? Yes/No (*)	Initial Velocity Difference	Relative Speed at Collision	Velocity Reduction Amount	Velocity Reduction Rate	Velocity Reduction Rate Median
10km	1						
	2						
	3						
15km	1						
	2						
	3						
20km	1						
	2						
	3						
25km	1						
	2						
	3						
30km	1						
	2						
	3						
35km	1						
	2						
	3						
40km	1						
	2						
	3						
45km	1						
	2						
	3						
50km	1						
	2						
	3						

(*) ○: Collision avoided, P: Passed (deemed avoided), Δ: Speed reduced, x: No activation, —: Not implemented

(2) CCRs Scenario FCWS Test

(a)

(b)

(c) = (a)-(b)

(d) =(c)/ (a)

Vehicle Speed	Test #	Collision Avoided? Yes/No (*)	Initial Velocity Difference	Relative Speed at Collision	Velocity Reduction Amount	Velocity Reduction Rate	Velocity Reduction Rate Median
10km	1						
	2						
	3						
15km	1						
	2						
	3						
20km	1						
	2						
	3						
25km	1						
	2						
	3						
30km	1						
	2						
	3						
35km	1						
	2						
	3						
40km	1						
	2						
	3						
45km	1						
	2						
	3						
50km	1						
	2						
	3						

(*) ○: Collision avoided, P: Passed (deemed avoided), Δ: Speed reduced, ×: No activation, —: Not implemented

(3) CCRm Scenario AEBS Test

(a)

(b)

(c) = (a)-(b) (d) =(c)/ (a)

Vehicle Speed	Test #	Collision Avoided? Yes/No (*)	Initial Velocity Difference	Relative Speed at Collision	Velocity Reduction Amount	Velocity Reduction Rate	Velocity Reduction Rate Median
10km	1						
	2						
	3						
15km	1						
	2						
	3						
20km	1						
	2						
	3						
25km	1						
	2						
	3						
30km	1						
	2						
	3						
35km	1						
	2						
	3						
40km	1						
	2						
	3						
45km	1						
	2						
	3						
50km	1						
	2						
	3						

(*) ○: Collision avoided, P: Passed (deemed avoided), △: Speed reduced, ×: No activation, —: Not implemented

(4) CCRm Scenario FCWS Test

(a)

(b)

(c) = (a)-(b)

(d) =(c)/ (a)

Vehicle Speed	Test #	Collision Avoided? Yes/No (*)	Initial Velocity Difference	Relative Speed at Collision	Velocity Reduction Amount	Velocity Reduction Rate	Velocity Reduction Rate Median
10km	1						
	2						
	3						
15km	1						
	2						
	3						
20km	1						
	2						
	3						
25km	1						
	2						
	3						
30km	1						
	2						
	3						
35km	1						
	2						
	3						
40km	1						
	2						
	3						
45km	1						
	2						
	3						
50km	1						
	2						
	3						

(*) ○: Collision avoided, P: Passed (deemed avoided), Δ: Speed reduced, x: No activation, —: Not implemented

APPENDIX 3: COLLISION DAMAGE REDUCTION SYSTEM [CAR-TO-CAR] PERFORMANCE TEST RESULTS [PRE-DATA]

[If the manufacturer fails to comply with the testing method requirements, their data will be deemed unusable and cannot be used as reference.]

Testing Date: (dd/mm/yyyy) _____ Location: _____ Overseer: _____

1. Test Vehicle Specifications

(1) Make/Model (model name): _____

(2) Sensor system: _____

(3) Installed tires

	Front	Rear
Size		
Brand/Type		
Air pressure (kPa)		

(4) Test Vehicle Load Allocation

		Left	Right	Subtotal	Grand total	Pre/post allocation
Load distribution at vehicle delivery (daN)	Front					%
	Rear					%
Load distribution at the time of the test (daN)	Front					%
	Rear					%

(Note) Describe 1daN as 1kgf

2. Testing Conditions:

(1) AEBS Activation Lower Limit Speed (vehicle speed at test start) CCRs: _____ km/h

CCRm: _____ km/h

(2) AEBS Activation Upper Limit Speed (vehicle speed at test end) CCRs: _____ km/h

CCRm: _____ km/h

(3) FCWS Available or Not (FCWS test needed or not): Available / Not available

(4) FCWS Activation Lower Limit Speed (vehicle speed at test start) CCRs: _____ km/h

CCRm: _____ km/h

- (5) FCWS Activation Upper Limit Speed (vehicle speed at test end) CCRs: _____ km/h
 CCRm: _____ km/h
- (6) FCWS specifications: audible/visual information / audible/tactile information
- (7) FCWS Test Brake Operation Setup Values
 Brake Pedal Stroke: _____ mm Application rate: _____ mm/s Pedal force: _____ N
- (8) Timing Manual Setup at start: Set up (_____) / NA
- (9) Accelerator/Brake Operator: Automatic driving device / Human driver

[If a human driver is operating the accelerator/brakes, record the measured values in Testing Methods 5.3(9): Accelerator/Brake Operation during the FCWS Test.]

3. Environmental Conditions

Day 1 Testing Date: (dd/mm/yyyy)_____ Location:_____ Overseer_____

Test start time:_____ Weather:_____ Temp.:_____ Wind Speed:_____

Test end time:_____ Weather:_____ Temp.:_____ Wind Speed:_____

Remarks:_____

Day 2 Testing Date: (dd/mm/yyyy)_____ Location:_____ Overseer_____

Test start time:_____ Weather:_____ Temp.:_____ Wind Speed:_____

Test end time:_____ Weather:_____ Temp.:_____ Wind Speed:_____

Remarks:_____

Day 3 Testing Date: (dd/mm/yyyy)_____ Location:_____ Overseer_____

Test start time:_____ Weather:_____ Temp.:_____ Wind Speed:_____

Test end time:_____ Weather:_____ Temp.:_____ Wind Speed:_____

Remarks:_____

4. Test Results

(1) CCRs Scenario AEBS Test (a) (b) (c) = (a)-(b) (d) =(c)/ (a)

Vehicle Speed	Test #	Collision Avoided? Yes/No (*)	Initial Velocity Difference	Relative Speed at Collision	Velocity Reduction Amount	Velocity Reduction Rate	Velocity Reduction Rate Median
10km	1						
	2						
	3						
15km	1						
	2						
	3						
20km	1						
	2						
	3						
25km	1						
	2						
	3						
30km	1						
	2						
	3						
35km	1						
	2						
	3						
40km	1						
	2						
	3						
45km	1						
	2						
	3						
50km	1						
	2						
	3						

(*) ○: Collision avoided, P: Passed (deemed avoided), Δ: Speed reduced, ×: No activation, —: Not implemented

(2) CCRs Scenario FCWS Test

(a)

(b)

(c) = (a)-(b) (d) =(c)/ (a)

Vehicle Speed	Test #	Collision Avoided? Yes/No (*)	Initial Velocity Difference	Relative Speed at Collision	Velocity Reduction Amount	Velocity Reduction Rate	Velocity Reduction Rate Median
10km	1						
	2						
	3						
15km	1						
	2						
	3						
20km	1						
	2						
	3						
25km	1						
	2						
	3						
30km	1						
	2						
	3						
35km	1						
	2						
	3						
40km	1						
	2						
	3						
45km	1						
	2						
	3						
50km	1						
	2						
	3						

(*) ○: Collision avoided, P: Passed (deemed avoided), △: Speed reduced, ×: No activation, —: Not implemented

(3) CCRm Scenario AEBS Test

(a)

(b)

(c) = (a)-(b) (d) =(c)/ (a)

Vehicle Speed	Test #	Collision Avoided? Yes/No (*)	Initial Velocity Difference	Relative Speed at Collision	Velocity Reduction Amount	Velocity Reduction Rate	Velocity Reduction Rate Median
10km	1						
	2						
	3						
15km	1						
	2						
	3						
20km	1						
	2						
	3						
25km	1						
	2						
	3						
30km	1						
	2						
	3						
35km	1						
	2						
	3						
40km	1						
	2						
	3						
45km	1						
	2						
	3						
50km	1						
	2						
	3						

(*) ○: Collision avoided, P: Passed (deemed avoided), Δ: Speed reduced, ×: No activation, —: Not implemented

(4) CCRm Scenario FCWS Test

(a)

(b)

(c) = (a)-(b)

(d) =(c)/ (a)

Vehicle Speed	Test #	Collision Avoided? Yes/No (*)	Initial Velocity Difference	Relative Speed at Collision	Velocity Reduction Amount	Velocity Reduction Rate	Velocity Reduction Rate Median
10km	1						
	2						
	3						
15km	1						
	2						
	3						
20km	1						
	2						
	3						
25km	1						
	2						
	3						
30km	1						
	2						
	3						
35km	1						
	2						
	3						
40km	1						
	2						
	3						
45km	1						
	2						
	3						
50km	1						
	2						
	3						

(*) ○: Collision avoided, P: Passed (deemed avoided), Δ: Speed reduced, x: No activation, —: Not implemented

ATTACHMENT A: VT SPECIFICATIONS

For the VT, those having specifications equivalent to those of the Euro-NCAP (Test Protocol - AEBS systems Version1.0 July 2013 ATTACHMENT A EVT SPECIFICATIONS) shall be used. (Currently, only "ADAC Advanced Emergency Braking System (AEBS)" by Messring Systembau (<http://www.messring.de/test-facilities-and-components/adac/>) meets the specifications.)

Attached Diagram 1 shows external appearance of the VT.

The VT is designed to be detected by such sensors as laser radars, millimeter-wave radars and cameras in an equivalent manner to Segment C vehicles in the EU.

A "JNCAP" logo made of fabric shall be placed in the license plate position of the VT. VT air pressure shall be set to 25kPa, which will be maintained during testing.



Attached Diagram 1: External appearance of VT

ATTACHMENT B: HOW TO SET UP BRAKE OPERATIONS FOR FCWS TEST

B.1 Definitions

- (1) T_{BRAKE} : When the brake pedal stroke exceeded 5mm
- (2) $T_{2\text{m/s}^2}$: When the filtered deceleration data exceeded 2m/s^2 for the first time
- (3) $T_{6\text{m/s}^2}$: When the filtered deceleration data exceeded 6m/s^2 for the first time

B.2 Measurement Method

Apply the measurement method and filtering described in Chapter 3.

B.3 Test Procedure for Brake Input Characteristics

B.3.1 Test Preparation

Perform the warm-up operation of brakes and tires described in 5.2 first. Check brake input characteristics right before conducting the FCWS test.

B.3.2 Brake Input Characteristics Test

- (1) Accelerate the test vehicle to be 85km/h or more. For test vehicles with automatic transmissions, select D-gear. For vehicles with manual transmissions, select the highest gear where the RPM will be at least 1500 at the test speed.
- (2) Release the accelerator and when the speed becomes slower than $80 (\pm 1)$ km/h, start applying brakes at the pedal application rate of $20(\pm 5)$ mm/s until deceleration becomes 7m/s^2 . For manual transmissions, throw out the clutch at the earliest timing possible before the RPM will be 1500rpm or less. When the deceleration becomes 7m/s^2 , end the test and measure the Brake Pedal Stroke and pedal force in operation.
- (3) Perform the above test 3 times in a row. The interval between tests shall be between 90 seconds and 10 minutes, and when 10 minutes is passed, perform the warm-up operation again before resuming the test.
- (4) Based on the deceleration data from the Brake Pedal Stroke between $T_{2\text{m/s}^2}$ and $T_{6\text{m/s}^2}$, apply quadratic curve approximation using least square, and calculate the Brake Pedal Stroke corresponding to deceleration 4m/s^2 (which shall be "D4" in unit of m. For the pedal force as well, use the same method to obtain the pedal force value corresponding to deceleration 4m/s^2 (which shall be "F4" in unit of N).

B.3.3 How to Set Up Brake Pedal Force and Repeating the Procedure

- (1) Run the test vehicle constantly at $80(+1)$ km/h. The test vehicle gear position shall be the same as B.3.2.
- (2) By manual trigger, not in response to FCWS, apply the brakes in accordance with the steps described in B.4. Based on the measured deceleration data, obtain average deceleration of the sections from $T_{\text{BRAKE}+1}$ sec to $T_{\text{BRAKE}+3}$ sec. If the average deceleration deviates from 4

(+0.25)m/s², use the correction formula below to correct the F4 value.

$$F4_{\text{new}} = F4_{\text{original}} * (4 / \text{average deceleration})$$

(e.g., when average deceleration is 5m/s², $F4_{\text{new}} = F4_{\text{original}} * 4 / 5$)

Use the corrected F4 and repeat brake operations of B.4 so that the average deceleration will be within a scope of 4 (+0.25)m/s².

B.4 Brake Operations during FCWS Test

- (1) Detect the activation of FCWS, time of which shall be T_{FCW} .
- (2) Release the accelerator at $T_{FCW}+1$ sec.
- (3) Brake pedal stroke control shall start at $T_{FCW}+1.2$ sec, and the application rate shall be either $D4 \times 5$ mm/s or 400mm/s, whichever is smaller. (In other words, it shall be the speed at which the stroke reaches D4 in 200ms, and the upper limit value shall be 400mm/s.)
- (4) Monitor the pedal force values processed by second-order filtering with a cutoff frequency 20Hz or moving average at 50ms, and upon reaching either of the following, switch to the pedal force control with target value of F4. The time of the switch shall be recorded as T_{switch} .
 - a. When the stroke D4 defined in B.3 is exceeded for the first time.
 - b. When the pedal force value F4 defined in B.3 is exceeded for the first time.

Furthermore, when it is shifted to pedal force control before reaching enough pedal stroke after performing filtering, etc., upon consultation with the vehicle manufacturer, T_{switch} timing may be adjusted. (For example, take a measure not to switch to pedal force control until reaching certain pedal stroke.)

- (5) At T_{switch} onward, control the brake pedal in such a way that the pedal force will be $F4 \pm 25\%$. Stable pedal force control should be realized within 200ms from T_{switch} ; however, even when the pedal force value exceeds $F4 \pm 25\%$ due to intervention by AEBS, it shall be acceptable when duration is 200ms or less.
- (6) It is desirable that the pedal force average value will be in the range of $F4 \pm 10N$ from $T_{FCW}+1.4$ sec to the end of the test.