

Test Procedure on Safety of Fuel Systems for Passenger Cars

1. Scope

This standard specifies the test procedure for evaluation of safety of fuel systems for passenger cars (hereinafter referred to as "automobiles") that use fuels having boiling points of 0°C or higher.

Remark: In this standard, units and numerical values are based on SI (International System of Units), while units and numerical values given in { } are of customary systems of units indicated for reference.

2. Purpose

This standard aims to standardize the test procedure on safety of the fuel system, in order to minimize the risk of fire that may be caused by fuel leakage from the fuel system in the event of turning, panic braking or collision.

3. Definitions

Definitions of major terms to be used in this standard are as follows.

(1) Fuel systems

The system consisting of all parts in which fuel is present, such as the fuel tank, filler hose, filler cap, piping, etc. (Refer to the following Figure)

(2) Test Fuel

The fuel used in the test vehicle, or a substitute fuel to be used, in terms of the safety and the handling ease in the test.

(3) Fixed Barrier

A fixed barrier to be used in the automobile collision test.

(4) Moving Barrier

A movable barrier to be used in the automobile collision test.

(5) Longitudinal Median Plane (of Automobile)

The vertical plane passing through the center point of the right and left wheels of the automobile in the straight forward running posture. The OY plane specified under JIS D 0030 (Three-dimensional Reference System for Automobiles).

(6) Fuel Tank Capacity

Nominal capacity of fuel system.

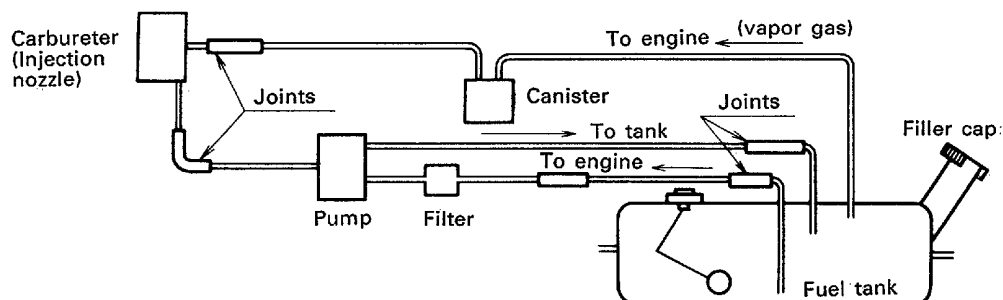
(7) During the Collision

Time required for the test vehicle to stop from the moment of collision.

(8) After the Collision

Period after the test vehicle has stopped.

Fig. An Example of Fuel System



Applicable Standards: Refer to 8

Reference Standards: Refer to 8

4. Test Items

Test items shall be as given below. However, either one of test items 4.1 and 4.2, and either one of 4.3 and 4.4 may be selected.

4.1 Turning Test

A test to turn the automobile to determine the fuel leakage from the fuel system.

4.2 Side Tilting Test

A test to tilt the automobile sideward to determine the fuel leakage from the fuel system.

4.3 Braking Test

A test to brake the automobile to determine the fuel leakage from the fuel system.

4.4 Vertical Tilting Test

A test to tilt the automobile vertically to determine the fuel leakage from the fuel system.

4.5 Frontal Collision Test

A test to have the automobile collide against the fixed barrier head on, in order to determine the fuel leakage from the fuel system.

4.6 Rear Collision Test

A test to have a moving barrier collide against the back of the automobile, in order to determine the fuel leakage from the fuel system.

5. Test Methods

5.1 Turning Test

5.1.1 Measuring Items

- (1) The centripetal acceleration during the turning.
- (2) Fuel leakage from the fuel system and its conditions, if any.

5.1.2 Proving Ground and Test Equipment

(1) Proving ground

The proving ground shall have a flat and even concrete or asphalt paved road surface, and an adequate space to cope with unexpected running of the test vehicle during the turning. It is recommended that a turning radius for the test is drawn on the proving ground.

(2) Measuring Instrument for centripetal Acceleration

An instrument capable of accurate measurement of the centripetal acceleration.

(3) Tracing Device

A device to record the running locus of the automobile, which shall be used only when it is particularly required.

5.1.3 Test Conditions

(1) Conditions of Test Vehicle

- (a) Standard parts and equipment shall be installed on portions of the vehicle, that may affect substantially on test results.
- (b) The tire pneumatic pressure shall be as specified.
- (c) The test fuel shall be filled to 90% or more of the fuel tank capacity.

(2) Proving Ground Road Surface and Meteorological Conditions

Proving ground road surface and meteorological conditions shall be as specified under 4.2 of JIS D 0210 (General Rules of Brakes of Automobiles and Motor Cycles).

(3) Turning Conditions

- (a) The test vehicle shall be driven at constant speed and circularly at a centripetal acceleration of 4.9 m/s² {0.5G} or greater, along the given circle. The duration of the centripetal acceleration shall be 10 seconds or longer. The centripetal acceleration shall be calculated by the following equation.

$$\alpha = 4.02 \frac{R}{T^2}$$

Where,

α : centripetal acceleration (m/s²)
{G} (gravitational acceleration)

R : turning radius (m)

T : time (s) required for a constant circular turning

- (b) The test shall be carried out for right and left turnings.

5.1.4 Test Procedure

- (1) Carry out the inspection and maintenance of the test vehicle and the test equipment.

running of the test vehicle on sudden braking.

(2) Deceleration Measuring Instrument

An instrument capable of accurate measurement of the deceleration during braking.

5.3.3 Test Conditions

(1) Conditions of Test Vehicle

- (a) Standard parts and equipment shall be installed on portions of the test vehicle, that may affect substantially on test results.
- (b) The test vehicle shall have normal braking performance.
- (c) The test fuel shall be filled to 90% or more of the fuel tank capacity.

(2) Proving Ground and Meteorological Conditions

As specified under 4.2 of JIS D 0210.

(3) Initial Speed

The initial speed shall be 100 km/h or higher. For light passenger cars, it shall be 80 km/h or higher.

(4) Braking Deceleration

5.9 m/s² {0.6G} or more

5.3.4 Test Procedure

- (1) Carry out the inspection and maintenance of the test vehicle and the test equipment.
- (2) Check the road surface conditions.
- (3) After accelerating the test vehicle to the specified initial speed, brake the vehicle at the specified deceleration.
- (4) Check to see if the fuel leaks out of the fuel systems, and the conditions of leakage, if any.
- (5) Record test data as follows.
 - (a) Date of test
 - (b) Place of test
 - (c) Specifications of test vehicle
 - Name and model of test vehicle
 - Chassis number
 - Type of engine installed on the test vehicle
 - Kind of fuel
 - (d) Initial speed
 - (e) Deceleration during braking
 - (f) Fuel leakage from the fuel system and its conditions, if any.
 - (g) Quantity of test fuel filled

5.4 Vertical Tilting Test

5.4.1 Measuring Items

- (1) Tilting angle of the tilting board
- (2) Fuel leakage from the fuel system and its conditions, if any.

5.4.2 Test Equipment

(1) Tilting Test Equipment

It shall be capable of tilting the board to 37° or more from the horizontal plane, with the test vehicle installed on the board.

(2) Tilting Angle Measuring Instrument

It shall be capable of accurate measurement of the tilting angle of the tilting board.

5.4.3 Test Conditions

(1) Conditions of Test Vehicle

- (a) Standard parts and equipment shall be installed on portions of the test vehicle, that may substantially affect on test results.
- (b) The test fuel shall be filled to 90% or more of the fuel tank capacity.

(2) Tilting Conditions

- (a) Set the test vehicle on the tilting board in such a manner that the median plane becomes vertical to the rotation axis and the vehicle faces the rotation axis.
- (b) Tilt the tilting board at a given velocity, until the tilting board inclines to 37° or more against the horizontal plane and hold the tilting angle for 10 seconds or longer, unless otherwise specified. However, some other optional tilting angle and its duration time may be selected according to the particularly purpose of the test.

5.4.4 Test Procedure

- (1) Carry out the inspection and maintenance of the test vehicle and test equipment.
- (2) Tilt the tilting board to the specified angle.
- (3) Check to see if the fuel leaks out of fuel system, and conditions of the leakage, if any.

(4) Record test data as follows.

- (a) Date of test
- (b) Place of test
- (c) Specifications of test vehicle
 - Name and model of test vehicle
 - Chassis number
 - Type of engine installed on the test vehicle
 - Kind of fuel
- (d) Tilting angle of tilting board
- (e) Fuel leakage from the fuel system and its conditions, if any.
- (f) Quantity of test fuel filled

5.5 Frontal Collision Test**5.5.1 Measuring Items****(1) Collision Speed**

The measurement of the speed shall be done as follows.

- (a) The distance between the location of the measurement and the collision spot shall not be more than 3 m.
- (b) Measure the time required for the test vehicle to travel over a given distance, or the distance travelled over for a given period of time.

(2) Fuel leakage from the fuel system and the measurement of the quantity of fuel leakage, if any.

- (a) Check to see immediately after the collision, whether any fuel leaked out of the fuel system during the collision, by means of visual inspection.
- (b) If any fuel leakage is found after the collision, collect the fuel flowing or dripping out of the fuel system, using a pan, etc. Determine the quantity (mass) of the fuel leaked out during the five minute period.

(3) Mass of test vehicle**5.5.2 Proving Ground and Test Equipment****(1) Test Course**

The proving ground shall be as follows.

- (a) Running course : it shall have an adequate space to accommodate the fixed barrier and other equipment necessary for the test.
- (b) The road surface of the zone of 15 m in front of the collision spot shall be firm and horizontal. The gradient of any 1 m portion of the zone shall be 3% or less.

(2) Fixed Barrier

The fixed barrier shall be as follows.

- (a) The portions above the ground shall consist of reinforced concrete blocks of a width 3 m or wider, a height of 1.5 m or higher, and the thickness 0.6 m or more. The mass shall be 70 ton or more.
- (b) The front of the barrier shall be flat and vertical, and covered by plywoods with the thickness of 20±2 mm. Metal sheets or structures having high rigidity may be inserted between the plywoods and the fixed barrier.

(3) Traction Equipment

It shall be as follows.

- (a) It shall be capable of accelerating the test vehicle to the specified speed according to the purpose of the test, and holding the speed nearly constant.
- (b) It shall be so constructed that the traction force and the guide system are released from the test vehicle immediately before the collision.

Remark: The installation of a jig or a guide system on the test vehicle to be tracted shall not have adverse effects on the performance of the test vehicle.

(4) Pit

It is recommended to equip with a pot on the running course near the collision spot, which should not impede the posture and behavior of the test vehicle.

(5) Speed Measuring Instrument

The instrument shall have the accuracy of less than ±1%, and the resolution of 0.5 km/h.

5.5.3 Test Conditions**(1) Conditions of Test Vehicle**

- (a) **Test vehicle mass:** it shall be the mass under standard equipment conditions. However, if any other specification is given according to the particular purpose of the test, it shall be followed.

The removal or addition of parts or auxiliary weights may be done in order to adjust the mass, when such parts or weights do not affect on test results.

- (b) Vehicle accessories and optional parts shall be installed as called for.
- (c) Coolant, lubricating oil, battery fluid, etc. may be drained out of the vehicle, when the draining does not affect on test results.
- (d) Test fuel shall be filled to 90% or more of the fuel tank capacity.
- (e) Test fuel shall be filled into the fuel pipe similarly to the normal condition.
- (f) The tire pneumatic pressure shall be as specified.
- (g) The transmission gear shall be at the neutral position.
- (h) The door lock shall be released.
- (i) For a test vehicle equipped with an electric fuel pump, the pump shall operate at the time of collision, if the pump is such that it operates whenever the electric system is working.

(2) Conditions of Collision

The conditions shall be as follows.

- (a) The test vehicle shall be collided against the barrier in such a manner that the deviation of the longitudinal median plane from the intended collision angle is less than 2°.
- (b) The lateral deviation between the vertical median plane, that crosses normally to the fixed barrier, and the test vehicle longitudinal median plane shall be within 300 mm.

(3) Collision Speed

It shall be within the range specified according to the test purpose.

The collision speed of the test vehicle against the fixed barrier shall be, however, within 48 to 52 km/h, and the speed for a light passenger car shall be 38 to 42 km/h unless otherwise specified.

5.5.4 Test Procedure

- (1) Carry out the inspection and maintenance of the test vehicle and test equipment.
- (2) Set the test vehicle in such a manner that the vehicle will collide against the fixed barrier at the specified location and the direction.
- (3) Collide the test vehicle against the fixed barrier at the specified speed.

- (4) Check to see if the fuel leaks out of the fuel system, and determine the quantity of leakage, if any.

(5) Record test data as follows.

- (a) Data of test
- (b) Place of test
- (c) Specifications of test vehicle
 - Name and model of test vehicle
 - Chassis number
 - Type of engine installed on the test vehicle
 - Kind of fuel
- (d) Collision speed
- (e) Whether fuel leaked out of the fuel system or not. If any leakage is found, draw the schematic of the fuel system and the location of the leakage.
- (f) Quantity (mass) of the leakage during the five minutes after the collision.
- (g) Test vehicle mass
- (h) Name of test fuel used
- (i) Quantity of test fuel filled

5.6 Rear Collision Test

5.6.1 Measuring Items

- (1) **Moving barrier collision speed:** the measurement of the speed shall be done as follows.

- (a) The distance between the location of the measurement and the collision spot shall not be more than 3 m.
- (b) Measure the time required for the moving barrier to travel over a given distance or the distance travelled in for a given period of time.

(2) **Fuel leakage from the fuel system and the measurement of the quantity of the leakage, if any.**

- (a) Check to see immediately after the collision whether any fuel leaked out of the fuel system during the collision, by means of visual inspection.
- (b) If any fuel leakage is found after the collision, collect the fuel flowing or dripping out of the fuel system, using a pan, etc. Determine the quantity (mass) of the fuel leaked out during the five minute period.

(3) **Mass of test vehicle**

- (2) Check the road surface conditions.
- (3) Accelerate the test vehicle until the specified centripetal acceleration is obtained, and turn the vehicle constantly and circularly.
- (4) Check to see if the fuel leaks out of the fuel system, and conditions of the leakage, if any.
- (5) Record test data as follows.
 - (a) Date of test
 - (b) Place of test
 - (c) Specifications of test vehicle
 - Name and model of test vehicle
 - Chassis number
 - Type of engine installed on the test vehicle
 - Kind of fuel
 - (d) Centripetal acceleration
 - (e) Fuel leakage from the fuel system and its conditions, if any.
 - (f) Quantity of test fuel filled.

5.2 Sideward Tilting Test

5.2.1 Measuring Items

- (1) Tilting angle of the tilting board
- (2) Fuel leakage from the fuel system and its conditions, if any.

5.2.2 Test Equipment

- (1) **Tilting Test Equipment**
It shall be capable of tilting the board to 30° or more from the horizontal plane, with the test vehicle installed on the board.
- (2) **Tilting Angle Measuring Instrument**
It shall be capable of accurate measurement of the tilting angle of the tilting board.

5.2.3 Test Conditions

- (1) **Conditions of Test vehicle**
 - (a) Standard parts and equipment shall be installed on portions of the test vehicle, that may affect substantially on test results.
 - (b) The test fuel shall be filled to 90% or more of the fuel tank capacity.
- (2) **Tilting Conditions**
 - (a) Set the test vehicle on the tilting board in such a manner that the test vehicle median plane becomes

parallel to the rotation axis of the tilting board.

- (b) Tilt the tilting board at a given velocity, until the tilting board inclines to 30° or more against the horizontal plane, and hold the tilting angle for 10 seconds or longer unless otherwise specified. However, some other optional angle and the duration may be selected, according to the particular purpose of the test.
- (c) Carry out right and left tilting tests.

5.2.4 Test Procedure

- (1) Carry out the inspection and the maintenance of the test vehicle and test equipment.
- (2) Tilt the tilting board to the specified angle.
- (3) Check to see if the fuel leaks out of the fuel system, and conditions of the leakage, if any.
- (4) Record test data as follows.
 - (a) Data of test
 - (b) Place of test
 - (c) Specifications of test vehicle
 - Name and model of test vehicle
 - Chassis number
 - Type of engine installed on the test vehicle
 - Kind of fuel
 - (d) Tilting angle of tilting board
 - (e) Fuel leakage from the fuel system and its conditions, if any.
 - (f) Quantity of test fuel filled

5.3 Braking Test

5.3.1 Measuring Items

- (1) Initial speed
- (2) Deceleration during the braking
- (3) Fuel leakage from the fuel system and its conditions, if any.

5.3.2 Proving Ground and Test Equipment

- (1) **Proving Ground**
The proving ground shall have a flat and even concrete or asphalt paved road surface and an adequate course to accelerate and brake the test vehicle. The width of the test course shall be adequate to cope with unexpected

5.6.2 Proving Ground and Test Equipment

(1) Test Course

The proving ground shall be as follows.

- (a) It shall have an adequate space to accommodate a running course and other equipment necessary for the test.
- (b) The road surface of the zone of 15m in front of the collision spot shall be firm and horizontal, and the gradient of any 1 m portion on the zone shall be 3%.

(2) Moving Barrier

The barrier shall be as follows.

- (a) The collision surface shall be flat vertical and firm plane that will not be deformed by the collision, and its dimensions shall be as given on **Table** below. However, these dimensions shall not be applied when the dimensions are specified otherwise according to the test purpose.

Table Dimensions of Collision Surface

Unit: mm

Width	Height	Ground clearance of lower end
2,500 or more	800 or more	175±25

- (b) The collision surface shall be covered by plywoods with the thickness of 20 ± 2 mm.
- (c) The collision surface shall be normal to the longitudinal axis of the moving barrier.
- (d) The main structure of the moving barrier shall not absorb the collision energy by deformation, etc. upon collision.
- (e) It shall be so constructed that the second collision with the test vehicle can be avoided.
- (f) The gross mass shall be $1,100 \pm 20$ kg. This may not be applied when a different specification is given according to the particular purpose of the test.

(3) Traction Equipment

It shall be as follows.

- (a) It shall be capable of accelerating

the moving barrier to the specified speed according to the purpose of the test, and holding the speed nearly constant.

- (b) It shall be so constructed that the traction force and the guide system are released from the test vehicle immediately before the collision.

Remark: The installation of a jig or a guide system on the test vehicle to be tracted shall not have adverse effects on the performance of the test vehicle.

(4) Pit

It is recommended to equip with a pit on the running course near the collision spot, which should not impede the posture and behavior of the test vehicle.

(5) Speed Measuring Instrument

The instrument shall have the accuracy of within the range of $\pm 1\%$, and the resolution of 0.5 km/h.

5.6.3 Test Conditions

(1) Conditions of Test Vehicle

- (a) **Test vehicle mass:** it shall be the mass under standard equipment conditions. However, if any other specification is given according to the particular purpose of the test, it shall be followed.

The removal or addition of parts or auxiliary weights may be done in order to adjust the mass, when such parts or weights do not affect on test results.

- (b) Vehicle accessories and optional parts shall be installed as called for.
- (c) Coolant, lubricating oil, battery fluid, etc. may be drained out of the vehicle, when the draining does not affect on test results.
- (d) Test fuel shall be filled to 90% or more of the fuel tank capacity.
- (e) Test fuel shall be filled into the fuel pipe similarly to the normal condition.
- (f) The tire pneumatic pressure shall be as specified.
- (g) The transmission gear shall be at the neutral position.
- (h) The parking brake shall be released, unless otherwise specified.
- (i) The door lock shall be released.
- (j) For a test vehicle equipped with an electric fuel pump, the pump shall

operate at the time of collision, if the pump is such that it operates whenever the electric system is working.

(2) Condition of Collision

The condition shall be as follows.

- (a) The moving barrier shall be collided against the barrier in such a manner that the deviation of the longitudinal median plane from the intended collision angle is less than 2°.
- (b) The lateral deviation between the vertical median plane, that crosses normally to the moving barrier, and the test vehicle longitudinal median plane shall be within 300 mm.

(3) Collision speed

It shall be within the range specified according to the test purpose.

The collision speed of the moving barrier against the test vehicle shall be, however, within 35 to 38 km/h unless otherwise specified.

5.6.4 Test Procedure

- (1) Carry out the inspection and maintenance of the test vehicle and test equipment.
- (2) Set the test vehicle and the moving barrier in such a manner that the moving

barrier will collide against the test vehicle at the specified location and the direction.

- (3) Collide the moving barrier against the test vehicle at the specified speed.
- (4) Check to see if the fuel leaks out of the fuel system, and determine the quantity of leakage, if any.
- (5) Record test data as follows.
 - (a) Date of test
 - (b) Place of test
 - (c) Specifications of test vehicle
 - Name and model of test vehicle
 - Chassis number
 - Type of engine installed on the test vehicle
 - Kind of fuel
 - (d) Collision speed
 - (e) Whether fuel leaked out of the fuel system or not. If any leakage is found, draw the schematic of the fuel system and the location of the leakage.
 - (f) Quantity (mass) of the leakage during five minutes after the collision.
 - (g) Test vehicle mass
 - (h) Moving barrier mass
 - (i) Name of test fuel used
 - (j) Quantity of test fuel filled

Applicable Standards:	JIS D 0030	Three-dimensional Reference System for Automobiles.
	JIS D 0210	General Rules of Brakes Test Method of Automobile Motor Cycle
Reference Standards:	JIS D 1042	Determination of Fuel Leakage in the Event of a Collision for Passenger Cars
	JIS D 1060	Frontal and Rear Vehicle Collision Test Procedure
	JASO C 402	Service Brake Road Test Procedure – Passenger Car
	JASO C 403	Service Brake Road Test Performance Requirements – Passenger Car
	JASO Z 103	Front Barrier Collision Test Procedure for Passenger Cars
	JASO Z 105	Moving Barrier Collision Test Procedure for Passenger Cars
	ISO 3437	Road Vehicles – Determination of Fuel Leakage in the Event of a Collision
	ISO 3560	Road Vehicles – Frontal Fixed Barrier Collision Test Method
	ISO 3784	Road Vehicles – Measurement of Impact Velocity in Collision Tests.
	ISO 3984	Road Vehicles – Passenger Cars – Moving Barrier Rear Collision Test Method

Explanatory Note on JASO B 301-89 The Procedure on Safety of Fuel Systems for Passenger Cars

3. Definitions

(1) Fuel system

The range of fuel leakage during the test is not limited to the fuel tank and its connecting unit, but as defined in the **Text**.

(2) Test Fuel

While it is most practical to use the fuel usually used on the vehicle, a substitute fluid, i. e., "a fluid with an equivalent viscosity and a specific gravity equivalent to, or greater than that of the fuel" may be used in the test, to prevent the risk of fire that may occur during the test.

The substitute fuel refers to a distilled fluid of petroleum which is not easily burned and use in dry cleaning, which is same as the Type 1 fluid specified under 7.1.1 of **FMVSS No. 301-75**. The type 1 fluid is specified under **ASTM D 484-71** "Standard Specification for Hydrocarbon Dry Cleaning Solvents". the properties of the said substitute fluid are given below.

Color:

Water white (not darker than #21)

Corrosion at 100°C:

ASTM Reference fraction or smaller

Doctor test: Negative

Content of sulfide: 5% or less

Flash point: 100° F (37.8°C) or higher

Fractional distillation at 370°F (176°C):
50% or more

Distillation end point temperature:

407°F (208.3°C) or lower

Residue: 1.5% or less

Acidity: Neutral

(6) Fuel Tank Capacity

A value corresponding to the nominal value of the specification, catalogue, etc. is given here.

4. Test Items

Six items of turning, braking, frontal collision, rear collision and sideward tilting and longitudinal tilting as the substitutes for the turning and braking tests are specified as in the **Text**.

As a result, regular test items were specified here because of the difficulties in the reproduction of turning and braking tests, which are once considered to be carried out as a test in a period of transition, or with limitation. Since turning and braking tests can be simulated by static tests, it is specified that may be substituted by tilting bench tests.

5. Test Methods

5.1 Turning Test

The turning test is related with a performance that should be basically ensured for the automobile fuel system. The provision is given based on the constant circular turning test method which is already established for the evaluation of kinematic performance of automobiles.

5.1.1 Measuring Items

(1) Centripetal Acceleration During Turning

The centripetal acceleration is usually calculated by the turning radius and the time required for the vehicle to turn circularwise, as specified in the **Text**. Therefore, it is necessary to measure the turning radius and the time required for turning.

Since the constant circular turning is generally done by running the vehicle with the inside front wheel going along a reference circle drawn in advance, the turning radius should be the value obtained by adding 1/2 value of the tread to the radius of the reference circle. A turning locus tracing instrument should be used in order to ensure a strict accuracy of the measurement (see (3) of **Explanatory Note 5.1.2**).

(2) Fuel leakage

As this standard is aimed mainly at the establishment of test procedure, no criteria value is given, and the provision is limited to the confirmation of the presence or absence of fuel leakage and its condition.

As for the quantitative measurement of fuel leakage, the method to install a plastic bag to the unit that may cause the fuel leakage is generally employed.

5.1.2 Proving Ground and Test Equipment

(2) Measuring Instrument for Centripetal Acceleration

The centripetal acceleration is measured by either the method to use accelerometers or the method to measure the turning time. For the measurement of the turning time, a stop watch is usually used.

(3) Tracing Device

The tracing device is a device to draw a tracing line of the turning locus of the test vehicle, which is generally installed on the front or rear bumper. As shown in **Explanatory Fig. 1**, ink fed by some pressure such as a high pressure air, gear pump, etc, is jetted against the road surface from a thin jet outlet.

There is also a device to jet the ink sideward once in a second or once in 1/2 second by means of electric watch or electromagnet, in order to provide time pulses on the turning locus at the same time.

5.1.3 Test Conditions

(1) Conditions of test vehicle

As the confirmation of the presence or absence of the fuel leakage is the main objective of the provision, conditions approximate to those under actual use of vehicle are specified in the **Text**.

The provision that the fuel be filled to 90% or more of the fuel tank capacity given in the **Text** is based on the assumption that the test will be done with the fuel filled to approximately 90%, but not less than 90%.

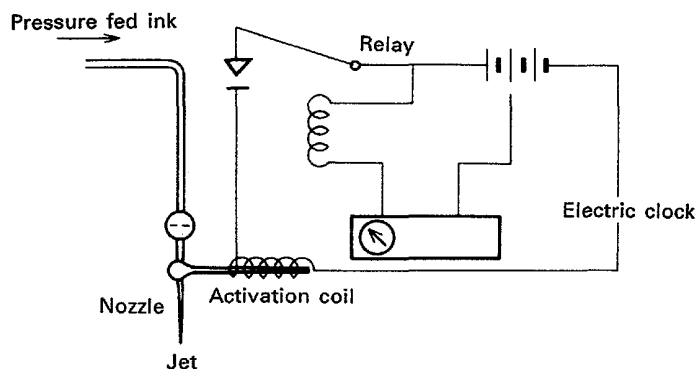
(2) Proving ground road surface and meteorological conditions

Such conditions are specified according to 5.2 of **JIS D 0210** (General Rules of Brake Test Methods of Automobiles Motor cycles).

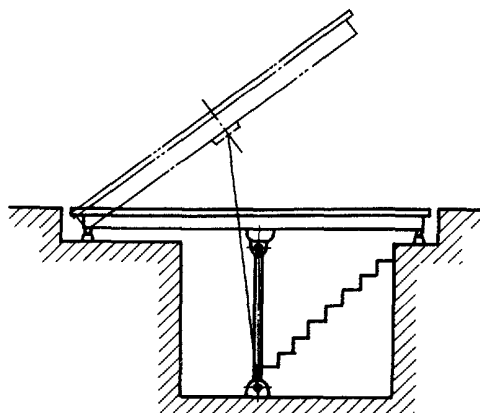
(3) Turning conditions

During investigation there were some opinions that the turning or centripetal acceleration should be 5.9 m/s^2 {0.6G}

Explanatory Fig. 1



Explanatory Fig. 2



or more as the turning condition. But in consideration of practical condition, it was decided as in the **Text**.

Conditions specified in the **Text** are equivalent to the conditions of turning the vehicle by 60° along a road of radius 160 m at the vehicle speed of 100 km/h.

5.1.4 Test Procedure

The standard recording procedure of test data is specified in the **Text** based on JIS D 1060 (Frontal and Rear Vehicle Collision Test Procedure).

5.2 Sideward Tilting Test

Although the primal objective of the sideward tilting test is to determine the rolling angle of the automobile, the sideward tilting test is employed in place of a turning test.

5.2.1 Measuring Items

- (1) Tilting angle of the tilting board
- (2) Same as **Explanatory Note (2)** in 5.1.1.

5.2.2 Test Equipment

(1) Tilting test equipment

The equipment should be able to tilt the test vehicle continuously to 30° or more, and stop the tilting at a given tilting angle, with an instrument to measure the tilting angle. The tilting test equipment shown in **Explanatory Fig. 2** is usually used in practice.

5.2.3 Test Conditions

(1) Conditions of test vehicle

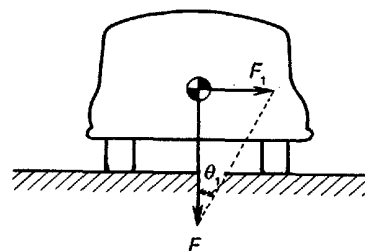
The same as given in (1) of **Explanatory Note 5.1.3**.

(2) Tilting conditions

Since this is a substitute of the turning test, efforts were made to make the conditions as similar as possible to the conditions of the turning test. However, only the centripetal acceleration and the duration time in the turning test are considered in the **Text**.

The basis for the determination of the conditions is given below.

(a) Side acceleration on turning test:



$$F_1 = F \tan \theta_1$$

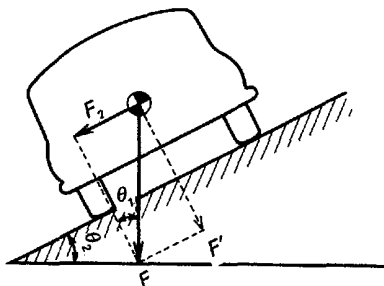
Assuming that $F_1 = 4.9 \text{ m/s}^2 \{0.5G\}$

$$\theta_1 = 26.6 \text{ deg}$$

F_1, F_2 : centripetal acceleration

F : gravitation acceleration

- (b) Side acceleration on sideward tilting test:



$$F_2 = F \sin \theta_2$$

In order to obtain $F' = F \cos \theta_2$

$$F_2 = 4.9 \text{ m/s}^2 \{0.5G\}$$

$$\theta_2 = 30 \text{ deg}$$

$$\text{where, } F' = 8.5 \text{ m/s}^2 \{0.87G\}$$

In order to make the magnitude of the side acceleration equal to that of turning test by the tilting test equipment, $\theta_2 = 30 \text{ deg.}$ is equivalent to actual turning test conditions, assuming that $F_1 = F_2 = 4.9 \text{ m/s}^2 \{0.5G\}$.

5.3 Braking Test

The same concept as that in 5.1 is followed here. Some provisions given under **JASO C 402** (Service Brake Road Test Procedure – Passenger Car) and **JASO C 403** (Service Brake Road Test Performance Requirements – Passenger Cars) are referred to in this standard.

5.3.1 Measuring Items

(3) Fuel leakage

The same as 5.1.1 (2) of the **Explanatory Note**.

5.3.3 Test Conditions

(1) Conditions of test vehicle

The same as 5.1.3 (1) of the **Explanatory Note**.

(2) Proving ground and meteorological conditions

The same as 5.1.3 (2) of the **Explanatory Note**.

(3) Initial speed

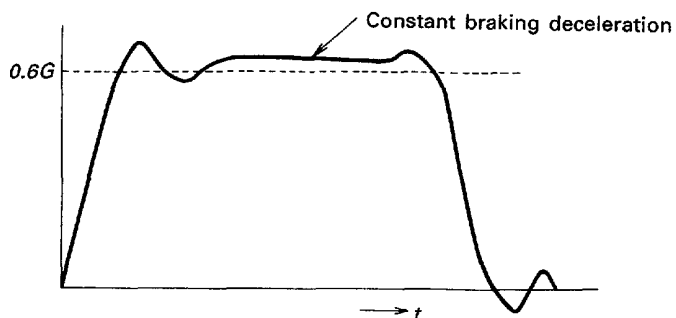
5.2 of **JASO C 402** was referred to in this standard, but the provision is divided respectively for general passenger cars and light passenger cars.

(4) Braking deceleration

The repeatability was taken into account for the braking deceleration, and the provision is given in the **Text**, making reference to **JASO C 402** and **JASO C 403**, which provide the conditions as critical as possible.

The specification of “5.9 m/s² {0.6G} or more” means that the constant braking deceleration should be 5.9 m/s² {0.6G} or more, and that the majority of decelerations is 5.9 m/s² {0.6G} or more at the time of braking as shown in **Explanatory Fig.3**. The reason for specifying “the constant deceleration” is to eliminate the possibility of effects on test results by the maximum or mini-

Explanatory Fig. 3



imum value, if the method to take the mean value is employed, which would not meet the objective of the provision.

5.4 Vertical Tilting Test

The objective of the provision is the same as 5.2 of the Explanatory Note, but this test is specified in place of the braking test.

5.4.1 Measuring Items

- (1) **Tilting angle of the tilting board**
The same as 5.2.1 (1) of the Explanatory Note.
- (2) **Fuel leakage**
The same as 5.1.1 (2) of the Explanatory Note.

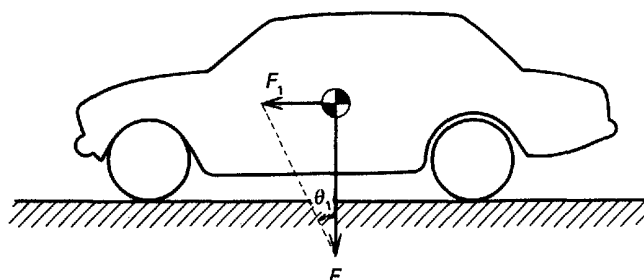
5.4.2 Test Equipment

The same as 5.2.2 (1) of the Explanatory Note. The maximum tilting angle is, however, specified as 37°C or more.

5.4.3 Test Conditions

- (1) **Conditions of test vehicle**
The same as 5.1.3 (1) of the Explanatory Note.
- (2) **Tilting conditions**
Since the test is the substitute for the braking test, efforts were made to make the conditions as similar as possible to the conditions of the braking test. However only the braking deceleration and the duration time in the braking test are considered in the Text.

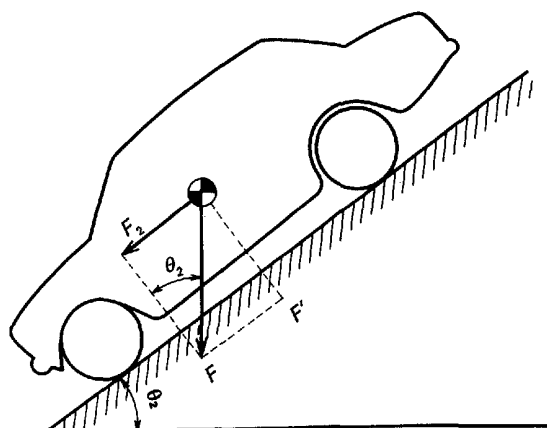
(a) Deceleration in braking



$$F_1 = F \tan \theta_1$$

Assuming that $F_1 = 5.9 \text{ m/s}^2 \{0.6G\}$
 $\theta_1 = 31 \text{ deg}$

(b) Acceleration in longitudinal tilting test



$$F_2 = F \sin \theta_2$$

In order to obtain $F_2 = 5.9 \text{ m/s}^2 \{0.6G\}$
 $\theta_2 = 36.9 \text{ deg}$

F_1, F_2 : braking acceleration 5.9 m/s^2
 $\{0.6G\}$
 F : gravitation acceleration
 $9.8 \text{ m/s}^2 \{1.0G\}$

As shown in Fig. above, it is necessary to tilt the vehicle with $F_1 = F_2 = 5.9 \text{ m/s}^2$ {0.6G}, in order to attain the deceleration of 5.9 m/s^2 {0.6G} by the longitudinal tilting. Thus, $\theta_2 = 37 \text{ deg}$ is equivalent to the actual braking deceleration conditions.

5.5 Frontal Collision Test

The frontal collision test procedure is specified generally identical to the provision given under JIS D 1060.

5.5.1 Measuring Items

- (1) **Collision speed**
It is specified according to JIS D 1060.
- (2) **Fuel leakage**
It is specified according to JIS D 1042 (Measuring Method of Fuel Leakage in the Event of a Collision of a Passenger Car).

5.5.2 Proving Ground and Test Equipment

According to JIS D 1060.

5.5.3 Test Conditions

- (1) **Conditions of test vehicle**
According to JIS D 1060.
No particular value of the test vehicle mass is given, which should be decided according to the purpose of each test. The quantity of the fuel filled is the same 5.1.3.
- (2) **Conditions of collision**
According to JIS D 1060.
- (3) **Collision speed**
It is specified that the speed should be within the range specified according to the purpose of each test, but it is re-

commended that the speed specified under technical requirements of 2 of Article 15, Safety Regulations for Road Vehicles should be used unless otherwise specified.

Collision speeds specified by regulations/standards in countries concerned are as shown on Explanatory Table 1.

5.5.4 Test Procedure

The recording is specified according to JIS D 1060 and JIS D 1042.

5.6 Rear Collision Test

According to JIS D 1060.

5.6.1 Measuring Items

- (1) **Collision speed**
According to JIS D 1060.
- (2) **Fuel leakage**
According to JIS D 1042.

5.6.2 Proving Ground and Test Equipment

According to JIS D 1060.

5.6.3 Test Conditions

- (1) **Conditions of test vehicle**
According to JIS D 1060.
No particular value of the test vehicle mass is given, which should be decided according to the purpose of each test. The quantity of the test fuel filled is the same as 5.1.3. While it is specified that the parking brake should be released, it is given in the Text that the brake may be applied for the prevention of possible danger.
- (2) **Conditions of collision**
According to JIS D 1060.

Explanatory Table 1

Regulation		Frontal collision
Technical requirements	Fuel leakage prevention	50±2 km/h (for light passenger cars, 40±2 km/h)
FMVSS 301	Fuel leakage prevention	Up to 30 mph
ECE 34	Prevention of fire	48.3 to 53.1 km/h

(3) Collision speed

It has been specified that the moving barrier collision speed should be within the range specified according to the test purpose, but it is recommended that the speed specified under technical requirement be employed unless otherwise specified. For light passenger cars, it has been specified that the speed should be 80% of ordinary passenger cars, unless otherwise specified. But

th is special condition was deleted according to the revision of technical requirement.

Collision speeds specified by regulations of other countries are as shown on **Explanatory Table 2**.

5.6.4 Test Procedure

The recording of test data was specified according to **JIS D 1060** and **JIS D 1042**.

Explanatory Table 2

Regulation		Rear collision
Technical requirements	Fuel leakage prevention	35 to 38 km/h
FMVSS 301	Fuel leakage prevention	Up to 30 mph
ECE 34	Fire prevention	35 to 38 km/h

Reference Standards and Reference Data: **FMVSS No.301** Fuel System Integrity
SAE J 850 Barrier Collision Test
SAE J 972 Moving Barrier Collision Tests

In the event of any doubt, the original standards in Japanese should be referred.

 : SECOND PHASED STANDARD
(The standard where customary units and converted values are given in brackets after values of SI units.)

Established by the Standard Council of JSAE

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