TECHNICAL REPORT

ISO TR 12155

First edition
1994-10-01

Commercial vehicles — Obstacle detection device during reversing — Requirements and tests

Véhicules utilitaires — Dispositifs de détection d'obstacles pendant la marche arrière — Exigences et essais

Reference number
ISO/TR 12155:1994(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 12155, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This document is being issued in the type 2 Technical Report series of publications (according to subclause G.4.2.2 of part 1 of the ISO/IEC Directives 1992) as a "prospective standard for provisional application" in the field of detection devices for reversing commercial vehicles because there is an urgent need for guidance on how standards in this field should be used to meet an identified need.

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

This document is not to be regarded as an "International Standard". It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the ISO Central Secretariat.

A review of this type 2 Technical Report will be carried out not later than two years after its publication with the options of: extension for another two years; conversion into an International Standard; or withdrawal.

Introduction

When road vehicles reverse there are repeatedly accidents involving personal injury and damage to property, despite special legislative provisions. The assistant stipulated by the rules is not available in practice, as the vehicles are generally operated by one person. Drivers often reverse without adequate visibility to the rear.

Technical aids to improve vision to the rear of vehicles have therefore been developed and placed on the market in recent years. Video systems mounted high up at the rear of the vehicle have proved useful for special applications (e.g. buses, tankers, airport apron vehicles). These devices have some disadvantages, such as high purchase price, the installation of a camera on platform vehicles or folding canopy tops being difficult or impossible, high theft rate, restricted visibility in fog or darkness. A further disadvantage to the driver is the additional burden of watching the monitor.

After evaluating all currently available alternatives, experts and organizations responsible for occupational safety consider that the most effective reduction of accidents can be achieved by monitoring the area to the rear of the vehicle with ultrasonic sensors which are linked to visual/acoustic warning devices in the cab.

Requirements and tests for reversing warning devices on road vehicles have been devised by a FAKRA working group which includes equipment manufacturers, vehicle and trailer manufacturers, and organizations representing operators and responsible for occupational safety, contained in this Technical Report. Manufacturers and test houses are requested to present their experience with the requirements of this Technical Report. In this regard, the following should be observed:

— According to the information available to the members of the working group in July 1991, there is no device on the market which meets the requirements of this Technical Report.

— In the opinion of the experts in the Working Group, rearward detection devices cannot be implemented on their own. The accident-preventing function can only be tested in conjunction with the relevant vehicle model, by optimizing the monitoring range. A generally mandatory measuring plan is necessary for this. Reversing detection devices are of the same type as devices such as safety light barriers, two-hand control units and SPS control systems with safety functions.

— As with these devices, the safety questions for reversing detection devices scarcely concern prevention of electrical contact or sharp mechanical edges, etc., but rather reliability of operation (possibly including self-monitoring). Requirements should focus primarily on this.

Commercial vehicles — Obstacle detection device during reversing — Requirements and tests

1 Scope

This Technical Report specifies requirements and tests for detection devices which indicate to the driver of a commercial road vehicle, when he is reversing, the presence of objects which are within the monitoring range of the device.

It applies to detection devices with non-contact sensors which can be fitted on commercial vehicles[1] to improve safety during manoeuvring. They are to be regarded as an additional aid to the vehicle driver when reversing at a speed of up to 5 km/h[2] (approximately walking pace), but they do not relieve the driver of his special responsibility when reversing (i.e. this is not a reversing alarm for other personnel in the area).

This Technical Report describes two basic designs:

— reversing detection devices with a pre-warning range;

— reversing detection devices without a pre-warning range (see 5.1).

NOTE 1 Detection devices having a monitoring range which extends to the full height of the vehicles are called rearward warning devices. The Technical Report currently does not include requirements for such devices.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1176:1990, *Road vehicles — Masses — Vocabulary and codes.*

ISO 3833:1977, *Road vehicles — Types — Terms and definitions.*

ISO 7637-2:1990, *Road vehicles — Electrical disturbance by conduction and coupling — Part 2: Commercial vehicles with nominal 24 V supply voltage — Electrical transient conduction along supply lines only.*

ISO 7637-3:—[3], *Road vehicles — Electrical disturbance by conduction and coupling — Part 3: Passenger cars and light commercial vehicles with nominal 12 V supply voltage and commercial vehicles with 24 V supply voltage — Electrical transient transmission by*

1) As defined in ISO 3833: solo vehicles only.

2) This corresponds to the average reversing speed of commercial vehicles and is related to the monitoring range specified in this Technical Report. Higher speeds lead to longer braking distances and would therefore require larger monitoring ranges. This would cause an increased number of false warnings and would thus jeopardize acceptance of the warning device.

3) To be published.

capacitive and inductive coupling via lines other than supply lines.

ISO 7731:1986, *Danger signals for work places — Auditory danger signals.*

ISO 9227:1990, *Corrosion tests in artificial atmospheres — Salt spray tests.*

ISO 11451-1:—[3], *Road vehicles — Electrical disturbances by narrow-band radiated electromagnetic energy — Vehicle test methods — Part 1: General and definitions.*

ISO 11452-1:—[3], *Road vehicles — Electrical disturbances by narrow-band radiated electromagnetic energy — Component test methods — Part 1: General and definitions.*

IEC 529:1989, *Degrees of protection provided by enclosures (IP Code).*

DIN-VDE 0879-3:1981, *Radio interference suppression of vehicles, vehicle equipment and internal combustion engines — Part 3: Interference suppression for on-board radio reception.*

3 Definitions

For the purposes of this Technical Report, the following definitions apply.

3.1 reversing detection device: Warning device which gives an acoustic and visual indication to the vehicle driver (not an alarm to other personnel in the area), when he selects reverse gear, of whether there are objects in the monitoring range.

NOTES

2 When reverse gear is selected, the detection device is automatically activated if the device for starting or stopping the engine is in such a condition that the engine can operate.

3 The reversing detection device is a system consisting of several components which are necessary to permit operation of the system. It includes in particular the following components: sensors, signal-processing unit (evaluation device), visual and acoustic indicator, and the transmission equipment.

3.2 sensor: Component which detects objects in the monitoring range.

3.3 evaluation device: Component which evaluates the sensor signals and monitors operation.

3.4 indication device: Component which transmits signals to the vehicle driver in the form of visual and acoustic information.

3.5 monitoring range: Specific three-dimensional area behind the vehicle, which is divided into a pre-warning range, a main warning range and a collision range. (See figure 1.)

3.6 test object: Object with a specific geometry and surface for testing the monitoring range.

Dimensions in millimetres

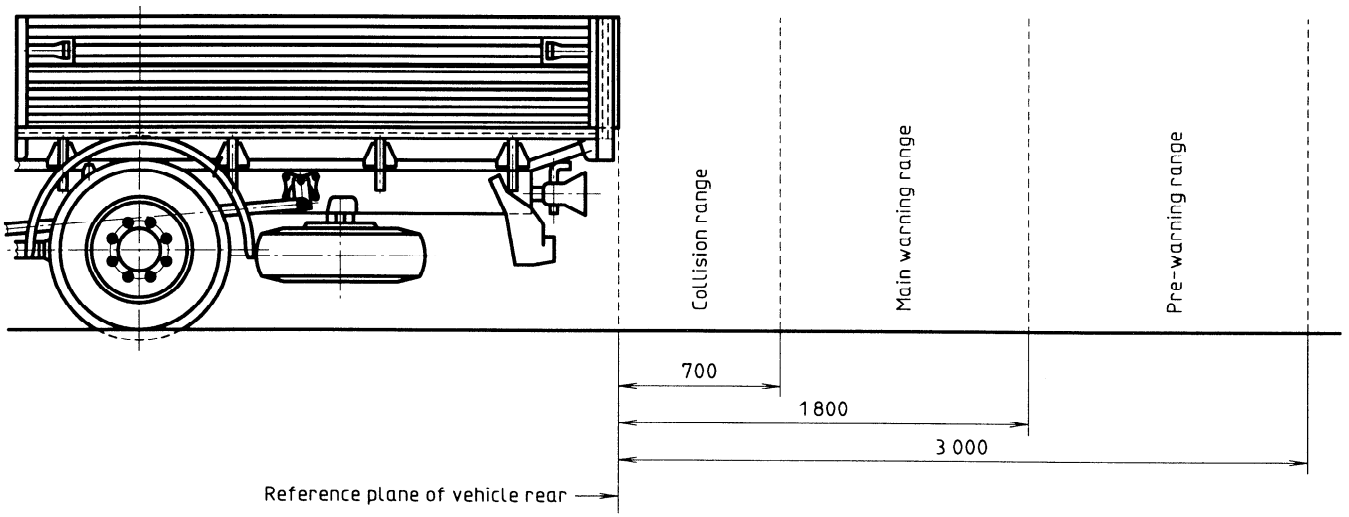


Figure 1 — Monitoring range of reversing detection device

4 Designation

When ordering, a model designation needs to be added to the standard designation in 4.1 and 4.2 to allow precise correlation between a reversing detection device and the intended vehicle model or vehicle range (see also 9.1).

4.1 The designation of a reversing detection device with a pre-warning range (monitoring range 3 m) (RW 30), which meets the requirements of this Technical Report is as follows:

Reversing detection device ISO/TR 12155 RW 30

4.2 The designation of a reversing detection device without a pre-warning range (monitoring range 1,8 m) (RW 18), which meets the requirements of this Technical Report is as follows:

Reversing detection device ISO/TR 12155 RW 18

5 Safety requirements

5.1 Monitoring range

The monitoring range for reversing detection devices is defined by the measuring points in figures 3 to 6. For application- and vehicle-related reasons, the pre-warning range can be dispensed with, if desired, for vehicles below 7,5 t complete vehicle kerb mass as defined in ISO 1176.

The dimensions relate to the complete vehicle kerb mass (ISO-M06), with fully laden rear axle.

5.2 Arrangement of sensors

The sensors shall be arranged so that the monitoring range specified in 5.1 is covered.

5.3 Indicators and signals

Reversing detection devices shall be equipped with indicators for conveying visual and acoustic signals.

5.3.1 Visual indicators

The visual indicators shall convey the messages in 5.3.1.1 to 5.3.1.3.

Range indicators may be either digital or analogue, so long as the requirements below are met.

5.3.1.1 Warning

Warning indications shall be as follows:

— intermittent yellow [not necessary for warning devices without a pre-warning range (see 5.1)]: if there are objects in the pre-warning range;

— intermittent red: if there are objects in the main warning range;

— continuous red: if there are objects in the collision range.

5.3.1.2 Monitoring

Monitoring indications shall be as follows.

a) Activation check: to check the operation of the visual indicator, it is acceptable when switching on the ignition, and necessary when activating the system, for both signals to light up briefly.

b) Readiness check: if desired, there may be an additional signal (e.g. green) which indicates that the reversing detection device is ready to operate correctly. This signal shall go out if there is a warning (5.3.1.1) or a fault (5.3.1.3).

5.3.1.3 Faults

System faults should be indicated by the signals in 5.3.1.1 and 5.3.1.2 flashing. System faults occurring when the system is activated should be indicated as follows:

— in the case of devices with a pre-warning signal, by continuous illumination of the red and yellow signals,

— in the case of devices without a pre-warning signal, by continuous illumination of the red signal.

5.3.2 Acoustic signal

The acoustic signals as specified in ISO 7731 have the functions given in 5.3.2.1 to 5.3.2.3.

5.3.2.1 Warning

Acoustic warning signals shall be as follows:

a) a continuous sequence of individual tones with a pulse frequency of 2 Hz: when there are objects in the pre-warning zone;

b) a continuous sequence of individual tones with a pulse frequency of 4 Hz: when there are objects in the main warning zone;

c) a continuous tone: when there are objects in the collision zone.

NOTE 4 This continuous tone acoustic signal may be so wired that the volume can be reduced manually, if required (advisable, e.g. when parking on a ramp between two other trucks). The volume reduction applies to the current activation process only.

5.3.2.2 Readiness check

A short acoustic signal is necessary to check the operation of the acoustic indicator, and may only sound on activation of the system (if there is no warning as in 5.3.2.1).

5.3.2.3 Faults

Faults should be indicated by a continuous tone. This tone shall differ markedly from the normal warning tones in its frequency and shall have a minimum duration of 3 s after selection of reverse gear. It shall only sound when reverse gear is engaged and sound every time this gear is selected as long as the fault remains. The circuit for the continuous tone shall be such that the volume can be manually reduced or switched off, or shall automatically switch off after 3 s. The ability to reduce the volume or switch off applies only to the current activation process.

5.4 System measuring time

The measuring time including all sensors in a reversing detection device should not take longer than 200 ms before the indication appears. This time is calculated as the arithmetic mean of at least 50 measurements, in the course of which a test object [as specified in 7.1 a)] is moved at a speed of 1 m/s from outside the main warning zone to the 1,6 m grid position — the trigger point for time measurement. The maximum measuring time until an indication is made should not be longer than 300 ms in these tests.

5.5 System activation time

The first indication of an object in the monitoring zone shall be made at the latest 600 ms after activation of the system — by engagement of reverse gear.

5.6 Resistance to manipulation

It shall not be possible to disable, by simply switching it off, the warning device.

The reversing detection device shall be so designed and installed that its reliable operation cannot easily be altered.

5.7 Monitoring of operational reliability

Reversing detection devices shall be equipped with test devices for the following self-testing functions.

5.7.1 Signal generation and echo reception

The test equipment shall verify the transformation of the electrical signal into a waveform (e.g. ultrasonic). This can be performed directly (e.g. with reference sensors) or indirectly (e.g. by the post-pulse oscillation of the sensor diaphragm). The test is performed in accordance with 6.5.1.

5.7.2 Measurement of distance

The test equipment shall check whether an echo signal from an object in the main warning range can still be related to this zone of the reversing detection device. This can be achieved, for example with an additional signal on an echo line which simulates the detection of an obstacle at a distance of 1 m. The correct correlation should be checked with the test device.

5.7.3 Self-testing device requirements

The self-testing device shall exhibit the following features with regard to the requirements specified in 5.7.1 and 5.7.2:

a) the procedures are obligatory;

b) they shall detect any fault which impedes the specific function;

c) when a fault is detected, they shall produce a warning signal (as described in 5.3.1.3 and 5.3.2.3); the warning signal may not be cancelled until the fault has been rectified (except as in 5.3.2.3);

d) they shall be activated each time reverse gear is engaged.

There are additional recommendations for computer-controlled systems:

e) a ROM[4] test should be carried out for all safety-related data storage areas (e.g. by signature formation using ROM with a single word width); and

f) a logical program run check should be performed (e.g. with a watch-dog circuit).

NOTE 5 Tests other than those in e) and f) which are at least equivalent may be performed as an alternative.

5.8 Trailer operation using trailers without detection devices

With this type of operation, the reversing detection device on the tractor shall be switched off. To achieve this, the reversing detection device shall be so designed or connected to the electrical system of the commercial vehicle that it is switched off when an electrical connection is made between the tractor and the trailer (see also clause 11).

6 Components: requirements and tests

Unless specified otherwise, the tests on the components shall be performed in the following sequence, and at an ambient temperature of (23 ± 5) °C and with relative air humidity of (60 ± 25) %.

6.1 Mechanical vibration

6.1.1 Test

Fit the component on the test device in the same position and with the same fixings as in the vehicle. Subject the component to be tested to the following sinusoidal vibrations on a suitable vibration test device:

frequency: 5 Hz to 200 Hz

vibration amplitude: ± 15 mm

acceleration: 49 m/s^2 (5g)

transition frequency: about 8 Hz to 9 Hz

number of frequency cycles: 50

rate of change of frequency: 1 octave/min

The frequency cycles may be interrupted.

The test shall be performed for 16 h in each of three directions of vibration which are perpendicular to one another, and one of which shall lie along the vehicle longitudinal axis.

6.1.2 Requirements

After the test, no cracks or changes shall be visible, and the component tested shall be capable of operation.

6.2 Climatic conditions

6.2.1 Test

Subject the components to be tested to five test cycles each lasting 24 h with the following climatic conditions:

a) Allow temperature equalization for 4 h at an ambient temperature of (23 ± 2) °C and 45 % to 75 % relative air humidity.

b) Increase the temperature in the test chamber to (55 ± 2) °C and the relative humidity to 95 % to 99 % within 0,5 h.

c) Maintain the temperature/humidity levels indicated in conditioning stage b) for 10 h.

d) Reduce the temperature in the test chamber to − (40 ± 2) °C within 2,5 h.

e) Maintain the temperature indicated in conditioning stage d) for 2 h.

f) Increase the temperature of the specimen to (100 ± 2) °C within 1,5 h.

g) Maintain the temperature indicated in conditioning stage f) for 2 h.

h) Reduce the temperature in the test chamber to ambient temperature within 1,5 h.

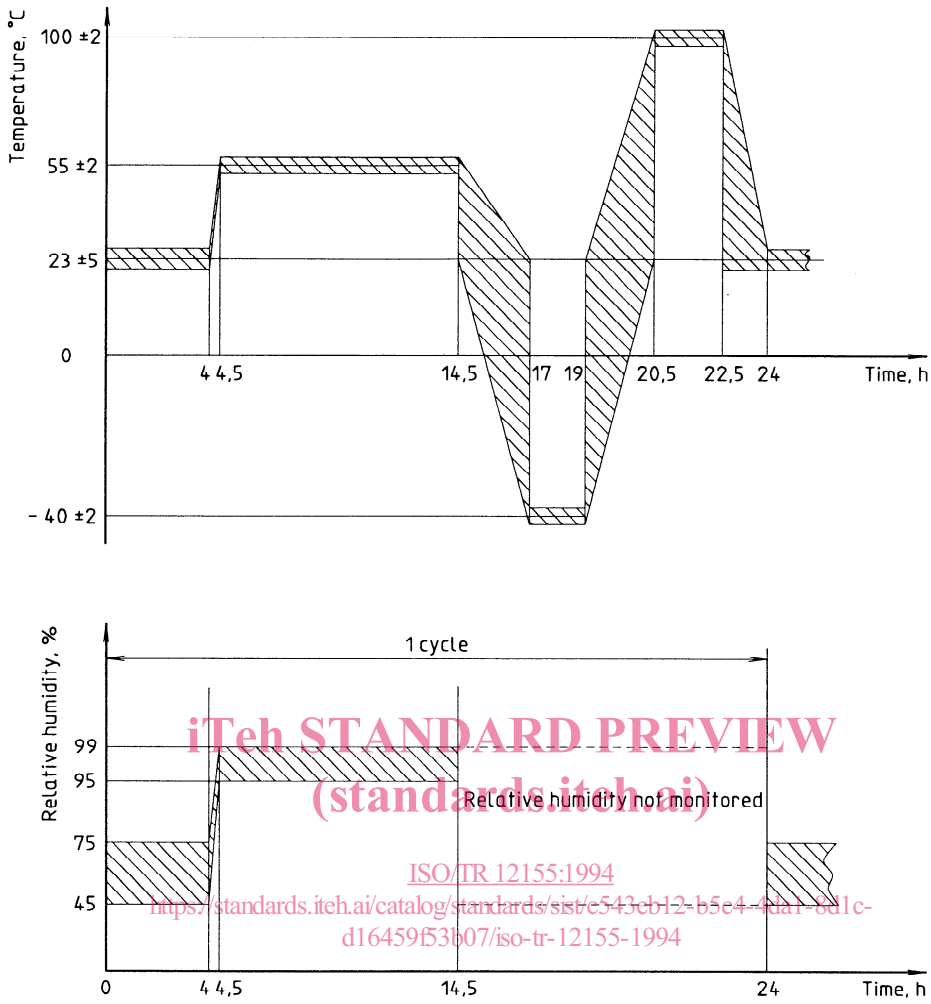
NOTE 6 During conditioning stages d), e), f), g) and h), the relative humidity is not monitored. During a break in the test procedure between two test cycles, the specimens are to be stored at ambient temperature.

The test cycle is shown diagrammatically in figure 2.

6.2.2 Requirements

After conditioning in the climates specified in 6.2.1, no changes shall be detected and the components shall be capable of operation.

4) ROM: read-only memory



NOTE — The hatched areas show the acceptable temperature changes (upper part of diagram) and the acceptable changes in relative humidity (lower part of diagram) of the test chamber(s) as a function of operating time.

Figure 2 — Temperature/humidity cycling

6.3 Static loading

6.3.1 Test

Place exterior components between two cylindrical metal plates at least 80 mm in diameter and subject them to a vertical load of 50 kg acting on the plates. Position the components between the plates such that the load is distributed over as large an area as possible.

6.3.2 Requirements

After the test no cracks or changes shall be visible and the component shall be capable of operation.

6.4 Salt spray

6.4.1 Test

Subject exterior components to the NSS test procedure in ISO 9227 for a period of 96 h. Test the components in the as-installed position. Seal cable ends. Use new, unused components for the tests.

6.4.2 Requirements

After the salt spray test, no corrosion shall be visible on the parts tested in a visual check with the naked eye, corrected if necessary.

6.5 IP protection

6.5.1 Test

Perform the test in accordance with IEC 529.

6.5.2 Requirements

Components mounted externally (e.g. sensors) shall conform to IP 59, and other components shall conform to IP 54, as specified in IEC 529.

6.6 Electromagnetic compatibility

6.6.1 Line-related interference on supply lines

Apply test pulses 1, 2, 3a, 3b, 4 and 5 in accordance with ISO 7637-2:1990 on supply lines and on all other lines of the reversing detection device which are connected with the supply lines.

6.6.1.1 System in non-activated condition

Apply test pulses 1 to 5 and severity level III. After the test, the system shall not be in functional status D or E according to ISO 7637-2:1990.

6.6.1.2 System in activated condition

Apply test pulses 1 to 5 and severity level III. The operating states specified in table 1 shall be observed for the individual test impulses.

Table 1

Test pulse	Test severity level	Operating state
1	III	C
2	III	A
3a	III	A
3b	III	A
4	III	B
5	III	A

6.6.2 Immunity from interference with excited interference on sensor and signal lines

Apply test pulses 1, 2, 3a, 3b and severity level III in accordance with ISO 7637-3. Operational state C is acceptable with test pulse 1; A shall be maintained with 2 and 3.

6.6.3 Immunity from high-frequency radiated disturbances

During and after one of the test procedures specified in ISO 11451-1 and ISO 11452-1, operating status A shall be maintained during and after exposure to severity level II over the whole frequency range from 10 kHz to 1 GHz.

6.6.4 Interference emission

Interference suppression level III to DIN-VDE 0879 Part 3 shall be maintained.

NOTE 7 CISPR is preparing equivalent international specifications.

7 Operational test of reversing detection device

7.1 Test object

Maintenance of the geometry of the monitoring range is tested with the following test objects:

a) test object H for the horizontal test: plastics tube, grey, Ø 75 mm, length 1 000 mm;

b) test object V for the vertical test: plastics tube, grey, Ø 75 mm, length 300 mm.

NOTE 8 Such plastics tubes are available commercially for domestic installation.

7.2 General ambient conditions

During the test the wind speed shall not exceed 5,4 m/s (wind force 3). The temperature shall be (23 ± 5) °C and the relative air humidity (60 ± 25) % (see however 7.4). The test shall not be affected by reflected sound from surrounding walls, auxiliary test equipment or other objects.

7.3 Test procedure

Perform the operational test on a vehicle or on a test structure with which the installation conditions of the selected vehicle model or selected vehicle range can be reproduced (see also clause 10).

Perform the operational test with components which have previously been tested in accordance with clause 6.

Carry out all tests on each of three specimens of the same model. If one specimen fails, replace it with a fourth, which shall pass all tests. If two specimens fail, the tests shall be performed with new specimens. The sequence of the tests shall be maintained.

Activate the system to be tested and perform tests 1 to 4. Note in a test log whether the test object