INTERNATIONAL STANDARD

ISO 11451-2

Second edition
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Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy —

Part 2: Off-vehicle radiation sources

Véhicules routiers — Méthodes d'essai d'un véhicule soumis à des perturbations électriques par rayonnement d'énergie électromagnétique en bande étroite —

Partie 2: Sources de rayonnement hors du véhicule

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 11451 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 11451-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This second edition cancels and replaces the first edition (ISO 11451-2:1995), which has been technically revised.

ISO 11451 consists of the following parts, under the general title *Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy*:

— *Part 1: General and definitions*

— *Part 2: Off-vehicle radiation sources*

— *Part 3: On-board transmitter simulation*

— *Part 4: Bulk current injection (BCI)*

Annex A of this part of ISO 11451 is for information only.

Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy —

Part 2: Off-vehicle radiation sources

1 Scope

This part of ISO 11451 specifies methods for testing the immunity of passenger cars and commercial vehicles to electrical disturbances from off-vehicle radiation sources, regardless of the vehicle propulsion system (e.g. spark ignition engine, diesel engine, electric motor). Two methods for calibrating electromagnetic fields are specified: a substitution method and a closed loop method.

The electromagnetic disturbances considered are limited to continuous narrowband electromagnetic fields.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO 11451. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 11451 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 11451-1:2001, *Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 1: General and definitions.*

3 Terms and definitions

For the purposes of this part of ISO 11451, the terms and definitions given in ISO 11451-1 apply.

4 General test conditions

The frequency range applicable for the tests is 0,1 MHz to 18 000 MHz. Testing over the full frequency range could require different field-generating devices, but this does not imply that testing of overlapping frequency ranges is required.

The user shall specify the test severity level or levels over the frequency range. Suggested test severity levels are given in annex A.

See ISO 11451-1 for descriptions of, and requirements for, the following standard test conditions:

— test temperature;

— supply voltage;

— modulation;

— dwell time;

— frequency steps;

— definition of test severity levels;

— test signal quality.

5 Test equipment

5.1 General

Testing consists of generating radiated electromagnetic fields using antenna sets with radio frequency (RF) sources capable of producing the desired field strength over the range of test frequencies. Electric fields (E-fields) are measured using probes that are small in relation to the wavelength ($< \lambda/10$) to ensure the specified test levels are achieved. To reduce testing error, the vehicle operation under test is usually monitored by fibre optic couplers.

5.2 Absorber-lined shielded enclosure

The aim of using an absorber-lined shielded enclosure is to create an indoor electromagnetic compatibility testing facility that simulates open field testing.

The size, shape, and construction of the enclosure can vary considerably. Typically, the floor is not covered with absorbing material, but such covering is allowed[1)]. The minimum size of the enclosure is determined by the size of the test region needed, the size of the field generation device or devices, the needed clearances between these and the largest vehicle to be tested, and the characteristics of the absorbing material. To create the test region, the absorber, field generation system and enclosure shape are selected such that the amount of extraneous energy in the test region is reduced to below a minimum value that will give the desired measurement accuracy. The design objective is to reduce the reflected energy in the test region to –10 dB or less. An example of a rectangular shielded enclosure is shown in Figure 1.

5.3 Instrumentation

5.3.1 Field generating device

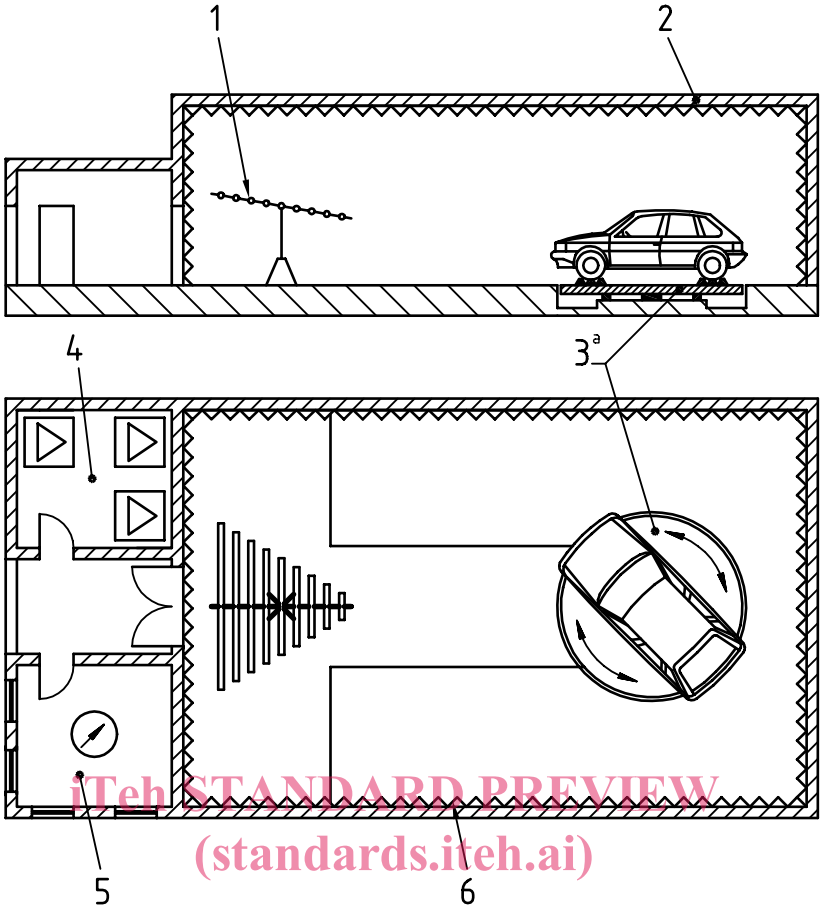
The field generating device can be an antenna or a transmission line system (TLS).

The construction and orientation of any field generating device shall be such that the generated field can be polarized in the mode specified in the test plan (see 6.1). An example of a parallel-plate TLS is shown in Figure 2. Multiple antennas, amplifiers and directional couplers could be necessary to cover the complete frequency range.

5.3.2 Field probes

The transmission lines from the field probes shall be fibre optic links.

1) Measurements in enclosures with or without floor absorbers can lead to different results.



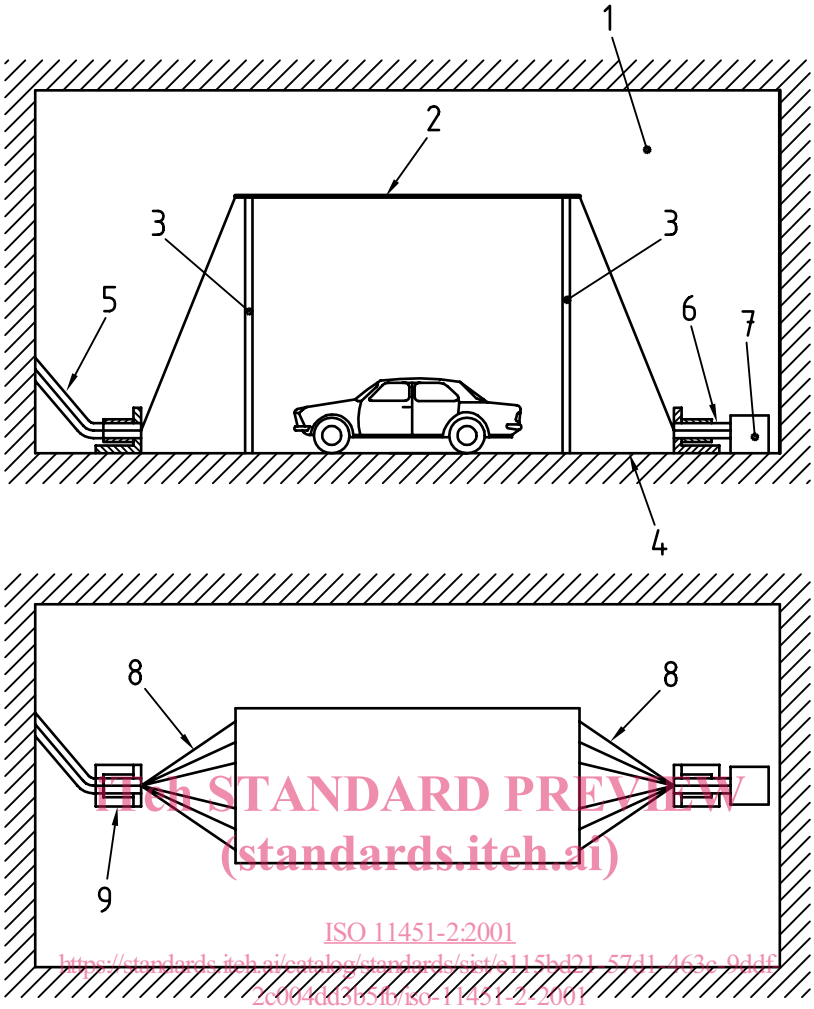
Key

1 Antenna
2 Shielded enclosure
3 Vehicle dynamometer on turntable
4 Amplifier room
5 Control room
6 RF absorber material

NOTE Not drawn to scale.

a Turntable shown rotatable through ± 180° with two pairs of variable wheelbase rollers to accommodate all vehicle sizes and functions.

Figure 1 — Example of absorber-lined shielded enclosure



Key

1 Shielded enclosure (absorbers permitted)
2 Conductive plate or set of wires
3 Non-metallic supports
4 Shielded enclosure floor
5 Signal source feed line (coaxial cable)
6 Coaxial cable
7 Load
8 Conductive wires
9 Signal source feed connection

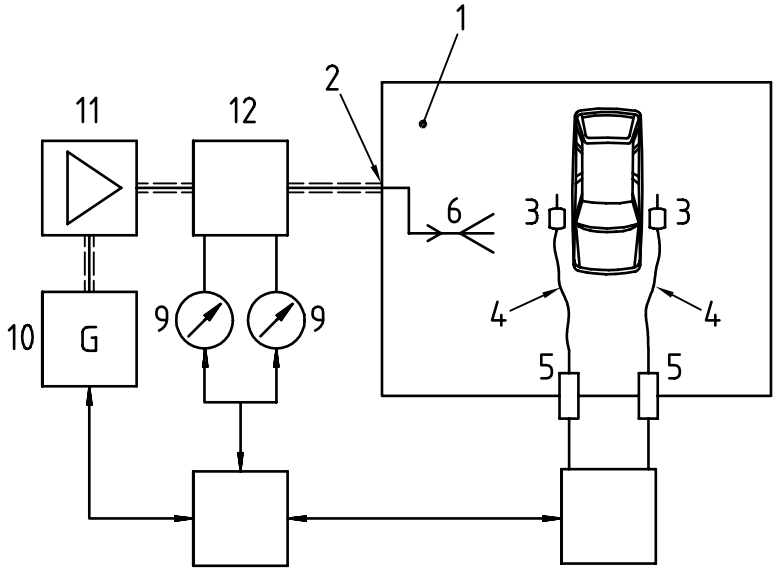
NOTE Not drawn to scale.

Figure 2 — Example of parallel-plate TLS

5.4 Test set-up

5.4.1 General

An example of a test set-up is shown in Figure 3.



Key

1 Shielded enclosure (see Figure 1)
2 Coaxial feedthrough
3 Field probes
4 Optical fibre
5 Waveguide beyond cut-off
6 Transmitting antenna
7 Field probe control unit
8 Process controller
9 Power meters
10 RF signal generator
11 Broadband amplifiers
12 Dual directional coupler

NOTE A similar arrangement is appropriate for the TLS in Figure 2.

Figure 3 — Example of a test set-up

5.4.2 Vehicle placement

The vehicle shall be placed in the shielded enclosure's test region. The test region may contain a vehicle dynamometer or turntable or both (see Figure 1).

5.4.3 Field generating device location (relative to vehicle and shielded enclosure)

5.4.3.1 General

The position or positions of the vehicle relative to the antenna or TLS shall be specified in the test plan (see 6.1).

The radiating elements of the field-generating device shall be no closer than 0,5 m to any absorbing material and no closer than 1,5 m to the wall of the shielded enclosure.

5.4.3.2 Antenna constraints

No part of the radiating antenna shall be closer than 0,5 m to the outer body surface of the vehicle.

The phase centre of the antenna shall be separated by at least 2 m horizontally from the reference point.

No part of an antenna's radiating elements shall be closer than 0,25 m to the floor.

There shall be no absorber material in the direct path between the transmitting antenna and the device under test.

5.4.3.3 TLS constraints

No part of a TLS, with the exception of the ground plane, shall be closer than 0,5 m to any part of the vehicle.

The TLS radiating element or elements shall be separated by at least 1 m vertically from the reference point (see 6.2.2.2 and 6.2.3.2).

The TLS shall extend centrally over at least 75 % of the length of the vehicle.

Particular care needs to be taken when testing heavy vehicles such as buses and large trucks. Under certain conditions related to dimensions and frequency, it is possible that close to 100 % of the applied power can be coupled to the vehicle by a directional coupler mechanism. Room resonances can also have a significant effect on the field uniformity, amplitude and direction under the TLS.

5.4.4 Test actuators and monitors

The device under test shall be operated as required under the test plan by actuators that have a minimum effect on the electromagnetic characteristics of the device under test (e.g., plastic blocks on the accelerator, pneumatic actuators with plastic tubes). Connections to equipment monitoring for electromagnetic interference reactions of the device under test shall be accomplished using fibre optics or high-resistance leads. The orientation, length, and location of the high-resistance leads shall be carefully documented to assure repeatability of the test results. The test equipment shall be hardened to withstand the test levels defined in the test plan.

6 Testing

6.1 Test plan

Prior to performing the tests, a test plan shall be drawn up which shall include:

— frequency band(s);

— method to be used [substitution (6.2.2) or closed loop (6.2.3)];

— reference point(s) (or line if substitution four-probe method is used);

— number and position of field probes if closed loop method is used;

— device under test mode of operation;

— device under test acceptance criteria;

— definition of test severity levels;

— device under test monitoring conditions;

— polarization;

— vehicle orientation;

— antenna location;

— test report content;

— any special instructions and changes from the standard test.

Every device under test shall be verified under the most significant situations, i.e. at least in stand-by mode and in a mode where all the actuators can be excited.

Additional vehicle positions, antenna locations or both could be needed to ensure complete illumination of the vehicle owing to the narrow beam widths of high-frequency antennas.

6.2 Test procedure

6.2.1 General

CAUTION — Hazardous voltages and fields can exist within the test area. Take care to ensure that the requirements for limiting the exposure of humans to RF energy are met.

Place the vehicle in the test region and operate it according to the test plan.

Tests shall be conducted both horizontally and vertically with polarized fields over the test frequency range. Any exceptions to this practice shall be specified in the test plan.

With the field generating device in the specified polarization, scan the frequency range at the strength level, noting any anomalies.

Continue testing until all modulations, polarizations, vehicle orientations, and antenna locations specified in the test plan are completed.

At frequencies at which excessive forward power (owing to floor reflection or shielded enclosure resonant frequencies) is needed to achieve the desired field strength, one or more of the following means shall be used when performing the test:

— add absorbing material to the floor;

— move the antenna;

— use the four-probe averaging method;

— shift the test frequency.

6.2.2 Substitution method

6.2.2.1 General

When this method is used, the specific test level (E-field) shall be calibrated prior to actual testing.

The substitution method is based upon the use of net power as the reference parameter for calibration and testing.

If the voltage standing wave ratio of the system can be demonstrated to be less than 1,2:1, then forward power may be used as the reference parameter for calibration and testing.

