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INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Railway applications – Electromagnetic compatibility –
Part 2: Emission of the whole railway system to the outside world**

**Applications ferroviaires – Compatibilité électromagnétique –
Partie 2: Emission du système ferroviaire dans son ensemble vers le monde extérieur**

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62236-2 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This second edition cancels and replaces the first edition published in 2003. It constitutes a technical revision and is based on EN 50121-2:2006.

The main change with respect to the previous edition is listed below:

– distance conversion factor n defined in the frequency range from 9 kHz to 150 kHz.

The text of this standard is based on the following documents:

FDIS	Report on voting
9/1185/FDIS	9/1213/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 62236 series, published under the general title *Railway applications – Electromagnetic compatibility*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

RAILWAY APPLICATIONS – ELECTROMAGNETIC COMPATIBILITY –

Part 2: Emission of the whole railway system to the outside world

1 Scope

This part of IEC 62236 sets the emission limits from the whole railway system including urban vehicles for use in city streets. It describes the measurement method to verify the emissions, and gives the cartography values of the fields most frequently encountered.

The limits refer to the particular measuring points defined in Clause 5 and Annex A. These emissions should be assumed to exist at all points in the vertical planes which are 10 m from the centre lines of the outer electrified railway tracks, or 10 m from the fence of the substations.

Also, the zones above and below the railway may be affected by electromagnetic emissions and particular cases shall be considered individually.

These specific provisions are to be used in conjunction with the general provisions in IEC 62236-1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-161, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility (EMC)*

IEC 62236-1, *Railway applications – Electromagnetic compatibility – Part 1: General*

IEC 62236-3-1, *Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle*

CISPR 16-1-1, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 22, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60050-161 and the following apply.

3.1
apparatus
electric or electronic product with an intrinsic function intended for implementation into a fixed railway installation

3.2
environment
the surrounding objects or region which may influence the behaviour of the system and/or may be influenced by the system

3.3
external interface
boundary where a system interacts with any other or where a system interacts with its environment

3.4
railway substation
installation the main function of which is to supply a contact line system at which the voltage of a primary supply system, and in some cases the frequency, is transformed to the voltage and frequency of the contact line

3.5
railway supply lines
conductors running within the boundary of the railway which supply power to only the railway but are not energised at railway system voltage

4 Emission limits

4.1 Emission from the open railway route during train operation

The emission limits in the frequency range 9 kHz to 1 GHz are given in Figure 1 and the measurement method is defined in Clause 5. For non-electrified lines, the limits are the same as those given for 750 V d.c.

Annex C gives guidance values for typical maximum field values at fundamental frequency of different electrification systems which may occur. They depend on numerous geometrical and operational parameters which may be obtained from the infrastructure controller.

For urban vehicles operating in city streets, the emission limits given in Figure 1 for 750 V d.c. conductor rail shall not be exceeded.

NOTE 1 There are very few external radio services operating in the range 9 kHz to150 kHz with which the railway can interfere. If it can be demonstrated that no compatibility problem exists, any emission level exceeding the relevant limits given in Figure 1 may be acceptable.

NOTE 2 It is not possible to undertake complete tests with quasi-peak detection due to the reasons stated in Annex B.

4.2 Radio frequency emission from railway substations

Radio frequency noise emission from the railway substation to the outside environment measured according to the method defined in Annex A shall not exceed the limits in Figure 2.

The limits are defined as quasi-peak values and the bandwidths are those used in CISPR 16-1-1:

	Bandwidth
frequencies up to 150 kHz	200 Hz
frequencies from 150 kHz to 30 MHz	9 kHz

frequencies above 30 MHz	120 kHz

The distance of 10 m defined in Annex A shall be measured from the fence of the substation. If no fence exists, the measurements shall be taken at 10 m from the apparatus or from the outer surface of the enclosure if it is enclosed.

Emission of trains shall not enter into the measurement.

NOTE 1 There are very few external radio services operating in the range 9 kHz to 150 kHz with which the railway can interfere. If it can be demonstrated that no compatibility problem exists, any emission level exceeding the relevant limits given in Figure 2 may be acceptable.

NOTE 2 For other kinds of fixed installations like auto-transformers, the same limit and measuring distance shall be applied.

5 Method of measurement of emission from moving trains

The method of measurement is adapted from the CISPR 16-1-1 to a railway system with moving vehicles. The background to the method of measurement is given in Annex B.

The electromagnetic fields generated by rail vehicles when operating on a railway network are measured by means of field strength meters with several different set frequencies. The horizontal component of the magnetic field perpendicular to the track and both the vertical and horizontal (parallel to the track) components of the radiated electric field are measured.

5.1 Measurement parameters

5.1.1 The peak measurement method is used. The duration at selected frequency shall be sufficient to obtain an accurate reading. This is a function of the measuring set and the recommended value is 50 ms.

5.1.2 Frequency bands and bandwidths at –6 dB used for measurements are in accordance with CISPR 16-1-1.

These are:

Frequency bands:	9-150 kHz	0,15-30 MHz	30-300 MHz	300 MHz -1 GHz
Bandwidth:	200 Hz	9 kHz	120 kHz	120 kHz

5.1.3 When connected to the antenna, the error of measurement of the strength of a uniform sine-wave field shall not differ more than ± 4,0 dB from CISPR 16-1-1 equipment.

5.1.4 The noise may not attain its maximum value as the traction vehicle passes the measuring point, but may occur when the vehicle is a long distance away. Therefore, the measuring set shall be active for a sufficient duration before and after the vehicle passes by to ensure that the maximum noise level is recorded.

5.1.5 To cover the full frequency range, antennas of different design are required. Typical equipment is described below:

- for 9 kHz to 30 MHz, a loop or frame antenna is used to measure H field (see Figure 3);
- for 30 MHz to 300 MHz, a biconical dipole is used to measure E field (see Figure 4);
- for 300 MHz to 1,0 GHz, a log-periodic antenna is used to measure E field (see Figure 5).

Calibrated antenna factors are used to convert the terminal voltage of the antenna to field strength.

5.1.6 The preferred distance of the measuring antenna from the centreline of the track on which the vehicle is moving is 10 m. In the case of the log-periodic antenna, the 10 m distance is measured to the mechanical centre of the array.

It is not considered necessary to carry out two tests to examine both sides of the vehicle, even if it contains different apparatus on the two sides, since the majority of the emission is produced by the sliding contact if the train is moving.

Where the tests are carried out at a site which meets all the recommended criteria except that the antennas are not 10 m from the track centreline, the results can be converted to an equivalent 10 m value by using the following formula:

$$E_{10} = E_x + n \times 20 \times \log_{10} (D/10)$$

where

E_{10} is the value at 10 m;

E_x is the measured value at D m;

n is a factor taken from the table below.

Frequency range	***n***
9 kHz to 150 kHz	2
0,15 MHz to 0,4 MHz	1,8
0,4 MHz to 1,6 MHz	1,65
1,6 MHz to 110 MHz	1,2
110 MHz to 1 000 MHz	1,0

The measured values (at the equivalent 10 m distance) shall not exceed the limits given in Figure 1 for the appropriate system voltage.

Where the physical layout of the railway totally prevents the use of reference distances, a method shall be agreed to suit the particular circumstances. For example, if the railway is in tunnel, miniature antennas can be used on the wall of the tunnel. In such a case, the limits selected shall take into account the method of measurement.

5.1.7 The height above rail level of the antenna centre shall be within the range 1,0 m to 2,0 m for the loop antenna, and within 2,5 m to 3,5 m to the centre of dipole or log-periodic antennas. If the level of the ground at the antenna differs from the rail level by more than 0,5 m, the actual value shall be noted in the test report.

The plane of the loop antenna shall be vertical and parallel to the line of the track. The biconical dipole shall be placed in the vertical and horizontal axis. The log periodic antenna shall be arranged to measure the vertical and horizontal polarisation signal, with the antenna directed towards the track.

Figures 3, 4 and 5 show the positions and vertical alignments of the antennas.

5.1.8 In the case of elevated railway systems, if the antenna heights specified above cannot be achieved, the height of the antenna centre can be referenced to the level of the ground instead of to the rail level. The conversion formula in 5.1.6 shall be employed where D is the slant distance between the train and the antenna. The train shall be visible from the location of the antenna and the axis of the antenna shall be elevated to point directly at the train. A measurement distance of 30 m from the track centreline is preferred for highly elevated railways. Full details of the test configuration shall be noted in the test report.

5.1.9 If tests are being done on a railway with overhead electrified supply, the measuring point shall be at the mid-point between the support masts of the overhead line and not at a discontinuity of the contact wire. It is recognised that resonance can exist in an overhead system at radio frequencies and this may require changes in the values of frequency chosen for measurement. If resonance exists, this should be noted in the test report.

The radio frequency emission will be affected by the state of the railway supply system. Switching of feeder stations and temporary works will influence the response of the system. It is therefore necessary to note the condition of the system in the test record and, if possible, all similar tests should be carried out within the same working day. Where the railway has a track-side conductor rail power supply, the test location should be at least 100 m from gaps in the rail, to avoid inclusion of the transient fields associated with the make and break of collector contact. The conductor rail and the antennas shall be on the same side of the track.

5.1.10 The test sites do not correspond to the definition of a completely clear site because they are influenced by overhead structures, rails and the catenary. However, wherever possible, antennas shall be placed well away from reflecting objects. If overhead power lines are nearby, other than those which are part of the railway network, they should be no closer than 100 m to the test site.

5.1.11 The values measured are expressed as:

– dBµA/m for magnetic fields,
– dBµV/m for electrical fields.

These are obtained by using the appropriate antenna factors and conversions.

5.1.12 Background noise shall be measured at the test site in the absence of train effects. This will give the noise values from the energised power supply conductors. If this is significant, it is advisable to measure also at 100 m from the test site, to identify any high non-railway sources of noise.

5.2 Frequency selection

5.2.1 Selected frequencies

The selection of the actual frequencies to be measured will depend on the circumstances of the test site.

If high signals exist, for example from public broadcasting stations, the selection of test frequencies shall take this into account.

It is recommended that test frequencies are selected so that there are at least three frequencies per decade.

5.2.2 Sweep frequency

In view of the short time available for measurement in one train passage, the use of a sweep frequency measuring technique, in which the peak noise is measured with a peak-hold circuit as the frequency is changed, may offer adequate information concerning generation of noise. There will still remain problems of time because the rate of change of frequency is a function of the bandwidth, due to considerations of accuracy. A sweep analyser will usually set its own sweep rate to meet this requirement. If this method is used, sweep rate as well as bandwidth shall be noted.

5.3 Transients

During the test, transients due to switching may be detected, such as those caused by operation of power circuit breakers. These shall be disregarded when selecting the maximum signal level found for the test.

5.4 Measuring conditions

5.4.1 Weather conditions

To minimise the possible effect of weather on the measured values, measurements should be carried out in dry weather, (after 24 h during which not more than 0,1 mm rain has fallen), with a temperature of at least 5 °C, and a wind velocity of less than 10 m/s.

Humidity should be low enough to prevent condensation on the power supply conductors.

Since it is necessary to plan the tests before the weather conditions can be known, tests will have to be made in weather conditions which do not meet the target conditions. In these circumstances, the actual weather conditions shall be recorded with the test results.

5.4.2 Railway operating modes

Two test conditions are specified for the traction mode and are:

a) measurement at a speed of more than 90 % of the maximum service speed, (to ensure that the dynamics of current collection are involved in the noise level) and at the maximum power which can be delivered at that speed.
b) at the maximum rated power and at a selected speed, (particularly if the lower frequencies are of concern).

If the vehicle is capable of electric braking, tests are required at a brake power of at least 80 % of the rated maximum brake power.

5.4.3 Multiple sources from remote trains

For the purpose of limits, the presence of "physically-remote but electrically-near" vehicles out of the test zone is regarded as insignificant when considering radio noise.

5.5 Test report

The test report shall contain the following information.

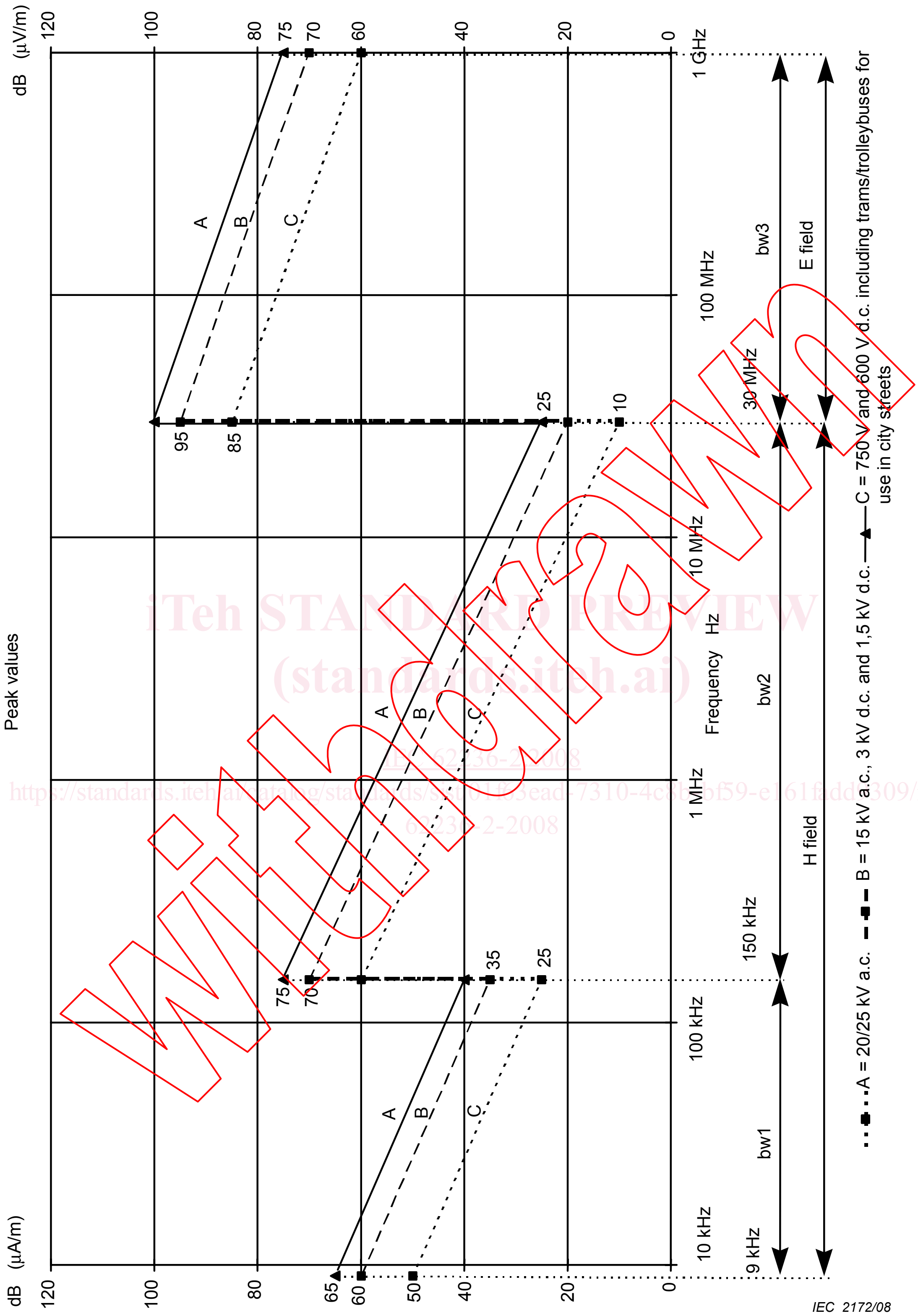
– description of site;
– description of measuring system;
– description of railway vehicle (type and configuration);
– numerical results;
– graphical results where relevant (the results shall include information such as bandwidths, date, time);
– weather conditions;
– name of person in charge at site.

5.6 Antenna positions

Figure 3 shows the position of the antenna for measurement of the magnetic field in the 9 kHz to 30 MHz frequency band.

Figure 4 shows the position (vertical polarisation) of the antenna for measurement of the electric field in the 30 MHz to 300 MHz frequency band. For the measurement of the horizontal field parallel to the track, the antenna is turned by 90°.

Figure 5 shows the position (vertical polarisation) of the antenna for measurement of the electric field in the 300 MHz to 1 GHz frequency band. For the measurement of the horizontal field parallel to the track, the antenna is turned by 90°.



NOTE 1 The discontinuities of the curves are due to changing of the bandwidth of the measurement receiver: bw1 = 200 Hz; bw2 = 9 kHz; bw3 = 120 kHz.

NOTE 2 Values are 10 m from the railway track.

Figure 1 – Emission limits in frequency range 9 kHz to 1 GHz

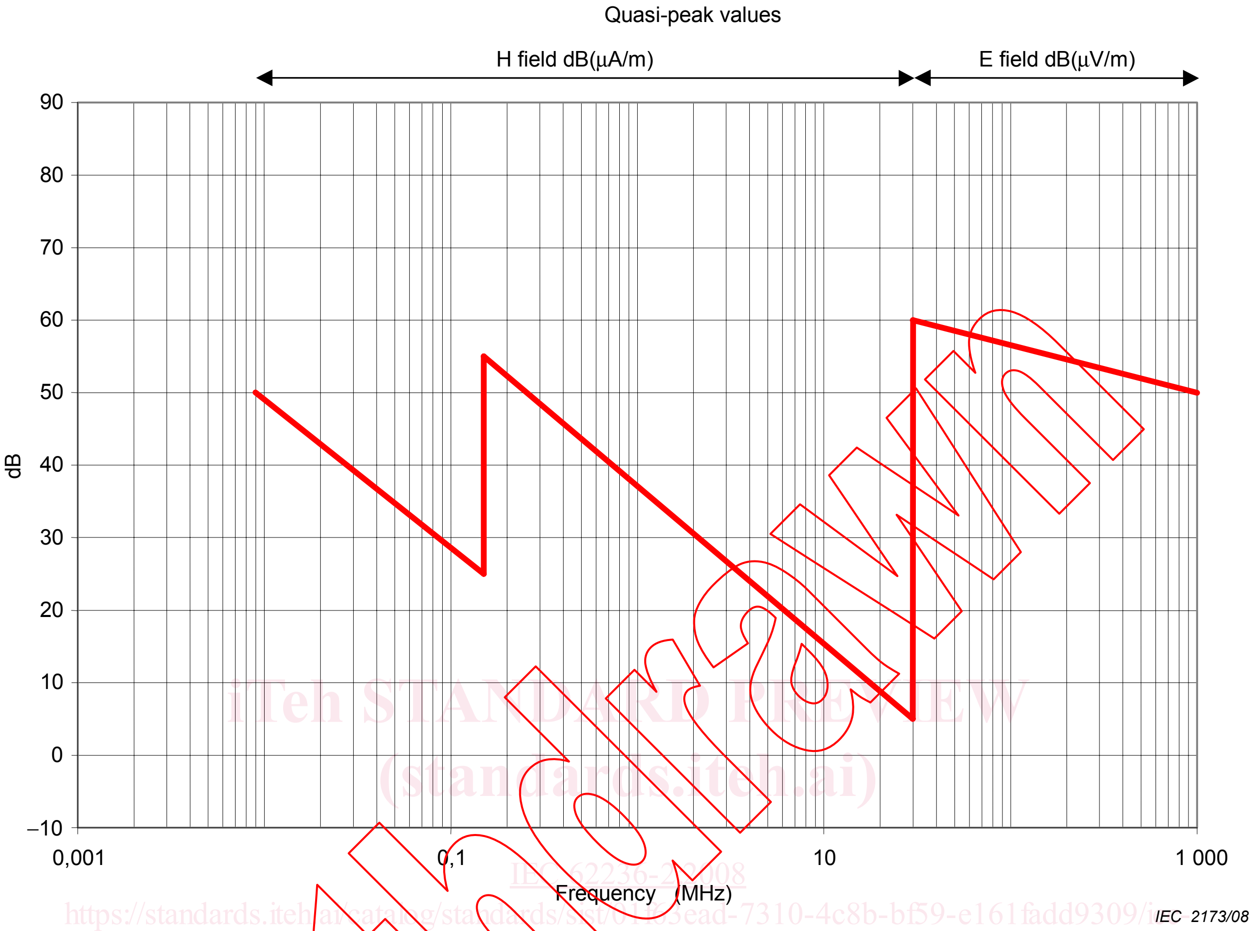


Figure 2 – Emission limit for substations