SLOVENSKI STANDARD
SIST ENV 50121-2:1998

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

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

Bahnanwendungen - Elektromagnetische Verträglichkeit -- Teil 2: Störaussendung des gesamten Bahnsystems in die Außenwelt

Applications ferroviaires - Compatibilité électromagnétique -- Partie 2: Perturbations générées par un système ferroviaire pris globalement vers les riverains

Ta slovenski standard je istoveten z: ENV 50121-2:1996

ICS:

33.100.01	Elektromagnetna združljivost na splošno	Electromagnetic compatibility in general
45.020	Železniška tehnika na splošno	Railway engineering in general

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English version

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

Applications ferroviaires - Compatibilité électromagnétique
Partie 2: Perturbations générées par un système ferroviaire pris globalement vers les riverains

Bahnanwendungen - Elektromagnetische Verträglichkeit
Teil 2: (To be completed)

This European Prestandard (ENV) was approved by CENELEC on 1995-12-11 as a prospective standard for provisional application. The period of validity of this ENV is limited initially to three years. After two years the members of CENELEC will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard (EN).

CENELEC members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC
European Committee for Electrotechnical Standardization
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Foreword

This European Prestandard was prepared by Technical Committee CENELEC TC 9X, Electrical and Electronic applications for railways, in accordance with the decision taken by CLC/TC9X at its 11th meeting on 1995-05-12/13.

The text of the draft was submitted to the formal vote and was approved by CENELEC as ENV 50121-2 on 1995-12-11.

The following date was fixed:

- latest date by which the existence of the ENV has to be announced at national level (doa) 1996-01-15

This European Prestandard is to be read in conjunction with ENV 50121-1:1996 - Railway Applications -Electromagnetic Compatibility - Part 1:General.

In this Prestandard, annexes A and B are informative.

Contents

1 Scope

This Prestandard sets the emission limits from the whole railway system, it describes the measurement method to verify the emissions, and gives the cartography values of the fields most frequently encountered.

These specific provisions are to be used in conjunction with the general provisions in ENV 50121-1.

2 Normative references

This European Prestandard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate place in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Prestandard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

ENV 50121-1	1996	Railway Applications - Electromagnetic Compatibility - Part 1: General
ENV 50121-3-1	1996	Part 3-1: Rolling stock - Train and complete vehicle
ENV 50121-4	1996	Part 4: Emission and immunity of the signalling and telecommunications apparatus
CISPR 16-1	1993	Specification for radio disturbance and immunity measuring apparatus and methods Part 1: Radio disturbance and immunity measuring apparatus

3 Definitions

Void

4 Emission limits

The emission limits in frequency range 9 kHz to 1GHz are given in figure 1.

For non-electrified lines, the limits are as these for 750 V d.c..

5 Method of measurement

The method of measurement is adapted from CISPR 16-1 to railway system with moving vehicle, the background to the method of measurement is given in annex A.

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 the vertical component of the radiated field are measured.

5.1 *Measurement parameters*

5.1.1 Peak measurement method is used 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 milliseconds.

5.1.2 Frequency bands and bandwidths at - 6dB used for measurements are in accordance with CISPR16-1. These are:

Frequency bands:	9-150 kHz	0,15-30 MHz	30-300 MHz	300 MHz -1GHz
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 exceed ± 4,0 dB.

5.1.4 Since 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, the measuring set shall be continuously active during the test and not triggered as the train approaches the test site.

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

- for 9 kHz - 30 MHz, a loop or frame antenna is used to measure H field (see figure 2);
- for 30 Mhz - 300 MHz, a biconical dipole is used to measure E field (see figure 3);
- for 300 Mhz - 1,0 GHz, a log-periodic antenna is used to measure E field (see figure 4).

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

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

Note that 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 antennae are not 10 metres from the track centreline, the results can be converted to an equivalent 10 metre value by using the following formula.

$$E_{10} = E_x + n \cdot 20 \cdot \log (D/10)$$

where E_{10} is the value at 10 metres
E_x is the measured value at D metres
n is a factor taken from the table below.

Frequency Range	n
0,15 to 0,4 Mhz	1,8
0,4 to 1,6 MHz	1,65
1,6 to 110 MHz	1,2
110 to 300 Mhz	1,0

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

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

These alignments are chosen to give standard conditions and may not detect the absolute maxima at a given site. If tests for horizontal polarisation or other alignments are required, these shall be specifically requested. Figures 2, 3 and 4 show the positions and alignments of the antennae.

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 resonances can exist in an overhead system at radio frequencies and this may require changes in the values of frequency chosen for measurement. If resonances exist, 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 all similar tests should if possible 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 metres 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 antennae shall be on the same side of the track.

5.1.10 Since the test sites are close to the track, they cannot correspond to the definition of a completely clear site since overhead structures, rails and the catenary have influences; however, wherever possible, antenna 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. Limit values shall be expressed in amps/metre and volts/metre and these can be derived as necessary.

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.

5.1.13 Statistical treatment of measurements from moving source

This process allows the noise to be expressed for example as the value which would not be exceeded on 80 % of train passages, with a certainty of 80 %.

Since in general only a small number of tests can be carried out, the non-central t-distribution method mentioned in EN 55013 shall be used to find the required exceedance and certainty values. This method states that

N [L,M] (dB scale) = Mean Value from tests (dB scale) + k. S_n (dB scale)

where L is the proportion of values of the total population which will be below the limit value **N**.
M is the probability that this proportion will be achieved.
k is a function of the number of results n and has values given in the table below, taken from [1] with $\bar{X}$ being the mean value and X_n being the nth result.

$$S_n = \sqrt{\frac{\Sigma (X_n - \bar{X})^2}{n-1}}$$

Table of k

Percentage of Values below Limit	Probability % that the test sample will be below limit	Number of Tests n					
L	M	n =	3	4	6	8	10
80	80	k =	2,04	1,68	1,42	1,30	1,24

This recognises that tests are difficult to arrange and allows a relatively small number of tests to be used. This treatment assumes a normal distribution of the results and should be reviewed if evidence is found of skew or other distributions. The setting of limit values shall take into account the need to use small numbers of tests and the use of statistical techniques.

5.2 *Frequency selection*

The selection of the actual frequencies to be measured will depend on the circumstances of the test site. A survey shall be made to identify the existing broadcast radio signals. Frequencies may then have to be changed from the proposed list.

A frequency list is given below and is proposed as the default list. The values are:

10 kHz	100 kHz	1,0 MHz	10 MHz	100 Mhz	1GHz
12	120	1,2	12	120	
15	150	1,5	15	150	
20	200	2,0	20	200	
30	300	3,0	30	300	
40	400	4,0	40	400	
50	500	5,0	50	500	
60	600	6,0	60	600	
80	800	8,0	80	800	

If this represents an excessive amount of testing, a recommended minimum frequency set is --

10 kHz	100 kHz	1,0 MHz	10 MHz	100 Mhz	1GHz
16	160	1,6	16	160	
25	250	2,5	25	250	
40	400	4,0	40	400	
63	630	6,3	63	630	

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

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 hours 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 but otherwise no limits are set since there is no evidence that the range of values found in Europe has any significant effect on noise.

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 standard conditions

Two test conditions are specified 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. This may then not allow a high power to be delivered.
b) at the maximum rated power and at a selected speed, (particularly if the lower frequencies are of concern).

Tests in the regenerative braking mode are required (since the radio noise characteristic can be different during braking). The brake power should be 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 shall be disregarded when considering radio noise.

5.4.4 Number of traction vehicles per train

Although more than one traction vehicle may operate in one train, the measurement of radio noise shall be carried out with only one traction vehicle or the minimum train consist.

5.5 *Test report*

The test report shall contain the following information.

- description of site;
- description of measuring system, with source reference for calibration and antenna factor data, including the dimension X of the log-periodic antenna if used;
- description of railway vehicle;
- numerical results;
- graphical results where relevant (The results shall include information such as bandwidths, date, time);
- mode of operation of railway vehicle;
- weather conditions;
- name of person in charge at site.

5.6 Figures

Figure 2 shows the position of the antenna for measurement of the magnetic field in the 9 kHz - 30 Mhz frequency band.

Figure 3 shows the position of the antenna for measurement of the electric field in the 30 Mhz - 300 Mhz frequency band.

Figure 4 shows the position of the antenna for measurment of the electric field in the 300 Mhz - 1 Ghz frequency band.