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Acoustics — Measurement of noise inside railbound vehicles

Acoustique — Mesurage du bruit à l'intérieur des véhicules circulant sur rails

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Descriptors : acoustics, railroad rolling equipment, acoustic measurement, noise (sound).

FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3381 was drawn up by Technical Committee ISO/TC 43, *Acoustics*, and circulated to the Member Bodies in March 1974.

It has been approved by the Member Bodies of the following countries :

Belgium	Hungary	Spain
Brazil	India	Sweden
Canada	Ireland	Switzerland
Czechoslovakia	Israel	Thailand
Denmark	Netherlands	United Kingdom
Finland	New Zealand	U.S.A.
France	Norway	U.S.S.R.
Germany	South Africa, Rep. of	

No Member Body expressed disapproval of the document.

Acoustics — Measurement of noise inside railbound vehicles

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the conditions for obtaining reproducible and comparable measurement results of the noise level and the noise spectrum inside all kinds of vehicles on rails or other types of fixed track.

The results may be used, for example,

- to compare various vehicles on a section of a standardized track specified in this International Standard;
- to characterize the acoustic comfort inside these vehicles;
- to orientate a program of more elaborate measurements for the purposes of studying noise reduction procedures.

NOTES

1 The test procedures specified in this International Standard are engineering methods as defined in ISO 2204. Note, however, that frequency band analysis is only required for type tests.

2 Measurements may be made on sources emitting noise of an impulsive character with an impulsive sound level meter (see clause 5).

2 REFERENCES

ISO 2204, *Acoustics — Guide to the measurement of airborne acoustical noise and evaluation of its effects on man*.

IEC Publication 179, *Precision sound level meters*.

IEC Publication 225, *Octave, half-octave and third-octave band filters intended for the analysis of sound and vibrations*.

3 NATURE OF TESTS

3.1 type tests : Measurements performed to prove that the vehicle delivered by the manufacturer is in accordance with noise specifications.

For type tests, the recommended test conditions shall be followed. If variations are unavoidable, these shall be stated in the test report.

3.2 monitoring tests : Measurements performed in order to check that the noise of the vehicle is still within

prescribed limits and that there have been no noticeable changes since acceptance or between the individual units in a series of vehicles.

For monitoring tests, the number of measurement positions and the number of engine operating conditions may be reduced.

4 MEASURED QUANTITIES

4.1 All readings of the sound level meter to be taken with the dynamic characteristic "fast".

4.2 The values to be measured at all microphone positions in type and monitoring tests are A-weighted sound pressure levels L_{pA} for the overall sound level expressed in dB.

4.3 For spectral analysis at some selected microphone positions in type tests, the values to be measured are octave band or 1/3 octave band sound pressure levels in dB.

5 MEASUREMENT EQUIPMENT

5.1 The sound level meter shall be of the precision class according to IEC Publication 179. The directivity of the microphone may influence the results. The type of microphone used shall be stated in the test report.

NOTES

1 A suitable wind-screen may be used to reduce the influence of wind on the reading.

2 If an impulse sound level meter in accordance with IEC Publication 179 A is available, it is recommended that the values read with A-weighting and the "impulse" dynamic characteristics designated as L_{pAI} and expressed in dB be stated.

5.2 If alternative measuring equipment, including for example a tape recorder and/or level recorder, is used, its overall electro-acoustic performance shall conform to the relevant clauses of IEC Publication 179.

5.3 For the measurement of noise spectra, the filters shall correspond to IEC Publication 225.

5.4 The performance of the measuring equipment shall be checked according to the instructions of the manufacturer or with a standard sound source (for example pistonphone) at the beginning and at the end of each series of measurements.

At time intervals no longer than 2 years, the sound level meter shall be calibrated for compliance in all relevant respects with IEC Publication 179.

6 ACOUSTICAL ENVIRONMENT, WEATHER CONDITIONS, BACKGROUND LEVEL

6.1 The test site for moving vehicles shall be such that the sound radiated by the vehicle to the outside contributes to the inside noise only by reflections from the track and not by reflections from buildings, walls or similar large objects outside the track.

In the immediate vicinity of the track, there should be no snow or other absorbent covering. The presence of such a covering shall be stated in the test report.

6.2 The meteorological conditions (such as temperature, wind, rain, etc.) shall be such that they do not influence the measurements.

6.3 The location for type tests made on stationary vehicles shall be chosen such that the A-weighted sound pressure level measured in the stationary vehicle at the location for test with all main and auxiliary equipment turned off is at least 10 dB below the sound level in the vehicle under test.

For other forms of tests or, if for any octave or 1/3 octave band of a spectral analysis this difference is less than 10 dB, the results shall be corrected according to the usual energy summation principle, as follows :

Difference between the sound pressure levels during the test and when stationary	Correction to be applied to the reading during the test
dB	dB
≥ 10	0
6 to 9	- 1
4 to 5	- 2
3	- 3

If the difference is less than 3 dB, only an upper limit for the result may be estimated.

NOTE – Care should be taken that spurious signals due to external influences, for example vibration of the measuring device and electromagnetic fields, do not affect the reading of the sound level or band pressure levels of the vehicle under test.

7 TRACK CONDITIONS

7.1 For conventional vehicles the measurements shall be made with ballast bed (preferably dry and not frozen) and wooden or reinforced concrete sleepers.

The track of the measuring section shall be straight, level, free of rail corrugations and laid without rail joints (welded rails).

7.2 Non-conventional vehicles shall be tested on their own tracks. The bed and the entire mounting of the rails shall be described in the test report with special attention to details in the case of non-conventional systems.

7.3 Special track conditions, for example tunnels, bridges, points, crossings, stations, may cause additional noises. To investigate these influences, supplementary measurements may be necessary. The track conditions must be described in the test report.

8 VEHICLE CONDITIONS

The wheel treads shall be as smooth and free of flats as possible. When unpowered coaches or wagons are to be tested, appropriate steps shall be taken to ensure that only the noise produced by that vehicle is measured, for example the distance between the power unit and the measured vehicle shall be such that the reading of the measuring instrument for the tested vehicle is not significantly affected by the noise of the power unit.

8.1 Loading of the vehicles

During the tests, the unpowered vehicles shall be unladen or unoccupied. The number of persons present shall be restricted to a minimum. For powered vehicles, however, the service weight and the number of personnel normally required for operation shall be used.

8.2 Doors, windows, auxiliary equipment, convertible furnishings

Gangway doors between coaches, entry doors, intermediate doors and windows shall be closed, unless their influence upon the sound level inside the vehicle is to be investigated.

Auxiliary equipment of the test vehicles which can operate during the run shall be in action if their noise contributes distinctly to the noise level at the microphone position. However, if the auxiliary equipment noise appears infrequently for only a short time (less than 1 min) and if it affects the noise level from other sources by less than 5 dB, it shall not be considered in the measurements.

If the disposition of furnishings inside the vehicle can be changed, for example berths in sleeping-cars, the measurements shall be repeated in each of the different furnishing conditions.

8.3 Constant speed test

In the measuring section of the track, the vehicle under test shall be run at the following specified speeds stabilized within ± 5 % limits :

- 1) 80 km/h for inter-urban trains
- 60 km/h for urban and underground trains
- 40 km/h for tramcars

NOTE – If additional measurements are performed at higher speeds, the following speeds are recommended : 120, 160,

200 km/h for inter-urban trains and 80, 100, 120 km/h for urban and underground trains, as far as allowed by the vehicles and the test track.

2) The maximum speed of the vehicle under test and, for power units, at full power.

8.4 Operating conditions for stationary vehicles test

8.4.1 Power vehicles with electrical engines and coaches

All auxiliary equipment shall be in operation. Additional measurements may be taken with this equipment operating individually and simultaneously at maximum load and, if necessary and feasible, also idling and at the lower speeds.

8.4.2 Power vehicles with internal combustion engines

8.4.2.1 Engine idling unloaded, fan at minimum speed, auxiliary equipment with minimum load, compressor not operating.

8.4.2.2 Engine at maximum speed unloaded (given by the speed-governor), fan at maximum speed if possible, auxiliary equipment with rated load, compressor operating with full load.

8.4.3 Power vehicles with turbines and other engines

These shall be tested under conditions comparable to those specified above. The operating conditions shall be described in the test report.

8.5 Acceleration and deceleration tests

With power units, tests under maximum acceleration conditions and under normal service braking from maximum speed to standstill shall be performed with all auxiliary equipment operating.

In both tests the highest. A-weighted sound pressure level attained during acceleration or deceleration shall be retained as a measurement result.

9 MEASUREMENT POSITIONS

The sound level inside a vehicle may vary considerably with location.

In particular, above the axles or underfloor auxiliary equipment a higher sound level is likely. Therefore, the number of measuring points selected shall be such that the sound level distribution in the vehicle is adequately represented.

In general, five to seven points, which include the middle and the ends of the vehicle, will be sufficient.

Their exact position shall be indicated on a plan.

9.1 Location of microphones

In all cases, the axis of symmetry of the microphone shall be oriented vertically.

9.1.1 Seated positions, microphone at a height of 1,2 m above the floor

- in the centre of a closed compartment;
- on the centre line of the open car and midway between two rows of seats.

9.1.2 Standing positions, microphone at a height of 1,6 m above the floor

- in the centre of areas accessible to standing passengers.

9.1.3 Driver's compartment

- in the centre of the compartment at a height of 1,6 m above the floor;
- at 0,2 m at ear level, from the ears of the driver or of any other person who normally occupies the compartment.

9.2 Special cases

9.2.1 If the furnishings are convertible (for example couchettes, sleeping-cars) the same measurements shall be taken at the same locations for each of the possible arrangements.

9.2.2 In couchettes and sleeping-cars, one of the microphone positions shall be 0,2 m above the pillow.

9.2.3 If auxiliary equipment can be kept in operation while the vehicle is stationary, the measurements shall be taken at the same locations for this condition.

10 PROCEDURE

10.1 For each measurement under constant operating conditions, a measuring time of at least 5 s shall be allowed.

If the level fluctuates, the mean value (or the most probable value) of the reading shall be estimated.

The reading shall be rounded to the nearest integral decibel.

Any peak which is obviously out of character with the general sound level being read shall be ignored.

10.2 The presence of easily audible pure tone components or a distinct impulsive character of the noise shall be stated in the test report.

11 TEST REPORT

The test report shall include all relevant details concerning :

- a) the nature of the tests;
- b) the test site, track and weather conditions;
- c) the measuring equipment, type of microphone;

ISO 3381-1976 (E)

- d) the background noise level;
- e) the vehicle, its traction system and its speed during the test;
- f) the operating conditions during the test (clause 8);
- g) the auxiliary equipment and its operating conditions;
- h) the microphone positions indicated on a plan;
- i) the sound levels and, if necessary, the noise spectrum;
- j) the presence of pure tone components or noise of an impulsive character.

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