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**Rolling stock — Measurement of noise
inside railway vehicles**

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Land, Infrastructure, Transport and Tourism, through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Association of Rolling Stock Industries (JARI)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently JIS E 4021:1994 is replaced with this Standard.

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Rolling stock — Measurement of noise inside railway vehicles*

Introduction

This Japanese Industrial Standard has been prepared based on the second edition of ISO 3381 published in 2005 with some modifications of technical contents so as to reflect current conditions of measurement of noise inside railway vehicles in Japan.

The portions with dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with explanations is given in Annex JB.

1 Scope

This Standard specifies the conditions for obtaining reproducible and comparable measurement results of levels and spectra of noise inside railway vehicles (hereafter referred to as “vehicle”).

This Standard is applicable for :

- type test;
- periodic monitoring test;

The results may be used, for example :

- to characterise the noise inside these vehicles;
- to compare the internal noise of various vehicles on a particular track section.

This Standard describes tests during different operating conditions, i.e. constant speed running, accelerating, decelerating and standstill. It is not mandatory to perform tests at all conditions, and the chosen operating conditions shall be in accordance with the agreement between the railway operator and the manufacturer (hereafter referred to as “between the purchaser and the manufacturer”).

Infrasound and messages intelligibility are not treated in this Standard.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows :

ISO 3381 : 2005 *Railway applications — Acoustics — Measurement of noise inside railbound vehicles* (MOD)

The symbols which denote the degree of correspondence in the contents between the relevant International Standard and JIS are IDT (identical), MOD (modified), and NEQ (not equivalent) according to ISO/IEC Guide 21.

*Editor's note: The original title "Rolling stock – Measurement of noise inside railbound vehicles" has been modified to "Rolling stock – Measurement of noise inside railway vehicles" in this document by Japan Association of Rolling Stock Industries (JARI).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. For standards with the year indication, only the editions of the indicated year shall be applied and the revisions (including amendments) made thereafter shall not be applied. For those without the indication of the year, the most recent edition (including amendments) shall be applied.

JIS C 1509-1 : 2005 *Electroacoustics — Sound level meters — Part 1 : Specifications*

NOTE : Corresponding International Standard : IEC 61672-1 : 2002 *Electroacoustics — Sound level meters — Part 1 : Specifications* (IDT)

JIS C 1514 *Electroacoustics — Octave-band and fractional-octave-band filters*

NOTE : Corresponding International Standard : IEC 61260 *Electroacoustics — Octave-band and fractional-octave-band filters* (IDT)

JIS C 1515 *Electroacoustics — Sound calibrators*

NOTE : Corresponding International Standard : IEC 60942 *Electroacoustics — Sound calibrators* (IDT)

JIS E 4001 *Railway rolling stock — Vocabulary*

NOTE : Corresponding International Standard : IEC 60050-811 *International Electrotechnical Vocabulary — Chapter 811 : Electric traction* (MOD)

JIS Q 17025 : 2000 *General requirements for the competence of testing and calibration laboratories*

NOTE : Corresponding International Standard : ISO/IEC 17025 : 1999 *General requirements for the competence of testing and calibration laboratories* (IDT)

JIS Z 8106 *International electrotechnical vocabulary Chapter 801 : Acoustics and electroacoustics*

NOTE : Corresponding International Standard : IEC 60050-801 *International Electrotechnical Vocabulary — Chapter 801 : Acoustics and electroacoustics* (IDT)

ISO 266 *Acoustics — Preferred frequencies*

ISO 3095 : 2005 *Railway applications — Acoustics — Measurement of noise emitted by railbound vehicles*

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in JIS E 4001 and JIS Z 8106, and the following apply.

3.1 type test for noise emission of railway vehicles (hereafter referred to as “type test”)

measurement performed to prove that, or to check if, a vehicle delivered by the manu-

facturer complies with the noise specifications

3.2 monitoring test for noise emission of railway vehicles (hereafter referred to as “monitoring test”)

measurement performed to check that the noise of one or more vehicles, taken among individual units in a consignment of vehicles, is within prescribed limits or to check if the noise of the vehicle has changed since initial delivery or after modification

3.3 roughness

root mean square (RMS) value of the amplitude variation of the running surface of a rail in the direction of motion (longitudinal level) measured over a rail length, expressed in μm

3.4 roughness level, L_r

(This term is defined in the corresponding International Standard, but since it is not used in this Standard, the definition has been deleted.)

3.5 sound pressure, p

root mean square value of an instantaneous sound pressure over a certain time period expressed in Pa, unless otherwise specified (see JIS Z 8106)

3.6 sound pressure level, L_p

logarithm of the ratio between a specified sound pressure and its reference sound pressure, expressed in dB

Sound pressure level is expressed in decibels by taking the logarithm with base 10 (common logarithm) of the ratio and multiplying it by 20 (see JIS Z 8106).

Sound pressure level is given by the following equation :

$$L_p = 20 \log[p / p_0] \dots\dots\dots (1)$$

where, L_p : the sound pressure level (dB)
 p : the RMS sound pressure (Pa)
 p_0 : the reference sound pressure; $p_0 = 20 \mu\text{Pa}$

NOTE 1 The corresponding International Standard gives the following equation for sound pressure level.

$$L_p = 10 \log[p / p_0]^2$$

The same equation (1) as that given in JIS C 1509-1 : 2005 is used in this Standard.

The same style as equation (1) is also used in 3.7 and 3.9.

NOTE 2 Definitions from 3.6 to 3.11 apply to values measured either as a frequency spectrum or in a particular frequency band of centre f (expressed in Hz).

3.7 A-weighted sound pressure level, L_{pA}

sound pressure level obtained by using the frequency weighting A (see JIS C 1509-1 :

2005), given by the following equation :

$$L_{pA} = 20 \log[p_A / p_0] \dots\dots\dots(2)$$

where, L_{pA} : the A-weighted sound pressure level (dB)
 p_A : the RMS A-weighted sound pressure (Pa)
 p_0 : the reference sound pressure; $p_0 = 20 \mu\text{Pa}$

3.8 AF-weighted maximum sound pressure level, $L_{pAF\max}$

maximum value of the A-weighted sound pressure level determined during the measurement time interval T by using time weighting fast F (see JIS C 1509-1)

3.9 A-weighted equivalent continuous sound pressure level, L_{AT} or $L_{pAeq,T}$

A-weighted sound pressure level given by the following equation :

$$L_{AT} = L_{pAeq,T} = 20 \log \left[\frac{1}{T} \int_0^T \frac{p_A^2(t)}{p_0^2} dt \right]^{\frac{1}{2}} \dots\dots\dots(3)$$

where, L_{AT} and $L_{pAeq,T}$: the A-weighted equivalent continuous sound pressure level (dB)
 T : the measurement time interval (s)
 $p_A(t)$: the A-weighted instantaneous sound pressure (Pa)
 p_0 : the reference sound pressure; $p_0 = 20 \mu\text{Pa}$

3.10 A-weighted short-term equivalent continuous sound pressure level, $L_{A,1s}$ or $L_{pAeq,1s}$

A-weighted equivalent continuous sound pressure level (see 3.9) where the measurement time interval T is one second ($T = 1\text{s}$)

3.11 A-weighted equivalent continuous impulsive sound pressure level, $L_{AI,T}$ or $L_{pAIeq,T}$

A-weighted equivalent continuous sound pressure level determined by using time weighting impulse I (see JIS C 1509-1, Annex C)

3.12 noise with impulsive character

noise which contains impulsive character

The impulsive character is conventionally confirmed if the difference between A-weighted equivalent continuous impulsive sound pressure level ($L_{AI,T}$) and A-weighted equivalent continuous sound pressure level (L_{AT}) is greater than 3 dB.

3.13 noise with tonal character

noise which contains audible tones

3.14 background noise

noise when vehicle is not power supplied or when its engine is shut down and stored in a quiet location (e.g. late night) or in the middle of a spacious depot with no other vehicles

4 Measurement quantities

The quantities to be measured at all microphone positions for both type and monitoring tests are specified below.

- a) Frequency analysis is required for type tests while it is optional for monitoring tests. The typical 1/3 octave band frequency range is from 31.5 Hz to 8 kHz according to **ISO 266**. The frequencies specified in ISO 266 are indicated in Annex JA. It is important, however, that the lower frequency limit is chosen to ensure that the product of the lowest bandwidth and signal duration exceeds unity.
- b) In presence of noise with suspected impulsive character, both A-weighted equivalent continuous impulsive sound pressure level, $L_{AI, T}$, and A-weighted equivalent continuous sound pressure level, L_{AT} , shall be measured. If they differ by more than 3 dB the impulsive character is conventionally confirmed.
- c) In presence of noise with suspected tonal character, at each microphone position it is suggested to make frequency analysis measurements according to a). The frequencies of the audible tones obtained through the analysis (such as a source of the noise) shall be described in the test report.
- d) The measurement quantity for trains running at constant speed is the A-weighted equivalent continuous sound pressure level, L_{AT} . Additionally, the A-weighted short-term equivalent continuous sound pressure level, $L_{A, 1s}$ may be measured.
- e) For measurements on stationary vehicles, in presence of noise with suspected impulsive character, at each microphone position it is suggested to make two measurements : one with time weighting slow S, the other with time weighting impulse I (see **JIS C 1509-1 : 2005**, Annex C).
- f) The measuring quantities for accelerating or braking tests shall be the maximum AF-weighted sound pressure level, L_{pAFmax} , and the A-weighted equivalent continuous sound pressure level, L_{AT} . The measurement time interval, T is defined in clause 7.

5 Instrumentation

The instrumentation system, including the microphones, cables and recording devices shall meet the Class 1 or Class 2 requirements specified in JIS C 1509-1 : 2005.

The class of instrumentation system used shall be described in the test report.

NOTE : The corresponding International Standard uses the term "Type 1" as the term corresponding to "Class 1." The terminology in JIS C 1509-1 : 2005 is used in this Standard.

The microphones shall have an essentially flat frequency response in a free sound field.

A windscreen shall always be fitted on the microphone.

The one-third-octave band filters shall meet the requirements of Class 1 according to **JIS C 1514**.

Before and after each series of measurements, a sound calibrator with a Class 1 accuracy according to **JIS C 1515** shall be applied to the microphone(s) in order to verify the calibration of the entire measuring system at one or more frequencies over the frequency range of interest.

If the difference between the two calibrations is more than 0.5 dB, all the measurement results shall be rejected.

The compliance of the calibrator with the requirements of **JIS C 1515** shall be verified at least once a year. The compliance of the instrumentation system with the requirements of **JIS C 1509-1 : 2005** shall be verified at least every 2 years.

The date of the last verification of the compliance with **JIS C 1509-1 : 2005** and/or **JIS C 1515** shall be recorded.

6 Test conditions

6.1 Deviations from the requirements

The conditions prescribed for each test shall be complied with as closely as possible. Slight deviations from the specified test conditions are permissible, but shall be described in the test report and in general, will lower the reproducibility.

6.2 Test environment

6.2.1 Acoustical environment

The test site for chiefly outside-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.

For vehicles moving inside tunnels (like underground) the measurement shall be carried out in real operating conditions.

In the immediate vicinity of the track, there shall be no additional absorbent covering (noise proof structure) or snow. However, measurements in sections with sound barriers are acceptable in accordance with the agreement between the purchaser and the manufacturer.

6.2.2 Meteorological conditions

Measurements shall be carried out only when there is no wind, rain, and/or snow that may affect inside noise.

When measurements are made under meteorological conditions that may impact inside noise, those conditions shall be described in the test report.

6.2.3 Background sound pressure level

Care shall be taken to ensure that the noise from other sources (for example other vehicles or industrial plants and/or wind) does not influence significantly the measurements.

To clarify the background noise conditions, the purchaser and the manufacturer