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**Acoustical requirement and measurement on station platform
of urban rail transit**

城市轨道交通车站站台声学要求和测量方法

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1 Scope

The document lays down the acoustical requirements for the platform of an urban rail transit station while a train enters and leaves the station, and the content of the measurement report, and describes the noise measurement method and the reverberation time measurement method.

It applies to the design, measurement and evaluation of the platform acoustic environment of new, rebuilt and extended urban rail transit systems whose maximum design running speed does not exceed 160 km/h, which are supported on steel wheel and steel rail and powered by electricity. Measurement of the platform acoustic environment of existing urban rail transit lines may be carried out with reference to the document.

2 Normative references

Four undated references are cited: GB/T 3785.1 on sound level meter specifications, GB/T 8170 on rules for rounding off numerical values and expressing and judging limiting values, GB/T 15173 on sound calibrators, and GB/T 36075.2 on the measurement of reverberation time in ordinary rooms.

3 Terms and definitions

3.1 equivalent continuous A-weighted sound pressure level, $L_{Aeq,T}$: the A-weighted sound pressure level of a steady sound that has, over a stated period of time, the same mean square A-weighted sound pressure as the time-varying noise. Note 1 abbreviates the term to equivalent sound level. Notes 2 and 3 refer to formulae (1) and (2). The symbol legend

gives $L_{Aeq,T}$ in decibels dB(A), t_2 minus t_1 as the stated period in seconds, $p_A(t)$ as the A-weighted sound pressure in pascals (Pa), and p_0 as the reference sound pressure, taken as 20 μ Pa. The source is given as GB/T 3947-1996, 13.7, modified.

3.2 reverberation time: the time required for the mean sound energy density to decay to one millionth of its original value (60 dB) after the source is stopped once the sound has become steady. Note 1 gives the unit as the second (s). Note 2 states that the reverberation time for a 60 dB decay may be obtained by linear extrapolation over the range from -5 dB to -25 dB or from -5 dB to -35 dB of the decay curve, denoted T20 and T30 respectively. The source is given as GB/T 50076-2013, 2.1.2, modified.

3.3 background noise: the noise on the platform when no train is passing.

3.4 train: an assembly made up of a number of vehicles and intended to run on an operating line.

3.5 platform screen doors: a continuous barrier set at the edge of the platform which separates the passenger waiting area from the train running area, corresponds to the train doors and has sliding doors that can be opened and closed under multi-stage control. The note records that platform screen doors may be full height or half height, and sealed or unsealed. The source is given as GB/T 50833-2012, 8.9.1, modified.

4 Acoustical requirements

4.1 The equivalent continuous A-weighted sound pressure level in the platform area while a train enters and leaves the station, abbreviated in the document to equivalent sound level, shall meet the limits of Table 1. Table 1, in decibels, gives two train running states with one permissible limit each: a train entering the station, 80, and a train leaving the station, 80.

4.2 With the station platform empty, the reverberation time at the 500 Hz octave band centre frequency shall not exceed 1.5 s.

5 Noise measurement method

5.1 The quantity measured shall be the equivalent sound level under the stated measurement conditions while a train enters and leaves the station.

5.2 Instruments. The sound level meter or equivalent measuring system shall not fall below the requirements of GB/T 3785.1 for class 1 measuring equipment, and its performance shall conform to GB/T 3785.1; an omnidirectional microphone is preferred. The sound calibrator shall conform to GB/T 15173. The instrument shall be calibrated with a class 1 sound calibrator before measurement, and its indication checked with a sound calibrator afterwards; the difference between the indications before and after shall not be greater than 0.5 dB. Sound level meters and sound calibrators shall have passed verification by a nationally recognised metrology body and be within their period of validity.

5.3 Measurement conditions. Rain, snow and wind are to be avoided, and the temperature, humidity and air pressure at the sound level meter recorded. No sound reflecting object shall lie within 1 m of the measuring point. The running condition of the train entering and leaving the station shall be the same as in normal operation. The platform screen doors shall be closed. Trains passing each other shall be avoided. Background noise shall be measured at each measuring point, preferably for 20 s, at the same point position and under the same environmental conditions as the platform noise measurement, and with other sources such as video and broadcast announcements not appreciably affecting the measurement. Where the background noise is more than 10 dB(A) below the platform noise no correction is needed; otherwise formula (3) applies, whose legend gives L_{eq} as the corrected equivalent sound level, $L_{Aeq,T}$ as the measured equivalent sound level and L_b as the background noise, all in dB(A). Where the difference between background noise and platform noise is less than 5 dB(A) the measurement shall be repeated.

5.4 Microphone position. Microphones shall be placed 1.5 m from the end of the platform and at the middle of the platform; positions for different platform types follow Annex A. The microphone shall be 1 m from the edge of the platform screen doors on the side of the track carrying the train under test and 1.6 m above floor level. Its front shall face the track under test, with its axis horizontal and perpendicular to the line. A windscreen shall be fitted.

5.5 Measurement period. For a train entering the station the period runs from the arrival of the head of the train to the train stopping; for a train leaving, from the train starting to the tail of the train leaving the station.

5.6 The number of measurements for a train entering and for a train leaving shall each be not less than 10.

5.7 Data processing. Noise for a train entering shall use the data from the entering end and the middle of the platform, and noise for a train leaving the data from the leaving end and the middle. The repeated measurements for entering and for leaving shall be averaged arithmetically. The averaged data shall be rounded to a whole number by the rules of GB/T 8170, and that value taken as the measurement result.

6 Reverberation time measurement method

Reverberation time shall be measured by the method of GB/T 36075.2 and shall also meet the provisions of this document. The octave band centre frequency selected shall be 500 Hz. The platform shall be empty during measurement, preferably with no more than four people present.

The platform shall be divided evenly into at least three zones, each preferably no longer than 50 m, and the reverberation time of each zone measured separately. Within a zone the source shall stand at the middle of that zone, more than 0.5 m from the edge of the platform screen doors and 1.5 m above the floor. Microphones shall be spread on both sides of the

source, offset 1.5 m from the longitudinal centre line of the platform, and not less than 1.0 m from the nearest reflecting surface; there shall be not fewer than three measuring points, at 1.6 m above the floor, with positions for different platform types following Annex B.

Raw reverberation time values shall be recorded to two decimal places. The raw values from the microphone positions in a zone shall be averaged arithmetically and the average rounded to give the result for that zone: two decimal places where the arithmetic mean of the raw values is less than or equal to 1 s, one decimal place where it is greater than 1 s.

7 Measurement report

A measurement report shall be submitted after measurement and shall contain at least the following: the measurement location; the name, model, serial number and verification date of the measuring instruments; the calibration record; a diagram of measuring point positions, train formation and platform type; the background noise; the measurement data and results, including equivalent sound level, measurement time interval, reverberation time and the results of data processing; the meteorological conditions, including wind speed, wind direction, temperature, humidity and air pressure; an account of any circumstance during measurement that could affect the result; and the measurement date and the name of the person who made it.

Annex A Layout of platform noise measuring points (normative)

Figures A.1 and A.2 illustrate the layout of noise measuring points for an island platform and for a side platform. The key to Figure A.1 lists the platform end door, the platform head noise measuring point, the track centre line, the platform middle noise measuring point, the platform tail noise measuring point, and l_1 , the distance from the end measuring point to the end of the platform, which is 1.5 m. The key to Figure A.2 lists the platform end door, the platform head noise measuring point, the platform middle noise measuring point, the platform tail noise measuring point, and the same distance l_1 of 1.5 m. The figures themselves are line drawings and are not reproduced in the extracted text.

Annex B Layout of reverberation time measuring points (normative)

Figures B.1 and B.2 illustrate the layout of reverberation time measuring points for an island platform and for a side platform. The key to each figure lists platform zone A, the source position, the microphone position, platform zone B, platform zone C, and l_2 , the length of a platform zone, which should not exceed 50 m. The figures themselves are line drawings and are not reproduced in the extracted text.