

## STANDARDIZATION OF THE METHOD FOR MEASURING THE SOUND POWER LEVEL BASED ON THE ISO 3740 SERIES IN JAPAN

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Since 1984, the standardization of the method for measuring the sound power level of sound sources has started in Japan. Due to the requirements on the style of the Japanese Industrial Standards and the present situations on the measuring method of sound radiation from the individual machinery and equipments, it is rather difficult to prepare the Japanese Industrial Standards (abbr. JIS) as the completely translated version from ISO 3740 series.

The Technical Committee has started the preparation of draft standards from the consideration of ISO 3740 series and adopted some refinements or amendments by considering carefully the conformity with the ISO 3740 series.

This paper describes the outlines of the main structures of JIS series.

### OUTLINES OF JIS SERIES

Based on the basic considerations on the ISO 3740 series and on the annual schedule for the preparation of JIS, it was decided to integrate seven standards of ISO 3740 series into three standards. Titles of these three standards and the correspondence with ISO standards are summarized in Table 1.

As shown in this table, the standardization is now under progress. Here, the contents of three standards are introduced, with possibilities to be performed some minor alterations, especially in the case of JIS Z 8734.

### PRECISION METHODS IN ANECHOIC AND HEMI-ANECHOIC ROOMS

This standard has the essential conformity with ISO 3745. Important amendments are adopted for the standardization of JIS Z 8732, as shown in the following.

Table 1. The methods for measurements of sound power level of sound sources.

JIS No.	Titles of standards	Corresponding ISO standards
Z 8732 – 1986	Precision method for the measurement of sound power level in anechoic and hemi - anechoic rooms	3745
Z 8733 (draft)	Engineering and survey methods for the measurement of sound power level in general sound fields	3743, 3744, 3746, 3747, 3748
Z 8734 (in preparation)	Precision method for the measurement of sound power level in reverberation rooms	3741, 3742

(1) Method for checking the sound field in the test room.

The specifications for the adaptability of the sound field in the anechoic and hemi-anechoic rooms are the same with those in ISO 3745, that is, the maximum allowable standard deviations in the inverse square characteristics are the same in both standards.

Procedures for the calculations of the deviations are specified in details in JIS Z 8732 as follows.

A loudspeaker is set in the room, so that the acoustic center of the loudspeaker should coincide with the center of the measuring spherical or hemi-spherical surface. Sound pressure levels are measured at the acoustic center of the loudspeaker. Measuring positions should extend over the range from the position on the measuring spherical or hemi-spherical surface. From the measured sound level versus distance from the acoustic center of the loudspeaker are estimated from the following equation, based on the inverse square law.

$$L_p(r) = 20 \log_{10} \{a / (r - r_0)\}$$

$$\text{Here, } a = \left\{ \left( \sum_{i=1}^N r_i \right)^2 - N \sum_{i=1}^N r_i^2 \right\} / \left\{ \sum_{i=1}^N r_i \sum_{i=1}^N q_i - N \sum_{i=1}^N r_i q_i \right\} \quad q_i = 10 - L_{pi}/20$$

$$r_0 = - \left\{ \sum_{i=1}^N r_i \sum_{i=1}^N r_i q_i - \sum_{i=1}^N r_i^2 \sum_{i=1}^N q_i \right\} / \left\{ \sum_{i=1}^N r_i \sum_{i=1}^N q_i - N \sum_{i=1}^N r_i q_i \right\}$$

$r_i$  : the distance between the  $i$ th measuring position and the center of the measuring spherical or hemi-spherical surface

$L_{pi}$  : the sound pressure level at the  $i$ th measuring position

$N$  : the number of measuring positions at some measuring direction

By using the above-estimated functional relations, the deviations from the inverse square characteristics of sound pressure level at

each measuring position are obtained.

(2) The limitation on the maximum volume of source to be tested.

In ISO 3745, it is specified that the volume of the sound source to be tested should be less than 0.5% of the volume of the test room. If the above-mentioned sound field condition is fulfilled, it is not necessary to specify the limitation on the maximum volume of the source explicitly. So, the specification on the volume of the source to be tested is deleted from JIS Z 8732.

The influence of the radius of the measuring spherical or hemispherical surface on the accuracy of the measurements of the sound power level was investigated basically by Tohyama, Imai and Tachibana (WG members of the Technical Committee) and the same conclusion was derived with the specification in ISO 3745.

#### ENGINEERING AND SURVEY METHODS IN GENERAL SOUND FIELD

In the actual situations for noise control problems, it is very important to specify the noise characteristics radiated from various kinds of noise sources. In many cases, the sound fields in test environments are not necessarily idealized just like in the laboratories where the sound fields are well defined as the free field or the diffuse field.

In order to get the measured results of sound power level with accuracy corresponding to the engineering grade or survey grade, it would be necessary to specify the measuring procedures carefully. In this case, it is important to take into consideration on the wide variety of the sound field met in the practical test environments, such as outdoors, large factory rooms, machine rooms in buildings and so on.

Important amendments with due conformity with ISO standards are adopted to prepare the draft JIS Z 8733, through the careful considerations on the corresponding ISO standards and also on the results of inter-laboratory measurements carried out in Japan. Outlines of the draft JIS Z 8733 are summarized in Table 2.

Principal items are summarized in the following.

(1) Survey method in quasi-diffuse field.

In site measurements, it becomes often necessary to measure the sound power level of noise sources situated in such rooms as machine room in buildings, small test room in the factory where there exists certain degree of reverberation, and so on. In ISO 3746, the method for measurements for these situations is specified according to the hemi-free field method, by applying the necessary correction on the sound field.

By considering the easiness of the measuring procedures, such as microphone arrangements and so on, it was concluded that the introduction of the new survey method based on the diffuse field procedures would be preferable, especially for field measurements. In order to prepare the draft for this method, ISO 3743 was referred to, with deletion of the limitation of the reverberation of the test room and with some simplification of the procedures for the determination of source and microphone positions.

(2) Determination of octave-band sound power level in survey method.

Even in the case of the survey method, the determination of octave band sound power level is strongly required in Japan, and so the necessary specifications are included in this standard.

(3) Determination of A-weighted sound power level.

For engineering and survey methods in hemi-free field, it is usually necessary to use the so-called sound field corrections, in order to correct the influence of the deviation from the ideal hemi-free field. Also, in the case of quasi-diffuse field method, the equivalent sound absorption area is used for the determination of sound power level.

In general, the sound field correction and equivalent sound absorption area depend on the frequency of sound. It is considered that the A-weighted sound field correction or A-weighted equivalent sound absorption area seems to be physically meaningless. So, this standard specifies that the A-weighted sound power level should be determined from the octave or 1/3 octave (method A) band sound power levels.

Table 2. Outlines of draft JIS 8733

	Accuracy	Test environment	Quantities to be determined
A. Engineering method in hemi - free field	Engineering	Outdoors, Large rooms	Octave and 1/3 octave band power level, A - weighted level, Directivity
B. Survey method in hemi - free field	Survey	Outdoors, Large rooms	Octave band level, A - weighted level
C. Survey method in quasi - diffuse	Survey	Rooms with certain reflection	Octave band level, A - weighted level

#### PRECISION METHODS IN REVERBERATION ROOM

This standard is now under preparation. It is expected that the important specifications in ISO 3741 and 3742 would be held in JIS 8734. The corner microphone method may be introduced in this standard.

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