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## RECENT TRENDS IN THE DETERMINATION OF NOISE EMISSION FROM MACHINERY AND EQUIPMENT IN JAPANESE INDUSTRIES

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### INTRODUCTION

In relation to the unification of European Community at the end of 1992, various kinds of standardization have been carried out in Europe. Also, noise control of machinery and equipment has been received special attention, corresponding to EEC Directive 89/392 "Machinery safety".

Based on these situations, extensive works for preparing International Standards have been carried out in ISO, by the requirements of European Committee for Standardization (CEN). Especially, for the declaration of noise emission values from machinery and equipment, sound power levels and emission sound pressure levels at specified positions are to be used. For this purpose, the revision of ISO 3740 series (Determination of sound power levels) and of ISO 4871 (Declaration of noise emission value), and the enactment of ISO 9614 (Determination of sound power levels by sound intensity technique) and ISO 11200 series (Determination of emission sound pressure levels) are being carried out.

In Japan, for the description and evaluation of noise emitted from machinery and equipment, A-weighted sound pressure levels or band sound pressure levels at specified positions have been mainly used until recently. However, in order to be conformed to the requirements in trade contract, some industries are making efforts sound power levels or emission sound pressure levels.

In this paper, present situations in Japanese industries are described.

### HISTORICAL BACKGROUND FOR NOISE MEASUREMENT IN JAPAN

From the 1950s, the environmental impacts of industrial noise

have been one of the important social problems in Japan. National and local regulations for noise abatement had been prepared. Corresponding to the development of these regulations, it has been strongly required to standardize the method for the measurement of noise and to specify instruments for the measurement of noise. So far, the standardization on methods for noise measurements in Japan has been mainly aimed at the general environmental noise, consistent with the regulatory requirements.

In recent years, the specification of emitted noise have been included in the order form for the machinery or equipment. Corresponding to these situations, it has become necessary to standardize the methods for noise emission measurements for individual machinery and equipment. A number of Japanese Industrial Standards has been established for individual machinery and equipment. Most of these standards specify A-weighted sound pressure levels as the noise emission quantities.

#### NOISE MEASUREMENT RELATED TO LOW-NOISE MACHINERY AND EQUIPMENT

In Japanese industries, major interests have been concentrated on the development of low-noise machinery and equipment. For these purposes, important aims of noise measurements are the analysis of noise generation mechanism and/or the noise source identification. Various types of noise measurement method have been developed and adopted extensively. New technologies, mainly based on digital signal processing techniques, have been widely adopted for these measurements. The important ones are summarized in **Table 1**.

**Table 1** Noise measurement and analysis method for development of low - noisemachinery and equipment

necessary information for noise reduction	measurement and analysis technique
· physical characteristics of emitted sound	· FFT (power spectrum, correlation / coherence, ...)
· source identification (localization of noise emission parts)	· sound intensity · acoustic holography
· relative contribution from respective part	· near - field acoustic holography (STSF)
· transmission path of vibration and / or sound	· modal analysis · FEM, BEM, SEA

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According to above-mentioned procedures, remarkable reduction of noise emitted from machinery and equipment has been accomplished in various field of industries, such as automobile industry, construction machinery industry, building service machinery industry, computer/business machine industry, household appliance industry and so on.

During the development of low-noise machinery and equipment, detailed characteristics of emitted noise from machinery and equipment are measured in octave-band, 1/3 octave-band or narrow-band sound pressure levels, or power spectrum.

### NOISE DECLARATION IN JAPANESE INDUSTRIES

In Japanese industries, compared with efforts for technological developments of low-noise machinery and equipment, less attention has been put on the declaration of noise emission values.

Until recently, A-weighted sound pressure levels at specified positions have been used mainly for the specification of machinery noise. Measurement procedures including measurement positions are specified in respective standards or test codes.

Present situations of measurement standards on machinery noise are summarized in the following :

- (1) Basic standards for the determination of sound power levels of noise sources

In comparison with actual circumstances in Europe and America, the importance of the sound power level of noise source has been practically neglected in Japanese industries. In recent years, due to the requirements in specifications for export of machinery and equipment, the standardization of methods for the determination of sound power levels have been strongly demanded by the industries.

Following three national standards have been published in Japan during 1986 and 1988.

JIS Z 8732	Precision method for the determination of sound power level of sound source in anechoic and hemi-anechoic room
JIS Z 8733	Engineering and survey methods for the determination of sound power level of sound source in general sound fields
JIS Z 8734	Precision method for the determination of sound power level of sound source in reverberation room

These standards have been prepared according to the conventional p-squared methods and prepared by considering the conformity with

the corresponding ISO 3740 series. During the drafting of these standards, it was considered to introduce some recision to account for recent developments in these fields. Especially, it was required to up-grade the survey method of ISO 3740 series [1],[2].

As to the measurement of sound pressure levels emitted by machinery and equipment, there is not the basic standard in Japan. In the older version of JIS Z 8731-1966 (Methods for measurement of sound level), brief description of the method for measurement of A-weighted sound pressure level for machinery and equipment had been specified. However, at the time of the full recision of JIS Z 8731 in 1983, this part of specification was completely deleted.

## (2) Measurement standards of noise emission for individual machinery and equipment

There are a large number of Japanese Industrial Standards which specify methods for the measurement of noise emitted by individual machinery and equipment. Titles of these standards are listed below.

JIS A 1708*	Method of test for noise of equipment units for dwellings
JIS A 4003+	Warm air furnaces
JIS A 8305+	Method for the measurement of airborne noise emitted by construction equipment intended for outdoor use
JIS B 1548	Measuring method of sound pressure levels of ball and roller bearings
JIS B 1753	Measuring method of noise of fears
JIS B 6004	Method of sound pressure level measurement for machine tools
JIS B 6406*	Mechanical presses-Methods of measurement of A-weighted sound pressure level
JIS B 6521**	Method of measurement for noise emitted by wood working machinery
JIS B 8005**	Measuring method of noise emitted by internal combustion engines
JIS B 8310++	Methods of A-weighted sound pressure level measurement for pumps
JIS B 8346++	Methods of A-weighted sound pressure level measurement for fans, blowers and compressors
JIS B 8350++	Methods of noise level measurement for oil hydraulic pumps and motors
JIS B 9064	Method of sound level measurement for industrial sewing machine
JIS C 8106	Luminaires for fluorescent lamps
JIS C 8108	Ballasts for fluorescent lamps
JIS C 8112	Table study lamps for fluorescent lamps

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JIS C 8115	Domestic pendant luminaires for fluorescent lamps
JIS C 9108	Electric vacuum cleaners
JIS C 9603	Ventilating fans
JIS C 9606	Electric washing machine
JIS C 9609	Electric blenders and electric juicers for household use
JIS C 9610	Portable electric grinders
JIS C 9611	Electric disc grinders
JIS C 9612	Room air conditioners
JIS C 9614	Electric shavers
JIS C 9615+	Air cleaners
JIS C 9625	Portable electric planers
JIS C 9626	Portable electric circular saws
JIS D 1024	Measurements of noise emitted by automobiles
JIS D 1038	Method of noise test for motor cycles
JIS D 6502	Testing method of motor graders
JIS D 6503	Testing methods of crawler tractors
JIS F 0904	Measurement of noise level on board vessels (Machinery part)
JIS F 0905	Measurement of noise level on board vessels (Accommodation part)
JIS S 3026	Kerosene feeders for kerosene combustion appliances
JIS S 3031*	General rules for test methods of oil burning appliances

- Note: \* Sound power level and (A-weighted) sound pressure level are specified.
- + Sound power level is specified.
- \*\* A method for determination of the approximate sound power level is given in explanatory notes which do not form integral parts of the standard.
- ++ A method for determination of the sound power level is described in the reference.

These standards are divided into two categories: one is the standard specifying the method for measurement and another one is the product standard in which the method for measurement is specified.

In most of these standards, (A-weighted) sound pressure level is adapted as the basic noise descriptor. Only small number of standards specify the method for determination of sound power level. This may be due to historical background in the field of machinery noise in Japan.

For a long time, the concept of sound power has been unfamiliar in Japanese industries. For example, JIS A 8305 specifies the method for determination of sound power level emitted by construction equipment which has complete conformity with ISO 4872. How-

ever, in construction machinery industry, it has been rather usual to measure the A-weighted sound pressure level, or octave- or 1/3 octave-band sound pressure level around the machinery to be tested, except for the case of export inspection.

As can be seen in the above list of Japanese standards, there is not national standards concerning the method for measurement and declaration of emitted noise from computer and business machine. Until several years ago, there was not the unified method for measurements in these industries. In some cases, it had been difficult to compare directly the noise emission values for products manufactured by different companies. Of course, in Japanese computer/business machine industries, the reduction of noise emitted by machinery and equipment is one of the important subjects on the development of advanced machines. At present, as to the measurement and declaration of emitted noise, Japanese computer/business machine industries are following to the corresponding ISO standard, such as ISO 7779, ISO 9295, ISO 9296 and so on. Thus, in Japanese computer/business machine industries, it is now possible to obtain the noise emission values with due conformity to the requirements specified in International Standards.

Including these industries, most Japanese industries recently have special interests on the measurement and declaration of noise emitted from machinery and equipment. Especially, in order to be conformed to the requirements for trade contract, various industries are now making efforts to determine and to declare the noise emission values, either by sound power levels or by emission sound pressure levels. Under the background of these situations, it is expected in the near future to be prepared the National Standards on noise emission values which are completely conformed to the corresponding International Standards.

#### *References*

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