

附件二 年會發表之論文及簡報內容

**13th International Meeting on
Low Frequency Noise and Vibration and its Control
Tokyo, JAPAN 21 – 23 October 2008**

**The development of low frequency noise
standards in Taiwan**

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Summary

Since 1992, the Noise Control Standard has been promulgated to confine the noise generated from factory plants or sites, entertainment premises, business premises, construction projects, public address facilities and other premises, construction projects or facilities officially announced by the competent authority which should not exceed the noise control standards according to different categories of noise control

zone and time interval. Despite Noise Control Standards was put into action for many years, the trend of noise complaint number still increases every year. In 2003, the Environmental Protection Administration (EPA) tried to mitigate the situation, we focused on the noise complaint cases which were not really settled. There were about thirty thousand cases of noise complaint that time. Some of the cases had not been settled even if the environmental protection officials had measured in site several times. Among the cases, some situations were not exceed the Noise Control Standards but still annoyed the complainants. The spectrum analysis has been made and that some main noise patterns distributed in low frequency. It showed that the existed noise standard needed to be revised for such annoyance. A lot of measurements have been implemented to measure the noise level in different places such as entertainment premises, business premises, factory plants or sites etc these years. The purpose was to assess the low frequency noise and propose the noise control standards to amend the regulation with low frequency noise. Several different criteria for low frequency noise such as Germany, Japan, Denmark, and Netherlands had been reviewed. One hundred complaint sites had been measured inside house to study the spectrum distribution. The sources of noise were cooling towers, air conditioners etc. The draft of standards was discussed in public. Finally, the low frequency noise standards for entertainment and business premises had been completed and amended in Noise Control Standard articles in 2005. Following that, the low frequency noise standard for factory plants or sites and construction projects or facilities were studied and amended in 2006 and 2008. This paper will depict the development and content of the low frequency noise control standards in Taiwan.

1. Introduction

Taiwan is one of the most densely-populated areas in Asia. The population density was about 633 /km² in 2007. Among the large cities, the population density of Taipei City was about 9,682/km² in 2007. With limited land and such high density population, mixed land use urban areas are quite common in Taiwan where commercial premises, such as entertainment, business and offices, are located adjacent to residential buildings. Such commercial and recreational activities usually generate noise, which have significant adverse effects on those living environment nearby. Besides, cooling towers, exhaust fans, and air conditioners are common sources of low frequency noise, which is the subject of repeat complaints. In addition, due to fast expansion of cities and massive urban population growth, it is quite difficult to create a buffer zone around construction sites to reduce construction noise impacts.

Taiwan's noise control efforts began as early as 1983 with the promulgation of the

Noise Control Act. The central competent authority is Environmental Protection Administration (EPA) and in which the Department of Air Quality Protection and Noise Control is assigned responsibility for noise control duties. Over the last two decades the living environment changes and people's consciousness is getting higher, people pay more attention in noise problems. It revealed on the trend of number of noise complaints cases. In 2003, the EPA tried to mitigate the trend of noise situation, focused on the noise complaint cases which were not really settled. There were about thirty thousand cases of noise complaint at that time. Some of the cases had not been settled even if the environmental protection officials had measured in site several times. Among the cases, some situations did not exceed the Noise Control Standards but still annoyed the complainants, this is why it had been complained repeatedly. Then the low frequency noise was proposed to be valued. The act and regulation amendment related with low frequency noise and measurement results describe as following.

2. RELATED ACT AND REGULATIONS

2.1 Noise Control Act

To provide a better living environment, the EPA promulgated the Noise Control Act on May 13, 1983. The Act is the source of noise control. The last amendments to the Act were approved in 2003. The main topics of Act include the following: The noise generates from factory plants or sites, entertainment premises, business premises, construction projects, public address facilities and other premises, construction projects or facilities officially announced by the competent authority which shall not exceed the noise control standards according to different categories of noise control zone and time interval. A fourth amendment to the Noise Control Act is going to be reviewed at the Executive Yuan in 2008 later, and the enforcement rules and related regulations are currently being added or revised. Upon completion, they will provide a more comprehensive legal framework for noise control.

2.2 Noise Control Act Enforcement Rules

The Noise Control Act Enforcement Rules were promulgated in 1984, which makes detailed description of Noise Control Act. The last amendments were approved in 2003 also.

2.3 Guideline for Noise Control Zone Making

The Noise Control Zone is based on "Guideline for Noise Control Zone Making" and the Noise Control Zones are designated to suit the different demand to local land

utilization conditions by local governments. There are four classes and general cases are as following:

Class 1: For the areas which need very quite environment

Class 2: The areas which for residential use mainly

Class 3: Residential and commercial areas mixed or residential and industrial areas mixed

Class 4: Industrial area

The detailed specified noise control zones are announced by local environmental protection bureaus.

2.4 Noise Control Standards

In 1992, the EPA announced the Noise Control Standards, which was stipulated in accordance with the Noise Control Act. In this standard, the noise emitted from the factories, business places, entertainment establishments, construction sites, and public announcement facilities within noise control zones shall not exceed noise control standards.

As a result of improved environmental awareness in recent years, Taiwan's residents have increased their demand for a quieter environment. The Standard is helpful to protect the living environment for the passed years, but several complaints were still not resolved even if the officials of Environmental Protection Bureaus (EPB) measured the noise sources. After several studies, measurement results revealed that some noise sources have the characteristic of low frequency noise. The first step was to set the low-frequency (20Hz-200Hz) noise standard in 2005 for both business places and entertainment establishments, which were the top in noise production that induce primary complaints among all noise sources. Taiwan is the first in the world to legislate the low frequency noise standards. Immediately following that was the amendment for Noise Control Standard in 2006 targeted mainly for factories and comes into effect from Jan, 1, 2008. The last amendments were announced on Feb, 25, 2008 which set the low-frequency noise standard for construction sites and will come into effect from Jan, 1, 2009. The development of the regulation of the low frequency noise is as following:

2.4.1 Measurement plan

Indoor measurement points: According to the guideline of Netherland and Germany, the low frequency noise shall be measured indoor. So the study set the indoor

measurement with such condition: the sound sensor was been placed at the altitude about 1.2 to 1.5 meters above the ground or floor and the length between any reflection surface above one meter. The doors and windows were closed while measuring.

Recorded data: dB(A), dB(C), dB(Lin) and one-third octave band frequency per minute.

Measurement sites: Seven local EPBs joined in this study to assist the measurement. There were 100 points been measurement. These points were the places where been complained before.

2.4.2 Main low frequency distribution

Because much low frequency noise is from rotary machine such as cooling tower, air conditioner, fan. The noise of such machine is distributed on some frequency. The noise annoys the complainants in the night especially. According to the DIN 45680, if the volume of a one-third octave band is 5 dB higher than the adjacent band, it is a characteristic of tone. Upon the 100 measurement points, there are 70 points fit in with this pattern. Figure 1 is the distribution of the results of the 70 measurement points. We found that the main frequency distributed between 20 Hz to 200Hz.

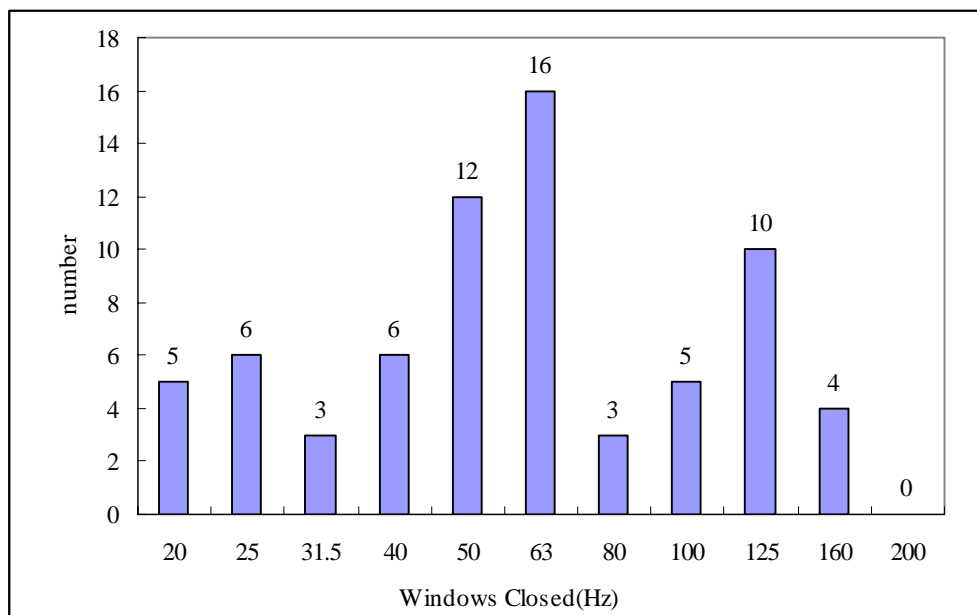


Figure 1 : The main frequency distribution of the results

2.4.3 Low frequency noise volume

Upon the 100 results, the noise source and their L_{eq} A weighting of recombined from 20Hz to 200Hz is as Table 1.

Table 1: The results of different items and volume of the measurement

	<30	30-35	36-40	41-45	46-50	>50
Cooling Tower	0	6	30	9	10	5
Air Conditioner	2	3	9	7	2	1
Fan	0	4	2	2	5	3
Total	2	13	41	18	17	9

The recombined L_{eq} A weighting of frequency from 20Hz to 200Hz and arranged in decreasing order is as Table 2.

Table 2: The results arrange in decreasing order

	1	2	3	4	5	6	7	8	9	10
0	54.8	53.8	52.1	51.1	50.8	50.8	50.0	49.7	49.6	48.7
10	48.4	47.8	47.3	47.3	47.1	46.9	46.4	46.3	46.2	45.8
20	45.4	45.3	45.2	44.7	44.2	43.8	43.6	43.3	43.2	42.9
30	42.8	42.6	42.3	42.2	41.9	41.1	41.0	40.8	40.7	40.0
40	39.7	39.7	39.4	38.8	38.7	38.7	38.4	38.3	38.3	38.3
50	38.1	38.0	37.7	37.7	37.4	37.2	37.1	37.0	36.9	36.9
60	36.8	36.7	36.7	36.5	36.4	36.0	35.6	35.6	35.4	35.4
70	35.2	35.2	35.0	34.7	34.7	34.6	34.0	33.9	33.9	33.7
80	33.6	33.3	33.2	33.2	32.8	32.8	32.2	31.4	31.2	30.3
90	30.1	29.7	29.7	29.6	29.2	28.8	27.9	27.8	23.4	21.6

If we set the noise control standard at 40 dB(A), the unqualified percentage will be at about 40%. And if we set the noise control standard at 35dB(A), the unqualified percentage will be at about 70%.

2.4.4 Related standards

The EPA had reviewed the low frequency criteria of Japan, Germany, Netherlands and Denmark, some of the criteria is limited by one third octave, some are by overall level. The EPA decided to adopt the recombined level from 20Hz to 200Hz. Just like the criteria of Denmark which is from 10-160Hz A weighting.

Table 3: The criteria of low frequency noise criteria of Denmark

	Low frequency noise criteria
Dwelling, evening and night	20
Dwelling, day	25
Classroom, office etc	30
Other rooms in enterprises	35

After public hearings, the EPA announced the new amended low frequency Noise Control Standards for business places on 31, Jan, 2005. Following the study direction, the low frequency noise for factories and construction site were decided and announced later.

2.5 The Table of Noise Control Standards

- Time intervals

The time intervals are dependent on the different class of noise control zones.

Table 4: The time intervals in Noise Control Standards.

	Daytime	Evening	Nighttime
Class 1 & Class 2	06:00-20:00	20:00-22:00	22:00-06:00
Class 3 & Class 4	07:00-20:00	20:00-23:00	23:00-07:00

- Instrumentation

According to the modification of CNS No. 7129 of standards for sound level meter, the Noise Control Standard amended the relevant content and mentioned the IEC 61260 for low-frequency noise measurement.

- Period of observation

Measurement shall be made at the time when the noise generated is most representative or at the time designated by the applicant concerned.

- Measurement Position

Measurement shall be made at any place outside the surrounding boundaries of a factories, business or entertainment place, an arcade or external walls of a building in addition to the residence. Surrounding boundaries shall mean the periphery of the place having a physical partition such as a retaining wall, or the periphery of the area occupied by the property of the entertainment or business place or of the area surrounding such place which is not often accessible by the public, if there is no physical partition surrounding the factory or business premises. If the low-frequency noise will be measured, the measurement position should be indoor and in which the air conditioner, fans, refrigerators should be turned off and the doors and windows be closed.

- Evaluation Method and Standards

Because people’s impression of noise not merely only by volume but also by duration. It is important to choose the suitable index. Based on the following sound characteristics to calculate the L_{eq} or L_{max} , the results shall not exceed the values shown in Table 2. The index is dB(A). There are two situations to check the results. If the peak of noise read from sound level meter displays regularly at periodic or intermittent cycles with the maximum value approximately the same, take the average of the L_{max} in five consecutive readings. Other situations shall be expressed by L_{eq} . The measurement time shall be not less than 2 minutes.

Table 5: Noise standards for factories/business places/construction site

category	Interval	Daytime	Evening	Nighttime
	value			
Class 1		50/55/70	45/50/50	40/40/50