



Development and Regulations on Noise Control of the Republic of China (Taiwan)

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ABSTRACT

The abatement of environmental noise is the main focus of the Noise Control Act enacted in Taiwan. Twenty regulations have been issued to regulate the noise pollution resulted from the growing commercial, industrial, and social activities, e.g., entertainment premises (low frequency noise -20 – 200 Hz) in 2005, factories in 2006, and construction sites in 2007. Each regulation is given a common nickname, e.g., Luban plan (constructor) and Nightingale plan (residential neighborhoods), to promote the public awareness. A 24-hr hotline is available for the public to report the noise complaints, which have been decreased from 86,317 in 2014 to 74,600 in 2016 as a result of more stringent regulations put in place. Easily recognizable quiet signs have been posted in public places since 2009 to remind the public to reduce the ambient noise levels. A roadside inspection program in collaboration with the police force was executed in 2010 to curb the noise emitted from the vehicles with modified mufflers. 26,936 vehicles were randomly inspected from 2010 to 2017, with 2,718 violations reported. Taiwan EPA continues to coordinate with both public and private sectors to abate the harmful effects of noise pollution on the public health and welfare.

1 INTRODUCTION

Taiwan is an island located in the east of Asia, with an area of 36,000 square kilometers. In 2017, the population was 23 million people and the population density was about 650 people per square kilometer. The capital city of Taipei is the most densely populated city on the island with a population density of 6,891 per km². With such a dense population, the environment is flooded with noise from various sources such as business premises, entertainment premises, factories, construction projects, and public address facilities, causing an increase in the number of noise complaint cases. The research of noise problem started in 1975 and since then, noise in the environment has been regulated for more than 30 years. For the past 10 years, the annual number

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of noise complaints has exceeded 50,000 each year. In addition, some improperly converted exhaust pipes also generate huge amount of noise. These new sources of noise causes serious annoyance with residents along the road and must be prevented. The Environmental Protection Administration of the Executive Yuan (EPA) as the central authority for environmental noise, has promoted various control measures to mitigate the impact of noise and maintain the peace of mind in the environment.

2 THE ORIGIN OF NOISE CONTROL

In 1975, a public pollution polls were conducted in Taiwan and the result showed that the severest of public pollution was noise pollution. After that, a series of research projects were commenced from 1977 to 1981 as a preparation for the draft of a noise control act. In May 1983, the "Noise Control Act" was issued to announce that "noise" was defined as "Noise as referred to in this Act means sounds that exceed control standards". In 1984, the "Noise Control Act Enforcement Rules" was formulated to explain or supplement the Noise Control Act. Subsequently, in 1985, the "Noise Control Standards" were established to control the noise sources related to business premises, entertainment premises, factories, construction projects, and public address facilities. The main sources of noise depended on the society and economic situation. In 1970s, most noise was from home because there was a policy of "family living room as factory", which caused serious noise problems as people were working day and night at home. Later, as the domestic economy prospered, additional noises resulted from an increase in the transportation demands, and more developed traffic constructions. As a result, one example is the aviation noise problems around the airports that result from an increase in the number of aircraft takeoffs and landings. As the cities continue to develop and expand, construction projects have become the main complaint noise sources.

In order to improve the effectiveness of education advocacy and noise inspection, the EPA started a series of noise control projects since 1988. Each project was assigned with an easy-to-remember name that highlighted its functions. For example, the "Luban Project" was launched in 1989. Luban was a master of architectural construction who is revered in Chinese folklore. Therefore, it is known that the project was related to construction pollution and focused on the noise and air pollution in the construction of road projects. A comprehensive ban on these noise leads to measurable improvements. At the same time, the "Oriole Project" was also launched to strengthen the control of noise from entertainment, business establishments and public address facilities. The project targeted at traditional temples, welcoming events, street vending, and other neighborhood noises. The selected key metropolitan areas were holding various promotional activities through schools, groups and publicity, expecting to awaken people's awareness and spontaneously reduce the use of public address facilities.

3 THE DEVELOPMENT OF NOISE CONTROL REGULATIONS

In 1981, the draft of the noise control act was submitted to the Legislative Yuan to prepare the enactment of the Noise Control Act. The noise control authority established in 1982 had formulated various laws and regulations, including the Noise Control Act, the Noise Control Act Enforcement Rules, the Noise Control Standards, the Rules for the Division of Noise Control Zones, the Rules for Dealing with Noise Complaint Cases, and the Noise Control Standard for Civil Aircraft. The Noise Control Act was enacted in May 1983. In 1987, the EPA was formed

and the fourth section of the Air Quality Protection and Noise Control Division was the named authority for noise control. It is also actively studying and amending relevant laws and regulations. As of the end of 2017, there are 20 noise control laws and regulations, including the Act and related sub-laws. Figure 1 illustrates the framework of noise control regulations.

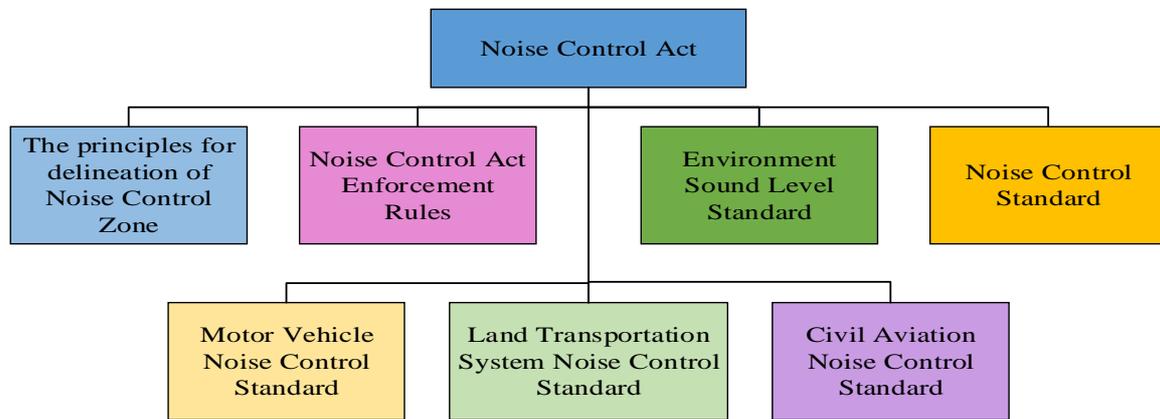


Figure 1– The Framework of Noise Control Regulations

3.1 Noise Control Act

Since 1983, the Noise Control Act has been formulated to maintain the public health and a quiet environment and to enhance the living quality of the public. The Act specifies that the Noise, as referred to in this Act, means sounds that exceed control standards. The local competent authority may delineate and officially announce each class of noise control zone based on noise conditions within their areas of jurisdiction, and shall perform evaluations at regular intervals and delineate and officially announce new noise control zone classes. Sounds emitted by the factories, entertainment premises, business premises construction projects and public address facilities within noise control zones shall not exceed the noise control standards. Noise control of motor vehicles and civil aircraft shall be determined by the Central Competent Authority in conjunction with the Ministry of Transportation and Communications. Road traffic noise shall be controlled by the competent authority of the central government in conjunction with the road authority. In 1992, an article in the Act was amended because of the complexity of noise measurement. The amendment states that the cases shall be handled by the police if the sounds involved are intermittent or difficult to measure, but sufficient to affect the lives of people nearby. The latest amendments to the Act were approved in 2008.

3.2 Noise Control Act Enforcement Rules

The Noise Control Act Enforcement Rules were promulgated in 1984 and have been amended five times. The details of these Rules are supplemented to improve the content of the Noise Control Act. The current version was revised and released in 2010. The amendment provisions are on environmental noise monitoring. The penalties for those who violate the standards or regulations, or who evade, obstruct, or refuse inspection or appraisal shall be determined by the special municipality, county, or city competent authority of the location in which the violations occurred. Also included are the definition of traffic noise and noise improvement plan, the contents of the subsidy plan, the procedures of the approved plan, the

time limit, the handling method, and the overdue processing and other relevant provisions. The calculation method and measurement conditions for day and night levels of aviation noise are defined. In addition, it is stipulated that personnel must pass training and receive a certificate before entering the public or private places to inspect or identify noise conditions.

3.3 The principles for delineation of Noise Control Zone

The Noise Control Zone is based on the related principles and shall be designated to satisfy the different demands related to local land utilization conditions by local governments. There are four classes and general cases:

Class 1: For the areas which need very quiet environment

Class 2: The areas which are for residential uses mainly

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

Class 4: Industrial areas

Figure 2 shows the noise control zone map of Taipei City. The color in blue, green, orange and pink represents class 1 to class 4, respectively.



Figure 2– The Overall Map of Taipei City Noise Control Zone announced in 2017.

3.4 Noise Control Standards

In 1985, the noise control standards were first announced. For factories, entertainment premises, business premises, construction projects and public address facilities, time intervals and Category 1 to Category 4 control zones were set respectively, including allowable limit and measurement conditions. In 1992, the EPA reviewed and re-announced the Noise Control Standards. The concept of the “Peripheral boundary” refers to the boundary lines managed or used by premises or facilities. The concept was further categorized according to the period of time of the different types of control zones, and standardized with measuring instruments, measurement height, dynamic response, time and location. In this standard, the sound emitted from the factory plants or sites, entertainment premises, business premises, construction projects, and public announcement facilities within the noise control zones shall not exceed noise control

standards. 10 years after implementation, the inspection measurement results revealed that some noise sources have the characteristics of low frequency noises. Several studies were conducted afterward, and the first step was taken in 2005 to set the low-frequency (20–200 Hz) noise standards for both business and entertainment premises, which were at the top of the noise complaints filed among all noise sources. Immediately following that was the amendment of the Noise Control Standards in 2006 which focused mainly on the factories and came into effect on Jan, 1, 2008. The fourth amendments were announced on Feb, 25, 2008, which set the low-frequency noise standard for construction sites, and were enforced from Jan, 1, 2009. The last amendment was issued in 2013, which enforced the limit to 3dB(A) for some noise sources and add the noise control standard for wind turbines. Figure 3 shows the measurement of the wind turbine noise in Taichung City.



Figure 3– The Noise Measurement for Wind turbine in Taichung, Taiwan

3.4.1 Time Intervals

The time intervals are dependent on the different class of noise control zones as shown in Table 1.

Table 1 – The time intervals in Noise Control Standards.

	Daytime	Evening	Nighttime
Class1 & Class2	07:00-19:00	19:00-22:00	22:00-07:00
Class3 & Class4	07:00-19:00	19:00-23:00	23:00-07:00

3.4.2 Evaluation Method and Standards

Based on the following sound qualities of the sound source, the result of calculations for equivalent sound level (L_{eq}) or maximum sound level (L_{max}), the results shall not exceed the values showed in Table 2. The index is dB(A). There are different situations to check the results for different noise source respectively. The measurement time shall be not less than 2 minutes. The L_{max} limit for construction projects for daytime is 100dB(A). Table 3 summarizes the low frequency noise standards.

Table 2 – The noise standards for factory plants/business premises/construction projects.

	Daytime	Evening	Nighttime
Class 1	50/55/67	45/50/47	40/40/47

Class 2	57/57/67	52/52/57	47/47/47
Class 3	67/67/72	57/57/67	52/52/62
Class 4	80/80/80	70/70/70	65/65/65

Table 3 – The low frequency noise standards for factory plants/business premises/construction projects.

	Low frequency(20 Hz-200 Hz)								
	Factory plants			Business and entertainment premises			Construction projects		
	Daytime	Evening	Nighttime	Daytime	Evening	Nighttime	Daytime	Evening	Nighttime
Class1	39	39	36	32	32	27	44	44	39
Class2	39	39	36	37	32	27	44	44	39
Class3	44	44	41	37	37	32	46	46	41
Class4	47	47	44	40	40	35	49	49	44

3.5 Environmental Sound Level Standards

The current environmental sound level standard was revised and promulgated in 2010. This standard includes general road traffic noise standards and aviation noise standards outside the aviation noise control zone. In addition, the general environmental sound level standards are stipulated in the “Code for the Delineation of Noise Control Zones”, which represents the environmental quality of various types of noise control zones. In accordance with the National Environmental Protection Plan, the environmental sound level monitoring results measured by the environmental protection departments are analyzed to ascertain the conformity of the overall environmental sound level quality. Figure 4 is the noise monitoring screen in Taipei train station in 1978 and in 2017.

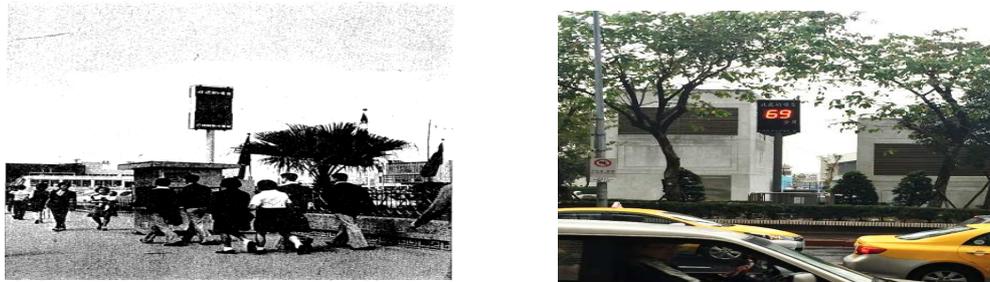


Figure 4– The Noise Monitoring Screen in 1978 and 2017(near Taipei Railroad station)

3.6 Land transportation system noise control

Land transportation system noise control standard was issued in 2010 and revised in 2013. This standard was used to control the noise emitted by land transport vehicles or trains, such as expressways, highways, railways and mass rapid transit systems. In response to practical needs, the provisions such as the calculation method of track system hourly equivalent noise level, the correction of background noise for the average maximum noise and the determination procedure of the noise of the complex traffic system are stipulated to facilitate the implementation of the standards. Figure 5 shows the monitoring of noise from of a passing Taiwan High Speed train.



Figure 5– The Noise Monitoring for Taiwan High Speed Train

3.7 Vehicle Noise Control Standards

The “Motor Vehicle Noise Control Standards” were issued jointly by the EPA and the Ministry of Transportation and Communications in 1990. The motor vehicles for domestic uses shall meet the noise control standards before they are imported, manufactured, or used. In reference to the relative ISO standards, the noise testing items for motor vehicles are accelerating noise and stationary noise. The test classification is divided into type approval, new vehicle inspections and in-use vehicle inspection. The motor vehicle noise control standards were designed according to model year and type of vehicle. The latest standards are the sixth version and they are revised according to the new ISO standard.

Besides the new vehicle noise control, if anyone finds an excessively loud motor vehicle on the road, he/she can also report it to the EPA through the reporting website. After the local EPD accepts and verifies the case, the vehicle will be notified and directed to the designated place to be inspected for the stationary noise.

4 THE IMPLEMENTATION OF VARIOUS NOISE CONTROL MEASURES

4.1 Noise Complaint Cases Analysis

The number of noise complaints showed that entertainment, business premises and construction projects noise were the most common noise sources in last five years. The number of construction project noise complaints exceeded the number of entertainment/business premises cases since 2010 and exceeded 30,000 in 2013. But it has gradually decreased to about 26,000 in 2015, and 22,000 in 2016. Although the proportion of entertainment and business premises increased in 2015, the cases from the construction projects still ranked number one

In addition, due to the elections and commercial activities, the use of political campaign cars, advertising cars and loud speaker noise disturbed the public. There are often public demands to tighten the control standards for public speaking facilities, and the number of noise complaints from public amplifying facilities showed that in 2013 and 2014 were 11,232 and 13,982 respectively. In response, EPA demands that the responsible party for these activities controls the volume of the speaker. After 2015, the number of complaint cases has declined.

The noise from a factory or a construction site is generally emitted by equipment or mechanical operations, as opposed to the noise emitted from the residential neighborhood that is caused by human activities. The noises from human activities are usually intermittent or difficult to measure. Examples include noise produced by neighbors (*e.g.*, loud music, loud talking, shouting, and loud barking by domestic dogs). It can also be generated by the public utilities in the building (*e.g.*, pipeline water hammer, shared pumps motors, elevators, *etc.*). Since these noises are usually emitted from the floor either above or below the unit in the building or from the next door neighbors, it is a dispute between neighbors. When this happens, it can be handled and resolved by the police according to the Social Order Maintenance Act, or by the apartment building management committee according to the regulations of the apartment building

management regulations. Figure 6 shows the number of noise complaints filed in various sources from 2007 to 2016 and Figure 7 shows the number of all noise complaints filed from 2012 to 2016.

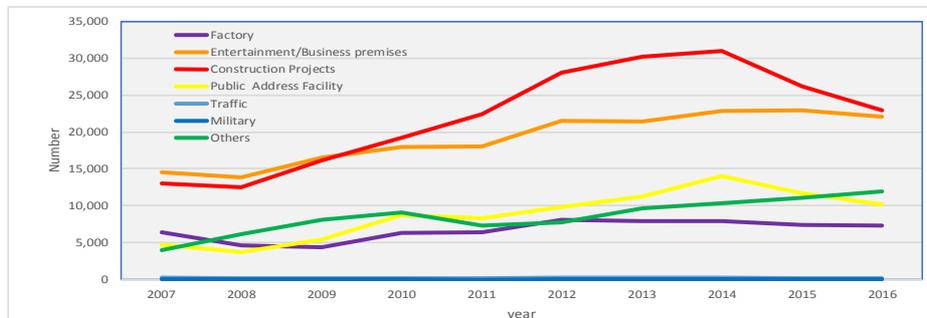


Figure 6– The Number of Noise Complaint Cases from 2007 to 2016

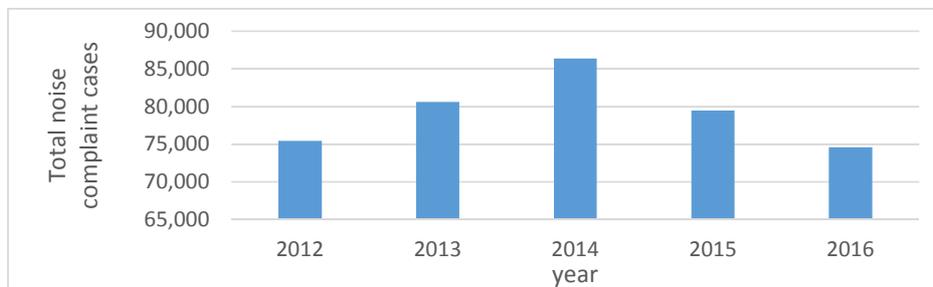


Figure 7– The Total Number of Noise Complaint Cases from 2012 to 2016

4.2 Low Frequency Noise

The number of noise complaint cases increased year by year. In 1989, the number of cases was 10,833 and in 2003 it was 31,659. In 2003, it was dominated by entertainment/business premises (41%), factories (19%) and construction projects (18%). According to the handling results, the EPA found that about 57% of the sources could not be measured or found in-situ, and only about 28% met the standards. In fact, only 9% of offenders were penalized by deadlines, penalties, or even suspension of business and other business operations. Therefore, up to 90% of the noise complaints might not be resolved. Some cases met the standards, but the complainants still felt affected, mostly in entertainment or business premises with cooling towers, motors, or musical sounds. In order to solve this problem, the EPA investigated the cases that met the standards after auditing, but many people still feel that their noise complaints were not resolved satisfactorily. In addition to the complainant's subjective feelings, the reason why some of the noise cases could not be solved was that the problem was caused by low-frequency noise.

After comparing and analyzing the data from the foreign literature, the EPA conducted 100 measurements for entertainment/business locations such as cooling towers, air conditioning systems, extractor fans, and subwoofers. Based on the measurement results, the low frequency noise control range is defined as A-weighted, 20 Hz to 200 Hz sum value. Since the low-frequency noise is easily affected by the wind, the measurements must be conducted indoors with the doors and windows closed. The formal implementation of low-frequency noise control in entertainment and business premises started in 2005, factories and construction projects also

implemented controls in 2006 and 2009 based on actual measurement results. Figure 8 shows the in-situ measurement of low frequency noise.



Figure 8– The Noise Measurement Research for Low Frequency Noise

Since the implementation of low-frequency noise control, the total number of low-frequency noise inspection in 2010 was 6,953, and the number of unqualified items was 750, and the percentage of disqualification was 10.8%. In last three years, the total number of inspections in 2014 was 3,678, and the number of unqualified items was 453, and the disqualified percentage was 12.3%. In 2015, there were 2,791 total inspections, 269 unqualified ones, and a disqualified percentage of 9.6%. In 2016, the total number of inspections was 2,028, the number of unqualified items was 118, and the disqualified percentage was 5.8%. In 2016, the number of unqualified low-frequency noise inspection was highest in business, entertainment premises, and construction projects, which together accounted for 60.1% of the total number of unqualified cases. The percentage of unqualified control facilities announced was 25.6% lower than that reported in 1999. It showed that the low-frequency noise control was effective.

4.3 Quiet Sign

The EPA started the “Quiet Sign” project in 2009 in order to reduce the environmental noise generated by social activities in public places as well as to promote the public awareness about the impacts of noise on the health of populations residing in or occupying the areas concerned. The project focused on the selection of an east-to-understand “Quiet Sign” design that was easily visible to the general public. The chosen design features a house silhouette that encloses a smile face with a “please be quiet” hand gesture (Figure 9). The EPA produced a short promotion video that was broadcasted on TV.



Figure 9 - The quiet signs in public places (left: at the museum entrance, right: at the airport).

In addition, 20,000 “Quiet Sign” stickers were made and distributed to all counties and cities on the island. The “Quiet Sign” can be downloaded and printed on the EPA website.

4.4 Motor Vehicle Noise Control

21.7 million vehicles were registered in Taiwan at the end of 2017, of which 13.8 million were motorcycles. Vehicles installed with modified mufflers give rise to noise pollution that disturbs the environment and the public. In order to effectively control the noise emissions from the improperly modified vehicle exhaust pipes, the EPA has implemented a jointed roadside noise inspection program with the police and other supervision agencies. 2,800 vehicles were inspected on site in first year of the program (2011), and the number of roadside inspections increased to 26,936 vehicles in 2016. The percentage of vehicles failed to pass the roadside inspections increased from 31.9% in 2011 to 63.6% in 2017. The results showed that the effectiveness of the roadside inspection program improved as the personnel involved became more proficient. The EPA's main measures to control the noise emitted from the improperly modified vehicle exhaust pipes are: (1) the enhancement of the joint inspection and ban program; (2) the development of a report notification inspection mechanism; (3) the promotion of public education and awareness; and (4) the development of test vehicle exhaust pipe certifications and posted qualified logos.

The public buses are primarily used in six metropolitan areas (Taipei, New Taipei City, Taoyuan City, Taichung City, Tainan City, and Kaohsiung City). The number of buses cited for noise violations was 106,307 from 2009 to 2016, among which 27,310 cases were in Taipei City, 27,214 cases in New Taipei City, and 12,761 cases in Taoyuan City. The number of reported violation cases in the six metropolitan areas accounted for more than 80% of the total cases, of which Taipei City and New Taipei City accounted for more than 50% of the total cases. Statistical data shows that vehicle noise pollution poses a more serious problem in the densely populated metropolitan areas as compared to other regions. Figure 10 shows the roadside motor vehicle noise inspections jointly conducted with the police.



Figure 10–The Motor Vehicle Roadside Inspection and Testing

5 THE FUTURE WORK

For the future work, the EPA will implement the following tasks to accomplish the mission of creating and maintaining the quiet environment.

1. Implement the "National Noise Control Plan": (1) Revise the noise control regulations; (2) Strengthen the traffic noise control; (3) Noise inspection, improvement and guidance; and (4) Promote the "Quiet Area"
2. Continue the research on the impacts of noise on health
3. Develop the specifications for building construction regulations

6 REFERENCES

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