14

Noise Control Criteria and Regulations

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Summary

In this chapter, the basic ideas behind the development of noise control criteria and regulations are discussed, taking into consideration that the standards and criteria vary from country to country and depend on governments in power. Legislations in the European Union and regulations in Japan are introduced as typical examples. Some indexes as measures of noise evaluation are described.

14.1 Introduction

In order to protect people from being exposed to excessive noise, different communities have implemented different types of legislative control. While the controls vary in scope, control mechanisms, and technical requirements, and are based on different control philosophies, they are intended to achieve a balance between the demand for a tranquil environment and the need for maintaining economic and social activities. In general, the noise standards vary according to the time of day and the use of the land concerned, with the more stringent standards applied to rest periods and areas where the noise sensitivity is high, such as those with schools and hospitals, and exclusive residential areas. Different countries have adopted different noise standards and regulations to meet their local situations and requirements. This chapter cannot describe all major control criteria and regulations in the world, or even in the major industrialized countries. Only the main issues of legislation on noise emission and reception are briefly introduced in the chapter. More details in the on-going noise control issues are found in Refs. [2,3].

14.2 Basic Ideas behind Noise Policy

Every noise policy originates from the idea of protecting the quality of life from noise pollution of all kinds. When establishing a noise policy, it is useful to consider the distinction between noise *emission* and *immission* (or *reception*) [6]. The former means literally emitting or radiating sound energy or power from a noise source, whereas the latter means receiving, perceiving, or observing radiated noise, which leads to the extent of the noise exposure at a position near the noise source. Therefore, noise emission is controlled with noise regulation law by the government, whereas noise immission is legislated with environmental quality standards. The measure of the extent describing the former is the "sound power level," and that describing the latter is the sound pressure level.

The global professional organization on noise control, the International Institute of Noise Control Engineering (I-INCE) recently started its activities to develop a global noise policy [5]. In response to the question "is noise policy a global issue, or is it a local issue?", I-INCE had a common theme presented in special session. It was felt that noise is primarily a global policy issue, but many noise problems can only be solved with the active participation of local authorities. The task of the technical study group is to take a global approach to noise in order to define the requirements for an international noise control policy to be effective, stated as follows:

> *All vehicles, devices, machinery,* and *equipment* that emit audible sound are manufactured products; most are entered into world trade and many are produced in two or more different countries by companies with worldwide operations. The *noise emission* of these products is an appropriate subject of international agreements and regulations. The *noise immisions* resulting from the operation of these products are growing in severity as traffic flow and the pace of industrialization continues to increase in many parts of the globe.

The technical study group reports the classification of noise areas as follows:

1. OCCUPATION NOISE—noise received at the workplace, indoors and outdoors, caused by all noise sources in the vicinity of the workplace.
2. ENVIRONMENTAL NOISE—noise perceived by individuals in the domestic environment, indoors and outdoors, caused by sources controlled by others.
3. CONSUMER PRODUCT NOISE—noise perceived by users and bystanders of noise generating products over which the individual has some control, including noise in the passenger compartment of vehicles, excluding occupational and environmental noise.

14.3 Legislation

The World Health Organization (WHO) published the historic "Guidelines for Community Noise" in 2000, which has been accepted as the most significant recommendations for noise exposure criteria. The bodies that are responsible for enacting the regulations as law include the Federal Government in the USA, the European Union (EU) in Europe, and the Japanese Government in Japan. In the following, the EU's legislation on noise immission is shown, as an example of the flow of legislation process [8].

On July 18th, 2002, a European Directive on the assessment and management of environmental noise was published in the *Official Journal of European Communities.* It was required to be implemented in the national legislation of the EU Member States no later than July 18th, 2004. From then on, a program was to start, containing periodic noise mapping, the making of action plans, and information of the public. The directive also has strengthened the position of the European Commission regarding the reduction of noise emission.

In 2002, the development of the European Directive on environmental noise resulted in an approved directive relating to the assessment and management of environmental noise, for which the acronym "DAMEN" is used. According to Article 1 of the DAMEN its objective is to "define a common approach to avoid, prevent or reduce harmful effects, including annoyance, due to exposure to environmental noise." A rough description of actions in the DAMEN is shown in Figure 14.1. Brief notes are given next to supplement Figure 14.1.

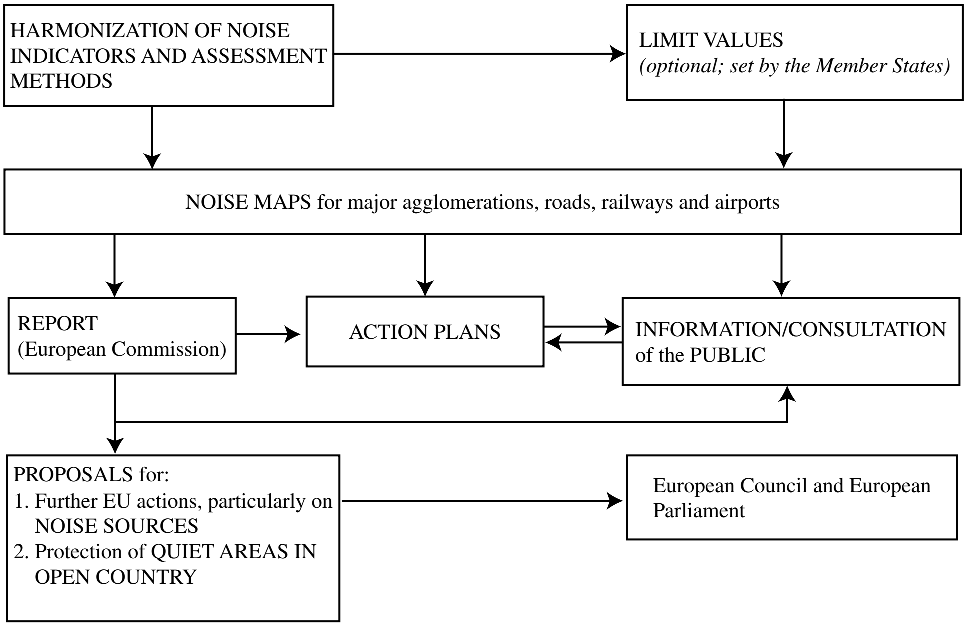


FIGURE 14.1 Overview of the DAMEN. (*Source*: Wolde, T.T. 2003. The European Union's legislation on noise immission, pp. 4367–4371. In *Proceedings of Inter-noise 2003* (N832). With permission.)

14.3.1 Action Plans

In a case where the mapping results are such that they violate the local or national limit value, or are found unsatisfactory for other reasons, action plans shall be developed for the improvement of the situation. These action plans shall be discussed with the citizens involved. A summary of the action plans shall be sent to the European Commission.

14.3.2 Publication of Data by the European Commission

Every five years, starting in 2009, the Commission shall publish a summary report from the noise maps and the action plans.

14.3.3 Proposal for Further European Union Action

In 2004, the European Commission was to submit a report to the European Parliament and the Council containing a review of existing EU measures relating to sources of environmental noise and present proposals for improvement, if appropriate. In 2009, the European Commission will submit to the European Parliament and the Council a report on the implementation of the directive. That report will in particular assess the need for further EU action and, if appropriate, propose implementing strategies on aspects such as:

- Long-term and medium-term goals for the reduction of the number of persons harmfully affected by environmental noise
- Additional measures on noise emission by specific sources
- The protection of quiet areas on the open country

14.4 Regulation

Noise regulation is executed by local governments once the central government enacts a noise regulation law. The law is considered the "national minimum." For example, factory noise, construction work noise, and road traffic noise are under the purview of the Noise Control Act, which means the central government is responsible of regulating these kinds of noise. On the other hand, community noise and factory noise are under the purview of the original regulation of local governments. It can be said that local governments are responsible for a great part of the noise policy, although they may not always fully understand the situations concerned. In what follows, an outline of the legal system for environmental noise problem in Japan is given as an example of a typical legal system for noise regulation [6].

In Japan, the "Environmental Quality Standards for Noise" was revised in 1999 after 27 years with the old law. Figure 14.2 outlines of the legal system in Japan.

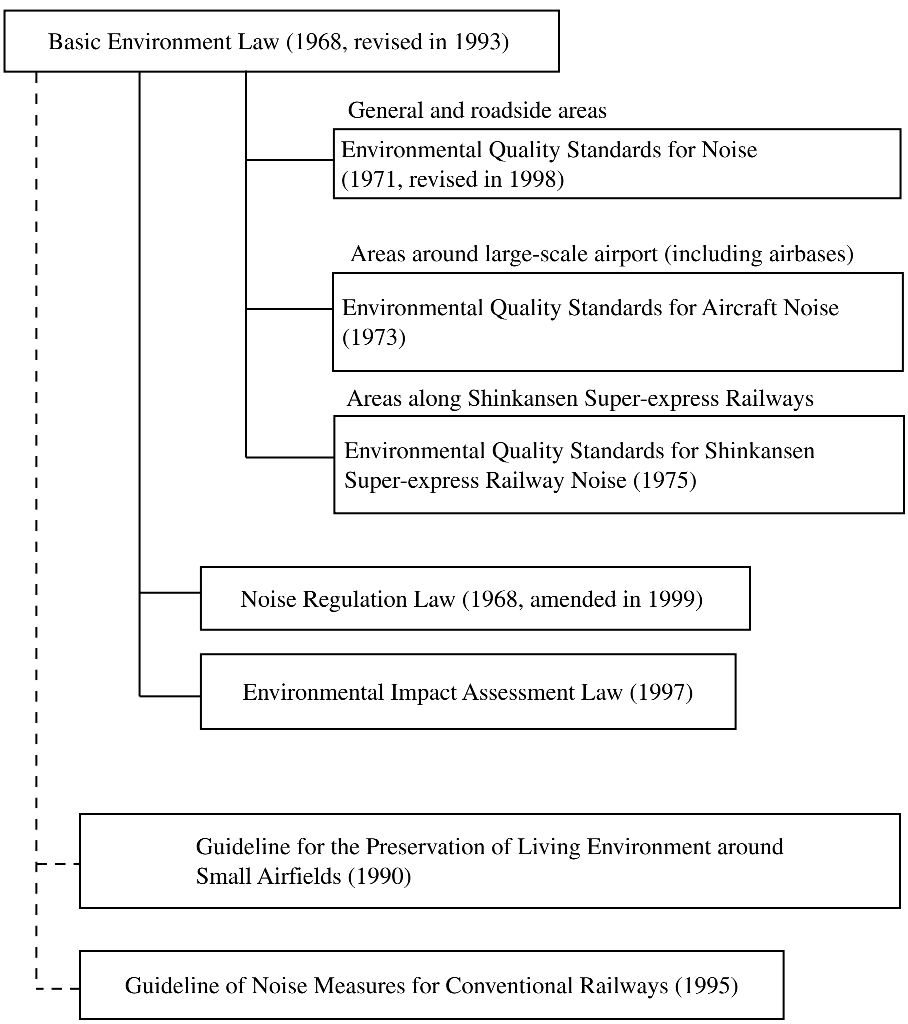


FIGURE 14.2 Legal system for environmental noise in Japan. (*Source:* Tachibana, H. and Kaku, J. 2003. Acoustic measures for the environmental noise assessment in Japan, pp. 3317–3322. In *Proceedings of Inter-noise 2003* (N1007). With permission.)

Each of these laws and standards is legislated for a specific noise problem (a noise source), and therefore different noise indices are specified according to the respective noise problems. To review this situation from a historical viewpoint, it can be said that each law or standard responds to a specific noise problem promptly, through the use of available measurement technology at that time. However, some laws and standards have become outdated since their establishment, when considering the current situation, international dynamics, and the current acoustic measurement technology.

14.5 Measures of Noise Evaluation

Basically, the A weighting networks are applied to obtain a measure of noise evaluation. As the measures are legislated by governments, they are dependent on the legislative regulations and standards. In what follows, the measure of noise evaluation legislated in Japan is given to show the concepts behind the legislation [6].

In the regulations and standards for environmental noise problems, a variety of noise measures are used. In order to improve these legislative regulations and standards in the future, the present measures shall be reviewed considering the difference between noise emission and immission and the difference between noise measurement and monitoring, and impact assessment and prediction. These measures legislated in Japan are listed and classified in Table 14.1 by considering the difference between noise characteristics.

TABLE 14.1 Assessment Methods Specified in Laws and Standards for Environmental Noises in Japan

Noise Sources	Law and Standards	Noise Indices	Assessment Time
Roads	Environmental Quality Standards for Noise	$L_{\mathrm{Aeq,T}}$ [a]	Daytime (6:00–22:00); nighttime (22:00–6:00)
Shinkansen superexpress railways	Environmental Quality Standards for Shinkansen Superexpress Railways	$L_{\mathrm{A,Smax}}$ [b]	Every event
Conventional railways	Guideline of Noise Measures for Conventional Railways	$L_{\mathrm{Aeq,T}}$	Daytime (7:00–22:00); nighttime (22:00–7:00)
Aircrafts	Environmental Quality Standards for Aircrafts Noise	WECPNL [c]	Time weighting
	Guideline for the Preservation of Living Environment around Small Airfields	L_{den} [d]	
Construction works Factories Large-scale retail stores	Noise Regulation Law (specific noise sources) Law concerning the measures by large scale retail stores for preservation of living environment	According to time variation: L_{A} [e]; $L_{\mathrm{A,Fmax}}$ [f]; L_{A5} [g]; $L_{\mathrm{A,Fmax,5}}$ [h]	Not specified; every event

[a] $L_{\mathrm{Aeq,T}}$, equivalent continuous A-weighted sound pressure level.
[b] $L_{\mathrm{A,Smax}}$, SLOW maximum value of A-weighted sound pressure level.
[c] WECPNL, weighted equivalent continuous perceived noise level(calculated from $L_{\mathrm{A,Smax}}$).
[d] L_{den}, day/evening/night equivalent continuous A-weighted sound pressure level.
[e] L_{A}, FAST maximum value of A-weighted sound pressure level.
[f] $L_{\mathrm{A,Fmax}}$, A-weighted sound pressure level.
[g] L_{A5}, upper value of the 90% range of A-weighted sound pressure level.
[h] $L_{\mathrm{A,Fmax,5}}$, upper value of the 90% range of the FAST maximum Aweighted sound pressure level.

Source: Tachibana, H. and Kaku, J. 2003. Acoustic measures for the environmental noise assessment in Japan, pp. 3317–3322. In *Proceedings of Inter-noise 2003* (N1007). With permission.

When considering the consistency between noise measurement and monitoring, and noise prediction for impact assessment, it is most reasonable to use energy based indices such as L_{Aeq}. Of course, L_{Aeq} is not a panacea and some secondary adjustment may be needed for the exact assessment of environmental noise with different characteristics. Nevertheless, the possibility of unification by L_{Aeq} should be considered in the near future in Japan. Although L_{Aeq} is now being widely used for the assessment of aircraft noise in almost all countries, WECPNL is still being used in Japan. WECPNL is very close to L_{Aeq} in concept and it is not difficult to change the assessment index from WECPNL to L_{Aeq}.

The aim of the laws and standards shown in Figure 14.2 is to measure and assess the environmental noise for prevention or maintenance of the present situation. Therefore, any noise index should be appropriately used for each of noise problems, as shown in Table 14.1, which presents assessment methods specified in laws and standards for environmental noise in Japan. In particular, when predicting the future noise situation in environmental impact assessments, the indices should be suitable for theoretical calculation. The statistical noise indices such as the percentile level (L_{A5}) and maximum level ($L_{A,Fmax}$ or $L_{A,Smax}$) specified in the laws and standards have to be predicted statistically. It is difficult to predict these quantities by a simple physical calculation model, in principle. In this respect, the energy-based noise indices such as L_{Aeq} can be easily treated in energy based calculation, and the prediction model becomes simple and clear in physical meaning. In an environmental impact assessment, the predicted results are to be compared with the related laws or standards. In the case of road traffic noise, L_{Aeq} has been adopted in the new environmental quality standards, and therefore prediction has become very simple in theory, founded on energy-based indices.

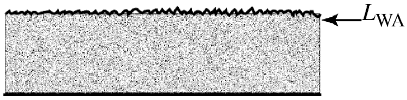
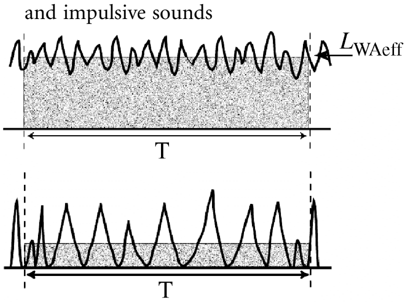
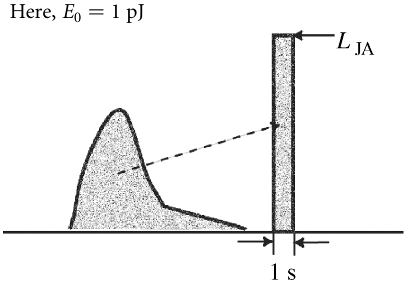
In the prediction of road traffic noise, a motor vehicle as the noise source can be treated as a stationary sound sources of a constant sound power for a limited path. On the other hand, in the case of predicting construction noise, there are many complicated problems because various kinds of machines and equipment with various temporal variations of characteristics must be treated. Therefore, in the construction noise prediction method given in the "Acoustic Society of Japan CN-model 2002" [7], various noise indices for describing the acoustic output of various types of noise sources are specified as given in Table 14.2, which presents classification of noise sources and indices for expressing their acoustic output. Finally, Table 14.3 presents definitions and indices of measurement for acoustical output of noise sources.

TABLE 14.2 Classification of Noise Sources and Indices for Expressing Their Acoustic Output

Temporal Variation	Indices for Expressing Acoustic Output Sign	Terms
Stationary	L_{WA}	A-weighted sound power level
	$L_A(r_0)$	A-weighted sound power level at the reference distance ($r_0 = 1$ m)
Fluctuating randomly and widely	L_{WAeff}	Effective A-weighted sound power level
	$L_{Aeff}(r_0)$	Effective A-weighted sound pressure level at the reference distance ($r_0 = 1$ m)
	$L_{A,Fmax,5}(r_0)$	5% value of A-weighted sound pressure level at the reference distance ($r_0 = 1$ m)
Intermittent impulsive	L_{JA}	A-weighted sound energy level
	L_{WAeff}	Effective A-weighted sound power level
	$L_{AE}(r_0)$	Single event sound exposure level at the reference distance ($r_0 = 1$ m)
	$L_{A,Fmax}(r_0)$	FAST max. of A-weighted sound pressure level at the reference distance ($r_0 = 1$ m)

Source: Tachibana, H. and Kaku, J. 2003. Acoustic measures for the environmental noise assessment in Japan, pp. 3317–3322. In *Proceedings of Inter-noise 2003* (N1007). With permission.

TABLE 14.3 Definitions and Measurements of Indices for Acoustical Output of Noise Sources

Indices	Definition	Measurement Method
L_{WA}	$L_{WA} = 10 \log \frac{P_A}{P_0}$ (1) Here, $P_0 = 1\ pW$ 	$L_{WA} = L_A(r) + 20 \log \frac{r}{r_0} + 8$ (2) Here, $L_A(r)$ is the A-weighted sound pressure level measured at a distance of r, $r_0 = 1$ m
L_{WAeff}	Effective A-weighted sound power level applied to fluctuating, intermittent and impulsive sounds 	$L_{WAeff} = L_{Aeff}(r) + 20 \log \frac{r}{r_0} + 8$ (3) Here, L_{Aeff} is the A-weighted sound pressure level measured at a distance of r $L_{Aeff} = 10 \log\left[\frac{1}{T}\int_1^2 \frac{p_A^2(t)}{p_0^2}\mathrm{d}t\right]$ (4) Here, $T(t_1 - t_2)$ is averaging time (s), $p_0 = 20\ \mu$Pa
L_{JA}	$L_{JA} = 10 \log \frac{E_A}{E_0}$ (5) Here, $E_0 = 1$ pJ 	$L_{JA} = L_{AE}(r) + 20 \log \frac{r}{r_0} + 8$ (6) Here, L_{AE} is the single event sound exposure level measured at a distance of r $L_{AE} = 10 \log\left[\frac{1}{T}\int_1^2 \frac{p_A^2(t)}{p_0^2}\mathrm{d}t\right]$ (7) Here, $T_0 = 1$ s, $t_1 - t_2$ is the time including the event (s)
$L_A(r_0)$ $L_{A,Fmax}(r_0)$	A-weighted sound pressure level converted to the value at the reference distance $(r_0) = 1$ m	$L_A(r_0) = L_A(r) + 20 \log \frac{r}{r_0} + 8$ (8) Here, $L_A(r)$ is the A-weighted sound pressure level measured at a distance of r

Source: Tachibana, H. and Kaku, J. 2003. Acoustic measures for the environmental noise assessment in Japan, pp. 3317–3322. In *Proceedings of Inter-noise 2003* (N1007). With permission.

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