

Editor's Note

The development of a global approach to the control of noise has been the subject of an on-going effort by I-INCE members. This is evident by the special technical sessions on noise policy held at InterNoise 99, 00 and 02 and NoiseCon 01 and 04. In addition, two special issues of NCEJ were devoted to global noise policy; one in July-August 2001 and one in November-December 2004, where a draft report on global noise policy was presented.

In this issue of NCEJ, the final I-INCE report on global noise policy, prepared by the Technical Study Group

5 under the direction of William W. Lang and Tjeert ten Wolde, is presented. This report reflects comments by fourteen member societies of I-INCE. Key players responsible for this report, to whom I-INCE are indebted, are listed in the Background. The importance of a global policy to the continued effort by I-INCE members clearly warrants the publication of the final report on global noise policy here, making this NCEJ truly special.

A GLOBAL APPROACH TO NOISE CONTROL POLICY

Primary subject classification: 08; Secondary subject classification: 80

APPROVED BY
THE INTERNATIONAL INSTITUTE OF NOISE CONTROL ENGINEERING

BACKGROUND

Preparation of I-INCE Publication 06-1, presented in this special issue of NCEJ, was initiated during INTER-NOISE 99. A special technical session during that congress addressed the question: Is noise policy a global issue, or is it a local issue? The conclusion was that noise is primarily a global policy issue, although many noise problems can be solved only with the active participation of local authorities. The I-INCE General Assembly subsequently decided that the development of global noise policy was a high-priority task and established I-INCE Technical Study Group 5, Noise as a Global Policy Issue, that began its work in 2001. Each member of TSG 5 was appointed by an I-INCE Member Society. The roster of TSG 5 and the countries in which their Member Societies are located are as follows:

Co-conveners: William W. Lang and Tjeert ten Wolde

Australia: W. Les Huson

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FOREWORD

This report was prepared under the auspices of, and as a public service by, the International Institute of Noise Control Engineering (I-INCE) for consideration by appropriate international and national authorities. This report is not an international or national standard. It is intended to provide recommendations to those authorities charged with the development of noise policies.

I-INCE is a non-government federation of professional societies from countries around the world and is dedicated to advancing the engineering control of noise and vibration. Operational policies and procedures of I-INCE are established by a Board of Directors and approved by a General Assembly that meets once a year during the annual congresses sponsored by I-INCE on noise control engineering. The General Assembly consists of representatives of the Member Societies and the Board of Directors.

This special issue of NCEJ includes the final report prepared by Technical Study Group 5 that has been approved for publication by a consensus of the Member Societies of I-INCE. An interim draft was published in the 2004 November-December issue of NCEJ for discussion and vote by the Member Societies. This report includes a number of the suggestions that accompanied the votes of 14 Member Societies of I-INCE. Only one negative vote was registered, not on technical grounds, but because the Member Society felt that policy matters were not within the jurisdiction of I-INCE.

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A global approach to noise control policy; Part 1: General

1 INTRODUCTION

In some countries, noise is considered to be strictly a local problem that is to be dealt with by municipal officials, rather than as an international problem within the purview of the central government. There are several reasons for this attitude.

In many regions of the world, excessive noise has a low priority compared with other problems, such as air and water pollution. Indeed, noise merits a higher priority as excessive noise poses serious problems in the workplace (occupational noise), in the community (community or environmental noise), and in the vicinity of tools, products, and equipment (consumer product noise).

Outdoor noise propagates through the air to the ears of listeners (receivers) over relatively short distances (usually less than one kilometer, rarely more than 10 kilometers). If all sources of noise were under the control of the listeners, then it might be reasonable to consider noise pollution as strictly a local problem. Listeners, however, rarely have sources of noise under their control.

Many sources of outdoor and indoor noise involve manufactured products, most of which are traded internationally. Parties to international negotiations seeking to regulate and control the noise produced by these sources are the governments of sovereign states. These governments therefore have the basic responsibility for formulation and implementation of national noise policies, both those that affect the worker in an occupational setting and those that affect the citizen in non-occupational settings. National noise policies should not compel domestic manufacturers to “offshore” production to those countries without noise policies. A “global” noise policy should discourage this.

Most of the manufactured products that generate outdoor noise are produced for export. Hence, from the standpoint of international trade, noise policy is primarily a global issue. Noise issues that can be effectively handled and controlled by local authorities acting independently are those involving the operation of manufactured products that are under the control of an operator, those that involve natural sources, such as sounds produced by people and animals, and those involving the ‘export dumping’ by foreign manufacturers of unnecessarily noisy products. Consequently, only a small percentage of outdoor noise sources involve policy decisions that are *not* global issues.

For many manufactured products that generate intrusive or annoying noise, engineering control of the noise source may be possible but is often not implemented. For many outdoor noise sources, for example those associated with entertainment and sports events, the absence of loud noise may reduce the perceived enjoyment of the spectators. For commercial reasons many sponsors of such events have no interest in noise control. To captive bystanders (neighbors) who are not participants in such entertainment or sports events, the excessive noise may be an abomination. In these cases local authorities and international bodies should work to provide an adequate amount of noise abatement. Local authorities should prescribe noise-control ordinances, and international bodies should provide standards and criteria by which to evaluate the noise produced by the sources. Such situations involve both global and local policy issues.

Many manufactured products, both those used in and around the home and those used in industry, are under the control of a user or operator. This individual, as well as bystanders who are located in the vicinity of the product, may be exposed to the noise it produces. The noise such products generate is a global policy issue.

Global noise control policies are needed in the following three areas: (1) occupational noise, (2) community or environmental noise, and (3) consumer product noise. For each area, this report develops recommendations for appropriate global noise control policies that could be issued by appropriate authorities for global applications along with recommendations for implementation and enforcement.

This report is issued in four parts. Part 1 presents general considerations. Part 2 presents recommendations for policies related to requirements for control of occupational noise. Part 3 presents details of, and recommendations for, policies related to the requirements for control of community noise, that is, noise in a non-occupational setting, indoors or outdoors. Part 4 presents recommendations for policies related to requirements for control of noise from consumer products.

This Part 1 of the report is intended to be particularly useful to those unfamiliar with the technical aspects of acoustics and noise control. Minimal technical discussions are presented about the physical aspects of sound, the units of measure, or the various psychoacoustical descriptors of human reactions to sounds.

The text of Part 1 is intended for all readers, including the general public. Definitions for specialized terminology and descriptors are given at the beginning of each of the following three parts as required for an understanding of the recommendations for global noise control policies, their implementation and enforcement.

Part 1 begins with definitions of general terms related to the development of noise control policies. These definitions are presented in five categories: (1) operative terms relating to policies in general, (2) terms relating to jurisdictions and levels of authority of issuing bodies, (3) general terms relating to noise, (4) terms relating specifically to noise policies, and (5) technical terms relating to noise.

Part 1 continues with a classification of the three areas requiring global noise control policies: occupational noise, community noise, and consumer product noise. Brief descriptions are given for the effects of noise. Then follows a discussion of market-driven noise control and the necessity for legislation when market forces are insufficient. The report notes the need to distinguish between issues that are self-regulated by market forces (industry-to-industry and industry-to-consumer), issues that completely lack that mechanism, and issues that are in between. The next section names the authorities responsible for the issuance of noise policies, for the development of the building blocks supporting such policies, and for declarations of the intent of these policies. Part 1 concludes with a discussion of emission noise control options for noise sources, of noise control options that apply to sound-propagation paths from a source to a receiver, and finally of options to control noise by limits on noise immission at receiver locations.

It is generally agreed that the design and installation of noise control measures for the source (S) of noise will yield the greatest noise reduction for the least cost. However, this approach will not provide a payoff for a considerable period of time after such a policy has been adopted.

2 DEFINITIONS OF TERMS (ADOPTED FOR THE PURPOSES OF THIS REPORT):

2.1 Operative Terms Relating to Policies in General

act	a statute
advisory	a report or recommendation with advice on action to be taken

code	a systematic statement of a body of law, especially one given statutory force
convention	a general agreement about basic principles or procedures
directive	an order issued by a high-level administrative body or official

NOTE: In Europe, a European Directive is an order issued by the European Union (EU) prescribing that EU Member States shall enact the contents of the Directive in their national legislation, and shall enforce the requirements of the Directive.

guideline	a recommended way of doing or managing something
harmonization	for a group of nations, the process of modifying their national laws to make them equivalent in all aspects
harmonized	a standard for which enforcement is mandatory within a group of
standard	nations bound by a treaty
law	a written set of principles governing an action or procedure established by a sovereign authority and expected to be observed by all who are subject to that authority
legislation	the written enactments of a legislative body that has the power to make laws
ordinance	an order, statute, or regulation governing some detail of procedure or conduct and enforced by a limited authority such as a municipality
policy	a high-level overall plan embracing the general goals and acceptable procedures of a governmental body or other authority regarding a particular subject
protocol	a preliminary diplomatic agreement that forms the basis for a final convention or treaty; the records or minutes of a diplomatic conference or congress incorporating the agreements arrived at by the negotiators to amend, clarify or add to a treaty
regulation	a set of rules, ordinances, or laws by which action, conduct, or procedure is controlled or governed
rule	an authoritative regulation governing action, method, or procedure

specification	a detailed precise requirement
standard	a common reference, method, or quantity, established by an authorized body
statute	a law enacted by a legislative body and set forth in a written document
treaty	a formal written agreement between two or more nations on a subject of mutual interest such as peace or trade

2.2 Terms Relating to Jurisdictions and Levels of Authority of Issuing Bodies

agglomeration	an urban area covering a defined territory with a specified number of inhabitants
authority	the exercise of power for a specific purpose within specified limits
city	an inhabited place of greater area, population, or importance than a town, township, village, or hamlet
commonwealth	a nation, state, or other political unit
country	the whole land or territory of a nation
county	see region
global	relating to, or involving, the entire world
government	the organization or machinery by which a political unit exercises authority and performs functions
international non-governmental organization	a private international organization that may have consultative status with the United Nations or one of its specialized agencies
international organization	an organization established for the maintenance of international peace and security such as the United Nations and its specialized agencies
jurisdiction	the right of a government to exercise legal authority; the territory over which such authority extends
local	relating to, or involving, a particular limited geographical area for administrative purposes
member state	a country that is part of a supra-national structure

municipality	an urban political unit that is usually self-governing in many aspects
nation	a politically organized body of people that is sovereign and occupies a defined territory with specified cultures and languages
preemption	the assumption by a government of the exclusive right to regulate a matter, effectively prohibiting a subordinate authority from issuing a regulation on the same matter
prefecture	see region
province	see region
region	an administrative area, division, or district of a country or a state, as, for example, a province, a county, or a prefecture
state	an independent nation, or a constituent unit of a country with a central federal government; a constituent unit governs itself in many aspects, leaving other aspects (such as defense and monetary policy) to the federal government
territory	an organized political subdivision that is not a state and is administered by an appointed or elected governor or elected legislature
union	a structure of nations cooperating according to the terms of a treaty

2.3 General Terms Relating to Noise:

emission	airborne sound radiated by a specified sound source (for example, a machine or piece of equipment)
immission	airborne sound that arrives, whether or not an observer is present, at a measuring point or at a receiver's ear, being a composite of all sounds from all sources in the vicinity of the measuring point or the receiver
system components: source-path-receiver	with noise control considered as a system problem, the components of the system that may be modified to achieve a particular end result at the location of an observer or at a point of observation
source	an object or device that emits sound

path receiver	the way along which sound travels from a source to a receiver a person, a structure, or an instrument that is exposed to the sound from a source
exposure	the length of time during which a receiver is a recipient of sound or the quantity of sound received
hearing loss	degradation in a person's ability to hear and understand or appreciate certain sounds or certain spectral components of a sound
annoyance	a general negative experience caused by noise that may be related to specific effects such as sleep disturbance and interference with spoken communications
health	a state of complete physical, mental, and social well-being, not merely the absence of disease and infirmity NOTE: A World Health Organization (WHO) Task Force has identified the following health effects caused by noise – (1) non-specific annoyance responses (that may be partially caused by certain specific effects) and (2) specific effects, including interference with communication; interference with sleep, effects on the cardiovascular and psycho-physiological systems of the body, performance, productivity and social behavior; and noise-induced hearing loss.
quality of life	an individual's perceived state of well-being
quality of life factor	an attribute such as a low level of noise that contributes to an individual's quality of life

2.4 Technical Terms Relating to Noise Policies

noise action threshold	the maximum amount of sound that triggers an action as set by a threshold responsible authority
noise control engineering	selection or design of techniques or materials to control noise and vibrations by engineering means
noise declaration	a statement of the noise emitted by a source
noise exposure limit	the maximum permissible amount of sound received as set by a responsible authority
noise guideline	recommendation without a mandatory requirement for compliance

noise initiative	the first step in a series of actions related to noise policy undertaken by a recognized authority or body
noise policy	a high-level overall plan that includes the general goals and strategy of a national or international governmental body or agency for the control of occupational, community, and consumer product noise, as well as specific references to relevant codes.
noise regulation	legally-imposed requirement on the upper emission limit for a noise source or an upper limit on noise immission or noise exposure
noise standard	technical description of the procedure and process for the measurement, assessment, or prediction of noise

2.5 Technical Terms Relating to Noise Measurement and Control

sound power	sound energy emitted by a source per unit of time. (Unit: watt; unit symbol: W.)
sound pressure	at a stated point in the presence of a sound wave, the instantaneous variation of the total pressure above and below the prevailing static pressure. (Unit: pascal; unit symbol: Pa.)

3 CLASSIFICATION OF AREAS REQUIRING NOISE POLICIES

OCCUPATIONAL NOISE,

Unwanted or harmful sound in the workplace, indoors or outdoors, caused by sources in the vicinity of a workplace

COMMUNITY NOISE (also referred to as environmental noise),

Unwanted sound in a non-occupational setting, indoors or outdoors, caused by sources over which an individual has little or no control, including sounds produced by neighbors

CONSUMER PRODUCT NOISE

Unwanted or harmful sound at the position of a user or bystander of a noise-producing product over which an individual may have some control, including noise in passenger compartments of vehicles, but excluding occupational and community noise.

4 EFFECTS OF NOISE

Noise, or unwanted sounds, affects people. Depending on the situation and the type of noise described in 3 above, the effects range from annoyance to interference with comprehension of spoken communications to physical harm.

Noise is a worldwide problem for which effective long-term mitigation requires a mixture of global, national, and local measures.¹⁻³ This report focuses primarily on global measures for noise control, although national and local measures should also be considered.

For occupational noise, the most important effect is hearing damage, while community noise is both an annoyance and a “quality-of-life” issue. Consumer product noise may cause a wide range of adverse effects but is best considered a “quality-of-life” issue because the exposure to the noise is seldom long, the effects are seldom severe, and an individual may alleviate the problem by making alternative choices for products. Global noise policies can help to provide alternative choices in the form of quieter products and services.

Global noise policies for each category of noise will benefit from worldwide harmonization of quantities used to evaluate noise emission and the corresponding public availability of noise emission data expressed in terms of these quantities. For noisy products that are involved in international trade, such as aircraft, automotive vehicles, office products, and construction equipment, noise emission limits should be applicable and enforceable worldwide⁴ as discussed further in Part 3.

In some cases, wide public availability of standardized data for the noise emissions of machines and products or the interior noise in transport vehicles may be sufficient to achieve lower noise levels for those noise sources. In this event, legislation may not be necessary because, over time, competitive market forces will tend to favor the quieter products, other factors being equal.

Global noise policies should serve to stimulate these market forces and hence the development of quieter products.⁵ The roles of market forces are discussed further in subsequent parts of this report.

Important elements of a worldwide approach are already in place to assist the development of global noise policies. These elements are discussed in Parts 2, 3, and 4 of this report; elements that are lacking are identified. This report provides specific recommendations for improvement of the elements of global noise policies.

5 ISSUING AUTHORITIES AND OTHER INTERNATIONAL ORGANIZATIONS

At present and in the near future, the principal participants in the development of worldwide noise policies are national governments. Most elements of global policy are dependent on treaties between nations. However, the actual implementation of any global policy is generally not assured but is dependent on national noise policy. For some elements of a noise policy the nations that signed a convention transferred some authority to international bodies. The work and the effectiveness of these bodies are analyzed.

Other international organizations, such as the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and the World Health Organization (WHO), have no legal authority to issue statements of policy. They do have an important role to deliver science-based building blocks that can be used by national governments or international organizations with issuing authority, such as the United Nations (UN). Still other international organizations that play an important role are the umbrella organizations representing industrial sectors, labor unions, community organizations, and consumer organizations.

I-INCE is a non-governmental federation of professional societies from countries around the world that is dedicated to advancing the adoption of a global approach to noise control policy.

6 DECLARATION OF INTENT FOR A NOISE POLICY

For each of the three policy areas requiring global noise policies, a proposal is given in the corresponding Part 2, 3, and 4 for a statement that could be issued by appropriate authorities. The proposals explicitly describe the purposes and intent of the each policy statement. An example of such a statement at the national level is the following:

The Congress declares that it is the policy of the United States to promote an environment for all Americans free from noise that jeopardizes their health and welfare. (U.S. Noise Control Act of 1972)

7 ELEMENTS OF GLOBAL NOISE POLICIES

A worldwide noise control policy should consider the possibility of influencing one or more of the following elements of a noise control system:

- the source,
- the transmission path from the source to a receiver, and

- the receiver of the noise.

NOTES

1. In existing policy statements, the distinction between source (emission), path(s), and the receiver (immission) is sometimes unclear.
2. The transmission path and the receiver are combined in some legislation.

An example is shown in Figure 1 of source-path-receiver considerations for a machine.

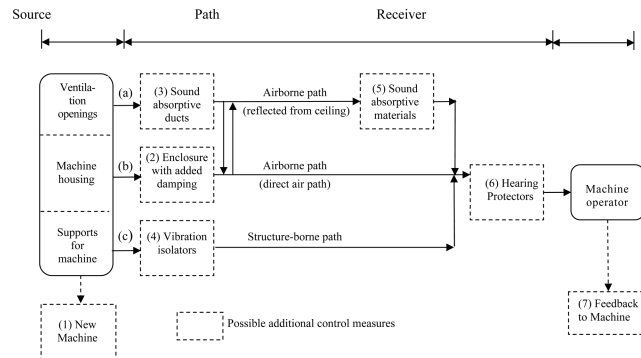


Fig. 1—Block diagram of noise control system showing sources, paths of sound propagation [(a), (b), and (c)], and possible methods for noise control in order of priority from (1) to (7); [adapted from Figure 40.1 in Chap. 40, “Control of Machinery Noise”, by Colin G. Gordon and Robert S. Jones, in “Handbook of Acoustical Measurements and Noise Control”, Third Edition, Cyril M. Harris, Ed. (McGraw Hill, New York, 1991)].

8 EMISSION SPECIFICATIONS (CONTROL OF NOISE BY REDUCING EMISSION OF NOISE FROM SOUND SOURCES)

8.1 General

A sound source is the basic element of a noise control system. Sound sources, whether stationary or moving, are best described in terms of their emission characteristics.

8.2 Methods of Noise Control

The amount of sound emitted by a source depends upon:

- its design,
- its installation and mounting conditions, and
- its operating conditions.

Selection and installation of quieter versions of a sound source may yield significant noise reduction.

8.3 Measurement Quantities

Sound emitted by a noise source can be quantified in terms of one or more of the following:

- the level of the sound power emitted by a source for specified operating conditions, (most suitable for small sources with largest dimension less than one meter, for example, consumer products)
- the level of the sound pressure at one or more specified points in the vicinity of the source for specified operating and environmental conditions, (most suitable for large sources with largest dimension greater than one meter, for ex-

ample, large machines and wheeled vehicles)

- the sound exposure accumulated during a work day at a listener’s position in a working environment (most suitable for measuring and evaluating exposure to noise in a workplace)

8.4 Measurement and Noise Declaration Methods

The methods prescribed by international standardizing bodies that should be followed to evaluate the sound emitted by a source, for both measurement and noise declaration purposes.

8.5 Trade Issues

All types of vehicles for transporting persons and goods will cross national borders and hence are involved in international trade, including road vehicles, trains, ships, and aircraft. Most machinery and equipment that is manufactured and then exported internationally is considered to be a part of global trade.

8.6 Applicability of Emission Specifications

Emission specifications are applicable to all products in international commerce. Emission speci-

cations may also be appropriate for products that are not involved in, or not initially involved in, international trade.

8.7 Possibilities to Control Source Emissions

It may be appropriate to incorporate one of the following strategies in a statement of noise control policy:

- Require measurement and declaration of noise emission from a sound source and let market forces as well as national noise policies implement the use of quieter products.
- When market forces are insufficient within a reasonable period, set noise emission limits and require testing by a qualified independent national laboratory, or an equivalent organization, to verify that the model of a product conforms to the standards for the applicable limits on noise emission. Market access is then permitted only when the model for the product has been shown to conform to the applicable standard and the conclusions from the results of the conformance test are made available to the public, for example, on the Internet website of the testing laboratory.
- Prohibit the use of older designs for noisy sound sources after an appropriate period of time, unless the products are modified to produce lower noise emissions complying with national or international requirements.
- Restrict the operations of noisy sound sources (for example, prohibitions or restrictions on operations in certain places or during certain periods of a day).

The first two of the above options should be considered in any global approach to noise policy development. These options will only be effective if there is worldwide harmonization of noise emission quantities, noise emission measurement methods, and noise immission requirements. The last two options may be appropriate for particular cases.

8.8 Issuing Authorities

Emission specifications are issued by international organizations (governmental and non-governmental) and by national governments that have the authority to prescribe policies relevant to products intended for international commerce. To avoid conflicting requirements within a country, regional and local authorities with responsibility for limited geographic areas within the country should be preempted from issuing noise emission specifications for major products.

9 PATH CONTROL SPECIFICATIONS (CONTROL OF NOISE ALONG THE PATH)

9.1 General

The paths along which sound travels between source and receiver are an essential component of a noise control system.

9.2 Methods of Noise Control

The level of sound reaching the receiver may be reduced by:

- designing the source to reduce the emission of noise
- installing a noise control system
- installing the source within an enclosure or container
- installing a barrier near the source to deflect the sound away from a receiver
- locating the source in such a position as to shield receivers from the sound produced by the source (for example, locating a roadway or train track below grade out of the sight of neighboring residences)
- increasing the distance between source and receiver

9.3 Measurement Quantity

The noise reduction achieved along a path is the difference between the time-average sound pressure at a point along the path near the receiver without and with the noise control system, enclosure, or barrier installed, with the sound source unshielded and shielded from the sight of a receiver, or with the sound source operating and not operating.

9.4 Measurement Methods

The methods prescribed by international standardizing bodies should be followed to determine the noise reduction at the location of a receiver provided by the noise control element.

9.5 Trade Issues

Products and materials that are used for the control of noise along the path are generally not involved in international trade.

9.6 Specifications

Local or regional authorities usually prepare specifications on products, locations, or operational procedures applicable to the control of noise along a path.

9.7 Possibilities to Control Noise along the Path

The possibilities to control noise during its transmission (by shielding, absorption, greater distance, or other methods) are not usually incorporated into global policies, as they typically involve local conditions. If used, they would be given in terms of noise limits or targets for noise levels not to be exceeded at receiver locations. The only aspect that clearly should be part of a global policy is the standardization of quantities and measurement methods for the description of noise control elements (for example, noise barriers, mufflers, and porous road surfaces).

10 IMMISSION SPECIFICATIONS (CONTROL BY SETTING NOISE LIMITS AT RECEIVER LOCATIONS)

10.1 Noise Control System

The receiver is the component of the noise control system that is best described in terms of specifications for limits on the immission at the receiver's location. Specifications on immission are therefore most appropriate for receivers.

10.2 Methods of Noise Control

The level of sound reaching a receiver depends upon three major factors:

- the number and location of all sound sources in the vicinity of the receiver,
- the operating pattern, as well as the installation conditions of these sources, and
- the paths between the source(s) and the receiver(s).

10.3 Measurement Quantity

Sound that reaches a receiver is measured in terms of the sound exposure or the level of the time-average sound pressure at the receiver.

10.4 Measurement, Evaluation, and Noise Declaration Methods

Methods prescribed by international standardizing bodies should be followed to determine the sound at the location of a receiver for measurement, evaluation, and noise declaration purposes.

10.5 Trade Issues

Many products involved in international trade produce noise at receiver locations. The amount of sound produced usually depends on the operating, installation, and mounting conditions of the source.

10.6 Applicability of Immission Specifications

Immission specifications are applicable to situations in which the sound exposure, or the level of the time-average sound pressure at the receiver, is the operable noise-control requirement. Enforcement of the prescribed requirements should be by means of local, or, in some cases, national directives.

10.7 Possibilities to Control Noise Immissions

It may be appropriate to incorporate one of the following control strategies into a policy:

- Set not-to-exceed limits on the noise exposure at receiver locations.
- Require use of hearing protective devices.

The first option is usually preferred for a global policy. Both options are important for national and local policies, and could greatly benefit from worldwide harmonization and rationalization of the quantities relating to the levels of noise at receiver locations and methods of assessment.

10.8 Issuing Authorities

National, regional and local authorities should issue appropriate immission specifications. Such specifications should follow the recommendations of international authorities. Local authorities should be preempted from issuing noise control emission specifications for major products.

11 REFERENCES

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A global approach to noise control policy; Part 2: Occupational noise

1 INTRODUCTION

This part of the I-INCE Technical Report on a global approach to noise control policies presents details of policies recommended by the International Institute of Noise Control Engineering (I-INCE). The policies discussed in Part 2 relate to occupational noise, that is, for the control of hazardous noise at a place of work, inside a building, dwelling, or vehicle or outdoors, caused by sources at or in the vicinity of the workplace. The primary purpose of this Part 2 is to foster the development of a worldwide policy on occupational noise. The secondary purpose is to assist governments, as well as employers' and workers' organizations, in the adoption of policies and practices aimed at progressive reduction of noise in the workplace with the primary aim of avoiding noise-induced hearing loss. Such policies are in keeping with the responsibility of managements and governments to provide safe and healthful workplaces free from unnecessary hazards, including excessive noise.

A key objective of this report is to promote international uniformity of requirements that limit occupational noise. Another objective is to stimulate the development of quieter machinery and equipment, some of which are traded internationally and are components of world trade. A third objective is to assist those jurisdictions that either do not adequately control noise at the workplace at the present time through existing occupational noise regulations or are in the process of enacting or changing such regulations.

This Part 2 uses and extends the information in I-INCE Publication 97-1 that was approved for publication by the I-INCE Member Societies in 1997.¹ Publication 97-1 was a comprehensive technical assessment of upper limits on noise in the workplace in countries of I-INCE Member Societies around the world. This Part 2 focuses on the international aspects of occupational noise policy, affirms the findings of Publication 97-1, and provides I-INCE recommendations for action to alleviate damaging exposures to noise in the workplace.

A report² of the World Health Organization states: *"noise-induced hearing loss is insidious, permanent, and irreparable... In a developed country, exposure to excessive noise is at least partially the cause in more than one-third of those in the population who have hearing loss... Noise-induced hearing loss is the most prevalent irreversible industrial disease, and noise is the biggest compensable occupational hazard."* This

deplorable situation continues to exist in the world today despite the best efforts of many developed countries where hearing conservation programs have been in place for several decades. Clearly there is need for intensified efforts internationally to ameliorate the current situation. The costs to implement effective programs for the control of occupational noise may be, at least partially, offset by significant reductions in the continuing enormous social costs resulting from current programs.

Hearing loss prevention programs instituted by some industrial enterprises, large and small, local and international, have been comprehensive and successful. Unfortunately, successful programs are the exception. Overall, the achievements of hearing-loss prevention programs around the world have been sparse. In developed as well as developing countries, many programs have been remarkable for their failures. Payments of compensation to injured workers for occupational hearing loss are a tacit admission that a hearing loss prevention program is inadequate and has failed. The many reasons for these failures will not be discussed in detail in this report. But three are noteworthy.

First, there has been a general over-reliance on hearing protection devices for which the actual performance in the workplace is much poorer than claimed.³ This deplorable outcome is in large measure the result of inadequate training and motivation of employees regarding hearing protection, and due to inadequate or insufficient supervision and enforcement of a worker's use of those devices by supervisory personnel.

Second, enforcement of existing regulations in many of the most-developed countries has been lax, irregular, or non-existent. Many developing countries have no applicable regulations to control noise in the workplace.

Third, in many instances inadequate noise control engineering has been implemented within industry to reduce the noise produced by manufacturing machinery and equipment to levels that will not cause hearing loss after years of exposure. Public health officials, audiologists, physiologists, safety personnel, industrial hygienists, medical teams, social scientists, and others have worked on occupational noise exposures for decades. Engineers, on the other hand, who are trained to solve complex noise control problems involving machinery and equipment, have been unable to fully participate in the effort to control noise in industrial settings. Many noise control engineers are firm in their

belief that if more effort were to be expended to develop and maintain quieter workplaces around the world, the result would be a remarkable improvement over the existing situation.

Employers have the primary responsibility to provide protection for the health and safety of their employees. This protection must be achieved by the design or purchase and installation of machines and devices producing noise levels that will not cause the sound exposure over the duration of a working shift to exceed a prescribed safe limit. The recommended limits recommended in this report were chosen to ensure that minimum hearing loss occurs over a long period of exposure to noise in the workplace.

To be able to properly design a machine to reduce its noise emission to acceptable levels requires a clear description of the acoustical design criterion for the level of the sound that is acceptable for the intended installation and the duration of the exposure. International consensus is needed on appropriate limits on the noise emission from machines and devices accompanied by labels that describe (or “declare”) the noise emission level under standardized conditions. Guidelines for the measurement and assessment of exposure to noise in a working environment are available in an international standard.⁴

The World Health Organization (WHO) took the position² that national programs for the prevention of noise-induced hearing loss should be established or strengthened in all countries. According to the WHO report, elements of such programs should include noise reduction, environmental and medical surveillance, effective legislation, inspection, enforcement, health promotion and education, hearing conservation, compensation for hearing loss, and training. While noise control is high on the list of necessary elements, attention to the engineering aspects of occupational noise control has been lacking in many jurisdictions. This Part 2 focuses on the engineering aspects. Clearly, the need is to eliminate, not simply monitor, noisy conditions that may be hazardous to a worker’s hearing. This report affirms that the engineering control of noise must be the *primary* consideration, if not the single most important element, in any national program for protection of hearing in occupational settings.

While other aspects besides noise control engineering are important in any program to prevent noise-induced hearing loss (NIHL), these other aspects have tended to dominate many programs. Primary consideration has *not* yet been given to the engineering task of providing sufficiently low levels of exposure to noise in the workplace because, in part, of the lack of engineering skills on the part of those who are most directly concerned with occupational noise problems. One

reason for this situation is that the principal specification regulating noise at the workplace is an *immission* requirement expressed as a noise exposure limit. It is a challenging engineering problem to control the emissions of noise sources in a workplace so that they comply with a limit on the accumulated daily sound exposure or, equivalently, a limit on the workday-time-average sound level and the total duration of exposure to the noise sources.

2 TERMS AND DEFINITIONS (ADOPTED FOR THE PURPOSES OF THIS REPORT)

For definitions of terms related to occupational noise exposure, see Refs. 4 and 5.

peak sound pressure: greatest absolute instantaneous sound pressure during a stated time interval Unit: pascal (Pa). NOTE: Peak sound pressure may be measured with one of the standardized frequency weightings.

reference pressure: reference quantity conventionally chosen equal to 20 μ Pa (twenty micropascals).

peak C-weighted sound pressure level twenty times the logarithm to the base 10 of the ratio of a peak

peak C-weighted sound level: C-weighted sound pressure that occurs during a given time period to the reference pressure Unit: decibel (dB). NOTE The mathematical expression for peak C-weighted sound pressure level, L_{Cpeak} , is given by:

$$L_{Cpeak} = 20 \lg(p_{Cpeak}/p_0) \quad (1)$$

where p_{Cpeak} is a peak C-weighted sound pressure and p_0 is the reference pressure.

sound (noise) exposure: time integral of the square of frequency-weighted sound pressure over a stated time interval or event Unit: pascal-squared seconds if running time is in seconds NOTE 1: Duration of integration is included implicitly in the time integral and need not be reported explicitly, although the nature of the event should be stated. For measurements of sound exposure over a specified time interval such as

1 h, duration of integration should be reported. NOTE 2: Sound exposure in pascal-squared hours is more convenient for applications such as measurement of exposure to noise in the workplace.⁶ NOTE 3: The mathematical expression for A-weighted sound exposure, E_A in pascal-squared seconds, is given by:

$$E_A = \int_{t_1}^{t_2} p_A^2(t) dt \quad (2)$$

where $p_A^2(t)$ is the square of the instantaneous A-weighted sound pressure at any instant of time t and $t_2 - t_1$ is the time interval, in seconds, for a measurement of sound exposure.

sound exposure level: ten times the logarithm to the base 10 of the ratio of a sound exposure to the reference sound exposure, reference sound exposure being the product of the square of the reference pressure and the reference time interval of 1 s Unit: decibel (dB) NOTE The mathematical expression for A-weighted sound exposure level, L_{AE} in decibels, is given by:

$$L_{AE} = 10 \lg[E_A/(p_0^2 T_0)] \quad (3)$$

where E_A is the A-weighted sound exposure, p_0^2 is the square of the reference pressure, and T_0 is the reference time interval of 1 s.

time-average sound level, time-average sound pressure level, equivalent-continuous sound pressure level: twenty times the logarithm to the base 10 of the ratio of a root-mean-square sound pressure during a stated time interval to the reference pressure, sound pressure being obtained with a standard frequency weighting Unit: decibel (dB) NOTE 1 The mathematical expression for time-average, A-weighted sound level, L_{AT} , is given by:

$$L_{AT} = 20 \lg \left\{ \left[\frac{1}{T} \int_{t-T}^t p_A^2(\xi) d\xi \right]^{1/2} / p_0 \right\} \quad (4)$$

where T is the averaging time, in seconds, for the measurement of sound level and the integration time for the measurement of sound exposure, and T_0 is the reference duration of 1 s.

8-hour-average sound level: time-average, frequency-weighted sound level when the time interval is explicitly stated to be 8 hours for the nominal duration of a work shift Unit: decibel (dB). NOTE: The mathematical expression for 8-hour-average A-frequency-weighted sound level, symbol L_{A8h} , is given by Equation (4) with averaging time T equal to 28 800 s (8 h).

normalized 8-hour-average sound level: for durations of exposure to noise that are either longer or shorter than 8 hours, the level of the 8-hour-average sound equivalent to the sound exposure stated as if it had been acquired during an 8-hour period Unit: decibel (dB)

noise-induced hearing loss (NIHL): permanent shift in hearing threshold resulting from exposure to noise Unit: decibel (dB)

sound power: sound energy radiated by a source per unit of time. Unit: watt (W); symbol W

sound power level: ten times the logarithm to the base 10 of the ratio of a given sound power in a stated frequency band or with a stated frequency weighting, to the reference power of one picowatt (1 pW) Unit: decibel (dB) NOTE The mathematical expression for the sound power level, L_W , is given by:

$$L_W = 10 \lg(W/W_0)$$

where W is the sound power and W_0 is the reference sound power.

frequency weighting: modification of the spectral components of a sound or vibra-

tion signal according to standardized amounts of electrical gain or attenuation that vary with frequency. Frequency weightings designated A, C, and Z (for zero) are internationally standardized.

A-frequency weighting: frequency weighting of a spectrum according to a standardized frequency weighting designated A.

3 EFFECTS OF NOISE

For occupational noise, the most important effect is the possibility of permanent loss of hearing caused by habitual exposure to excessive noise, as can occur on a daily basis over many months or years in the workplace. The scientific evidence is incontrovertible that excessive noise may cause physiological damage to the human hearing mechanism.² Such hearing impairment, known as noise-induced hearing loss (NIHL), often progresses slowly over many years and may go unnoticed until permanent damage occurs. This report deals primarily with the effect of occupational noise on the hearing acuity of workers in any workplace, indoors and outdoors, including, as examples, engine rooms onboard ships, forestry occupations, truck and crane cabs, and aircraft.

Occupational noise tends to mask safety signals and important voice communications among workers. Furthermore, excessive noise may make it difficult to monitor the sounds emitted by production machinery. High levels of noise are stressful, tiring, and unpleasant for workers.

Policies requiring the development and use of low-noise machines and equipment in workplaces will address and correct these detrimental effects of noise on human hearing.

4 ISSUING AUTHORITIES AND INTERNATIONAL NON-GOVERNMENTAL ORGANIZATIONS

4.1 Introduction

The following authorities and organizations currently have or could have an important role in the future in the area of worldwide control of occupational noise:

- National governments
- The European Union
- The World Health Organization (WHO) of the United Nations

- The International Labor Organization (ILO) of the United Nations
- The World Trade Organization (WTO)
- International industrial lobbies
- National research institutes
- The International Organization for Standardization (ISO) and other international standardization organizations
- National standardization institutes
- The International Institute of Noise Control Engineering (I-INCE)
- The International Commission on the Biological Effects of Noise (ICBEN)

4.2 National Governments and the European Union

At present and in the foreseeable future, the principal responsibility for the development of worldwide noise policies lies with national governments and the European Union. Noise-induced hearing loss is sometimes considered a local problem to be dealt with exclusively by local authorities or by different jurisdictions within the country involved. This situation has resulted in a plethora of sometimes conflicting and uncoordinated regulations. Noise exposure that causes permanent loss of hearing from sounds in the workplace is a problem that is handled most effectively as a national problem with a *single* regulation applicable to all workplaces in the country. All workers in the country who are exposed to occupational noise should be covered by the same regulation. The issuing authority or jurisdiction for a workplace noise regulation should be a central federal government or union of such governments.

Within a jurisdiction, the same upper limits on exposure to noise in the workplace as well as hearing conservation measures should be applied to all industries, all workers, and all employers.⁷ The jurisdiction should coincide with the geographical boundaries of a country. The uniform limits should be expressed in terms of immission quantities that are accepted internationally.

Legislation on occupational noise may be incorporated in general legislation on health and safety for workers (see, for example, Ref. 8) and in legislation on the health and safety aspects of machinery (see, for example, Ref. 9).

4.3 WHO

The **World Health Organization (WHO)** of the United Nations “works to assist its Member States and their populations in achieving a sustainable basis for health for all by ensuring an environment that promotes

health, and by making individuals and organizations aware of their responsibility for health and its environmental basis".² Its activities in this area include noise. In the area of noise, one of its activities involves the publication of "Guidelines for Community Noise".¹⁰ WHO's work regarding the effects and the measurement of noise is also applicable to occupational noise.²

WHO is attempting to play a central role in the development of worldwide consideration of noise as a detrimental factor. In this process it is very much dependent on the support of the UN Member States and non-governmental international organizations. Its own budget for noise control is limited.

4.4 ILO

The **International Labor Organization (ILO)** is the specialized agency of the United Nations that seeks to promote social justice and internationally recognized human and labor rights.¹¹ "*The ILO formulates international labor standards in the form of Conventions and Recommendations setting minimum standards of basic labor rights...and other standards regulating conditions across the entire spectrum of work related issues. It provides technical assistance...on working conditions...*" Within the UN system, the ILO has a unique tripartite structure with workers and employers participating as equal partners with governments in the work of its governing organs. Among the working conditions of interest to the ILO are noise and noise control at the workplace.

4.5 WTO

The **World Trade Organization (WTO)** is the only international organization dealing with the rules of trade between nations.¹² WTO agreements are negotiated and signed by most of the world's trading nations and ratified by their parliaments. WTO's goal is to help producers of goods and services, exporters, and importers conduct their business. WTO's main function is to ensure that trade flows as smoothly, predictably, and freely as possible. By lowering trade barriers, WTO breaks down other barriers between peoples and nations. WTO could play an important role in regulating noise emissions from internationally-traded equipment used in workplaces.

4.6 International Industrial Lobbies

There are many national and regional lobbying organizations for the various industries for which occupational noise is covered by this Part 2 of the I-INCE Technical Report. But there are few worldwide lobbying organizations for these industries.

4.7 National Research Institutes

Many countries have national institutions devoted wholly or in part to research on occupational safety and health. Examples of national research institutes involved with occupational noise include:

- National Institute of Occupational Safety and Health, Cincinnati, Ohio, USA
- Federal Institute for Occupational Safety and Health, Dortmund, Germany
- Institut National de Recherche et de Sécurité, Paris, France

4.8 International Standardization Organizations

Most international standardization in the field of noise control occurs under the jurisdiction of a Technical Committee of the **International Organization for Standardization (ISO)**. The ISO Technical Committee 43 Acoustics and specifically its Sub-Committee SC1 on Noise, have an extensive program to develop international standards in the field of noise and noise control.^{13,14} In the context of occupational noise the following International Standards are important:

- Determination of occupational noise exposure and estimation of noise-induced hearing impairment¹⁵
- Guidelines for the measurement and assessment of exposure to noise in a working environment⁴
- Basic measurement standards on noise emission^{16,17}
- Statistical methods for the determination of stated noise emission values (like the guaranteed sound power level).¹⁸

Another international standardization organization that is active in this area is the **International Electrotechnical Commission (IEC)**, and particularly its Technical Committees 29 Electroacoustics and 59 Electrical Machinery. An important International Standard prepared by IEC Technical Committee 29 gives specifications for personal sound exposure meters that display sound exposure in pascal-squared hours⁶

Both the ISO and the IEC maintain websites.^{12,19}

4.9 International Commission on Biological Effects of Noise (ICBEN)

The **International Commission on Biological Effects of Noise (ICBEN)** is a non-governmental organization of scientists and experts concerned with all aspects of noise-induced effects on human beings and animals, including preventive regulatory measures.²⁰ ICBEN operates with eight international

noise teams. One team is responsible for efforts in relation to noise-induced physiological hearing loss, another to noise and communication, and a third to regulations and standards. An IC BEN congress is held every five years during which the international noise teams report on advances in the state of the art. IC BEN makes recommendations on exposure standards and research into noise-induced hearing loss.

5 DECLARATION OF INTENT FOR A NOISE POLICY

The following wording, suitably modified to suit local requirements, is recommended for inclusion in a prefatory clause of a statement from an 'issuing authority' of national or international noise policy relating to occupational noise:

"It is the policy of the 'issuing authority' to reduce the risk and magnitude of permanent noise-induced hearing loss to a minimum by reducing the exposure of individuals habitually exposed to hazardous noise in the workplace."

Inclusion of the word 'minimum' in the declaration allows for the possibility of hearing damage to a very small fraction of the population of exposed workers, the individuals who are most susceptible to noise-induced hearing loss. An upper limit on the amount of hearing damage incurred by these individuals is set by the policy on permitted noise exposure deemed by competent authorities to be acceptable for the most noise-sensitive members of the population of exposed workers. The state of the technology when this Technical Report was published did not permit the identification of noise-sensitive individuals prior to their incurring an actual NIHL. However, annual hearing tests may identify even the most noise-sensitive individuals so that measures can be taken to protect them from further hearing loss.

NOTE: Competent authorities in many countries of the world have set an A-weighted sound exposure limit of $1 \text{ Pa}^2\text{h}$ for a worker's daily exposure to noise of 8 hours, or an equivalent 8-hour duration¹ as discussed below.

6 IMMISSION SPECIFICATIONS (CONTROL BY SETTING NOISE EXPOSURE LIMITS AT RECEIVER LOCATIONS)

For the measurement and assessment of all kinds of noise in workplace environments, the A-frequency weighting should be used, except for short-duration impulsive sounds where C-weighting of the peak sound pressure is more appropriate. Sound levels should

represent the time average, without exponential time weighting, of the A-weighted sound pressure signal.

There is general agreement in Europe, and by most researchers in the field of hearing impairment caused by occupational noise, that the methods described in International Standard ISO 1999:1990¹⁵ are important for regulatory bodies. These bodies should set the upper limit on daily average A-weighted sound level, preferably as a limit on A-weighted sound exposure.

While valuable guidance may be obtained from ISO 1999:1990 on how to determine an estimate of noise-induced hearing loss resulting from long-term exposure to noise, the setting of upper limits on exposure to noise in the workplace depends on many factors. ISO 1999:1990 contains the following disclaimer: *The selection of maximum tolerable or maximum permissible noise exposures... requires consideration of ethical, social, economic and political factors not amenable to international standardization. Individual countries differ in their interpretation of these factors and these factors are therefore outside the scope of this International Standard.*¹⁵ Additional guidance on the choice of limits on exposure to noise is provided in International Standard ISO 9612:1997.⁴

Many jurisdictions have already established regulations that set upper limits on employee exposure to noise in the workplace. These limits invariably specify upper limits on the time-average A-weighted sound level to which workers may be exposed, that is, they specify an *immission* limit. For exposure to noise from all relevant sources, most jurisdictions set the upper limit in terms of an 8-hour-average, A-weighted sound level in decibels, eight hours being the duration of a common work shift. Higher noise levels are allowed for shorter durations and lower noise levels for longer durations. The time-average sound level includes all sources of noise, not just steady or continuous sounds. A separate limit is needed for short-duration impulsive sounds. Unfortunately, some of these limits are based on measurements of SLOW-time-weighted (also called S-time-weighted) sound levels, which means that some important contributions to the total sound exposure may not be properly accounted for in the time average. This report recommends that sound exposure or sound level be measured without any exponential time weighting.

Most legislation already enacted regarding occupational noise contains limits in terms of an 8-hour average A-weighted sound level accompanied by a limit on a peak sound pressure level (for high-level impulsive sounds) for the permissible exposure of a worker to noise in the workplace. The measurement of peak sound pressure levels should be accomplished using the widest commonly-available frequency

bandwidth that is standardized for sound level meters,²¹ namely the C-frequency weighting. These immission specifications are limits on the airborne sound arriving at a worker's location from all noise sources in the vicinity of the workplace.

This Report affirms that national programs for hearing protection should direct that all feasible engineering efforts be taken during the design of new industrial and manufacturing facilities (and for retrofit or upgrade of existing facilities) to achieve A-weighted, time-average sound levels not exceeding 85 dB in all frequently-occupied work spaces. An A-weighted, 8-hour-average sound level of 85 dB corresponds to an A-weighted sound exposure limit of 1 Pa²h for a worker's daily exposure to noise of 8 hours duration.

In some jurisdictions the European Union (EU), for example see Ref. 8, multiple limits have been established to correspond to different actions to be undertaken by the employer. An exposure limit value is prescribed which sets an upper limit on the noise exposure of the individual worker. A lower exposure action value is set to specify an action to be taken by the employer when the lower limit is exceeded.

An exposure limit in terms of an 8-hour-average, A-weighted sound *level* is exactly equivalent to a limit on A-weighted sound *exposure* for an 8-hour duration of exposure to noise.

When the duration of a worker's exposure to noise differs from 8 hours, the limit on time-average, A-weighted sound level should be decreased or increased as necessary to maintain the specified limit on total A-weighted sound exposure. The following mathematical expression is provided as an analytical means to determine the time-average, A-weighted sound level for exposure durations other than 8 hours and for a specified limit on the permitted sound exposure for an 8-hour workday:

$$L_{pAT} = 10 \lg(E_{A,\text{lim}}/p_0^2 T) \quad (6)$$

where:

L_{pAT}	is the time-average A-weighted sound level, in decibels, for averaging time T ;
\lg	is the mathematical operator representing base-10 logarithms;
$E_{A,\text{lim}}$	is a specified limit for an A-weighted sound exposure, in pascal-squared hours, for an exposure duration of 8 hours;
p_0^2	is the square of the reference pressure of 20 micropascals; and
T	is the duration of the exposure to noise in hours.

As an illustration of the application of Equation (6),

assume that we want to know the limit on the time-average, A-weighted sound level if the exposure duration is 5 hours and the sound exposure limit is 1.6 Pa²h for the 8-hour exposure limit of the European Union⁸ to an 8-hour-average, A-weighted sound level of 87 dB. Insertion of the exposure duration and exposure limit in Equation (6) yields a corresponding limit for the 5-hour-average, A-weighted sound level of 89 dB, to the nearest decibel.

Other examples are the following: If the 8-hour-average, A-weighted sound level is not to exceed 85 dB and hence the A-weighted sound exposure is not to exceed 1 Pa²h, then over a 6-hour work shift the average sound level should not exceed 86 dB and over a 12-hour work shift the average sound level should not exceed 83 dB. For a 4-hour work shift, the average sound level should not exceed 88 dB; for a 16-hour work shift, the average sound level should not exceed 82 dB. These last two examples illustrate the so-called 3-dB *exchange rate* whereby a halving or a doubling of the exposure time requires a 3-dB increase or a 3-dB decrease in the average sound level, respectively, in order to maintain the same sound exposure.

As it is the responsibility of the management of an industrial enterprise to provide safe and healthful workplace environments free from unnecessary hazards, such as excessive noise, an increasing number of companies are establishing internal noise control policy aimed at reducing 8-hour-average, A-weighted noise levels to less than 85 dB throughout all of their frequently occupied work spaces. Some industrial enterprises have voluntarily decided on an even lower value for the acoustical design criterion.

While significant engineering efforts are often required to achieve a goal of not exceeding a specified limit on the sound exposure in a workplace, achieving the goal ensures that the company's workplaces are free of hazardous and harmful noise. Achieving the goal also removes the need for, and the costs associated with, the implementation and maintenance of a hearing conservation program.

Achieving 8-hour-average, A-weighted sound levels not exceeding 85 dB, as well as peak C-weighted sound levels not exceeding 135 dB, throughout all occupied workspaces is generally most difficult as a retrofit implementation in existing industrial facilities and least difficult, and least expensive, when designing a new facility.

For immission, this I-INCE Technical Report recommends, in consonance with the earlier I-INCE report,¹ the following for a national or international noise policy:

- a) The limit for an 8-hour exposure to noise in the workplace is 1 Pa²h; therefore, the correspond-

ing limit for the 8-hour-average, A-weighted sound level is 85 dB. The recommended limit on peak C-weighted sound level is 135 dB for impulsive sounds that occur within a work period of any duration,

- b) The exchange rate shall be 3 decibels,
- c) Engineering noise control measures shall be applied to all relevant sources of noise to ensure there is no exceedance of the limit of 1 Pa²h for an 8-hour-exposure to noise and no exceedance of the limit of 135 dB for peak C-weighted sound level, and
- d) Limits on exposure to noise in the workplace shall not be linked to the use or non-use of hearing protection devices.

7 EMISSION SPECIFICATIONS (CONTROL OF NOISE BY REDUCING EMISSION OF NOISE FROM SOUND SOURCES)

National and international programs for hearing protection should require that all feasible engineering efforts be included during the design of new industrial and manufacturing facilities (and for retrofit or upgrade of existing facilities) to achieve the I-INCE recommended levels given in Section 6 above.

When purchasing new noise-producing equipment or designing new industrial facilities, persons who are responsible for the health and safety of the workers should include noise *emission* limits in purchase specifications. The noise *emission* limits should be chosen to ensure compliance with the I-INCE *immission* occupational-noise-exposure recommendations described above. Selecting and installing a new low-noise machine or replacing an existing noisy machine with a quieter model are noise control actions requiring *noise emission* specifications.

Machinery and equipment that are responsible for excessive noise in the workplace may be produced in a country other than the one in which a program is being implemented for the control of the exposure to occupational noise. If so, such machinery is entered in world trade and is subject to international trade regulations. Global noise policies should serve to stimulate market forces and hence the development of quieter products.²²

Noise *emission* limits are most often specified in terms of a limit on the A-weighted sound power level, or on the A-weighted, time-average sound level at a specific distance from the new machine or equipment. Such specification limits have to account for the specific installation and operational configurations of the machines and equipment, worker locations, and the

acoustical characteristics of the particular working environment. For example, for a new machine the limit on A-weighted, time-average sound level might be specified as 80 dB at a distance of 1 m from any machine surface when averaged over the duration of any operating cycle and measured in an anechoic or hemi-anechoic test facility. A corresponding limit for the peak C-weighted sound level might be specified as 130 dB at any position normally occupied by someone working with or around the machine or piece of equipment.

The sound power levels of machines should be required to be determined in accordance with the applicable International Standards of the ISO 3740 series.¹⁶ Sound levels at the operator's position should be required to be determined in accordance with the applicable International Standards of the ISO 11200 series.¹⁷

When designing or specifying the purchase of machines or equipment for low noise levels, the duration of a worker's exposure to noise should always be assumed to be 8 hours even though there may be indications that a shorter duration might be involved for some, or all, of the present workplaces. Design or purchase specifications should recognize that hearing impairments caused by high levels of noise are usually the result of incremental degradations that occur over a period of many years.

The responsible approach of a professional noise control engineer to those national regulations that deal with occupational noise is always to attempt to realize the I-INCE recommendations for occupational noise exposure, preferably with a practical allowance for a margin of error.

The engineering challenge is to design or purchase to a criterion based on A-weighted sound power level, or A-weighted sound level and peak C-weighted sound level at a specified distance from the new machine or equipment, while conforming to the limit of an 8-hour sound exposure of no more than 1 Pa²h. The directionality of the noise emitted by the machine or device must be taken into account either from experimental data or from an assumption based on previous experience. With the intent to achieve an 8-hour-average sound level from each machine and equipment that will operate in the workspace, and with estimates of the durations of the exposure from each relevant noise source, the noise control engineer responsible for the design will prepare an estimate of the ability to comply with the limit of 1 Pa²h for the total A-weighted sound exposure during an 8-hour work shift along with an estimate of the associated costs of purchase, installation, and maintenance.

I-INCE does not recommend national or interna-

tional legislation concerning noise *emission* limits for machinery that contributes to occupational noise because, as outlined above, *immission-oriented* legislation should lead to *emission* requirements set by the professional engineers, and *emission* legislation should not interfere with that process.

However, there are exceptions to this practice, particularly regarding equipment which is mobile, widely used, and for which the position of the user is fixed. For such equipment, noise *emission* requirements have an added value.²³ Examples are power generators and portable chain saws. Also for operator positions inside the cabins of trucks, ground moving machinery, tower cranes, etc., legal noise *emission* requirements in terms of the A-weighted sound level¹⁷ should be considered. For all equipment that contributes to occupational noise, it is important that the information on noise *emission* be made available in a harmonized way.⁹

In view of free trade considerations, there is need for worldwide harmonization of *emission* requirements for machinery and equipment that produces excessive noise in the workplace.

8 PATH CONTROL SPECIFICATIONS (CONTROL OF NOISE ALONG TRANSMISSION PATHS)

A decision to install sound-absorbing materials on room surfaces when the workplace is indoors requires engineering specifications not only on their nominal sound-absorbing qualities, but also on other qualities such as fire and moisture resistance, durability, immunity to the growth of mold, color, and certain aesthetic characteristics. Additional engineering specifications are needed to ensure proper installation and maintenance in order to achieve and maintain the intended acoustical properties. The sound-absorbing materials may be sold in world trade.

Hearing protectors are path-control devices intended to block the transmission of noise along the path to a worker's ear and hence require engineering specifications for the minimum attenuation provided in the field, not in a laboratory, at various frequencies, by the devices when properly fitted. Hearing protection devices may be sold in world trade.

NOTE: Instead of considering hearing protective devices as blocking the transmission path, they are sometimes considered to be part of the receiver.

9 NOISE CONTROL ENGINEERING ACTIONS REQUIRED IN AN OPERATING INDUSTRIAL ENTERPRISE

9.1 Noise Measurements and Analysis

For control of exposure to noise in an existing facility, the first required action is to determine the existing levels and exposure to the noise at all relevant workstations. Personnel trained in the fundamentals of noise control engineering should carry out, or at least supervise, such measurements. The quantities to be measured include A-weighted sound exposure or A-weighted sound-exposure level (and the corresponding integration time), and peak C-weighted sound level. The locations where the quantities are to be measured are at all workstations in the industrial enterprise that are, or will be, occupied continuously during a work shift or for shorter time periods during the workday.

If the noise control engineer finds that the 8-hour sound exposure and peak C-weighted sound level do not exceed the recommended I-INCE limits on noise exposure at all workstations, then further action is necessary only if and when changes are made within the enterprise that could increase the noise exposure at one or more workstations.

9.2 Noise Control Analysis

If one or more of the work stations within the enterprise exceed the recommended I-INCE limits on noise exposure, then additional measurements are necessary²⁴ to identify the pieces of equipment that are the primary contributors to the sound exposures at the workstations and the dominant sources of noise within these pieces of equipment. This information is needed to select the noise-control design features for the machinery or equipment, and the priority order in which the noise-control measures should be implemented.

9.3 Noise Control Measures

The noise control engineer should then develop one or more solutions to reduce the excessive noise of each of the dominant noise sources.

9.4 Repeat Measurements and Analysis

Following implementation of the proposed engineering actions that are approved by the management of the enterprise, the A-weighted sound exposure and peak C-weighted sound level should again be measured at those locations where the recommended I-INCE limits on noise exposure are exceeded. If, following imple-

mentation of the noise control measures, all workstations in the enterprise comply with the recommended I-INCE limits on noise exposure, no further action is needed unless additional changes are made that affect the noise levels, or work durations, at the workstations. The workers will be appreciative of a work environment in which they will be able to communicate with fellow workers without shouting; they will be able to hear safety signals and monitor the sounds of production equipment, and they will find the atmosphere to be less stressful and tiring. Most, if not all, workers will be protected from noise-induced hearing loss.

Compliance with the recommended I-INCE limits can often be achieved with the involvement of a small staff. For a small industrial enterprise, follow-on, rudimentary noise control can often be accomplished by a dedicated technician who has been trained by a qualified noise control engineer. For example, reducing air velocity, installing mufflers, properly adjusting and lubricating equipment, and tightening up joint and seams in enclosures are simple fixes that don't require a noise control engineer after the engineer has completed the required preliminary measurements and analysis. For a larger industrial enterprise, a small engineering group with at least one qualified noise control engineer should be able to accomplish the necessary tasks.

10 FOLLOW-ON ACTIONS

Follow-on actions are necessary only when the recommended I-INCE limits on exposure to noise cannot be achieved with engineering changes. There are many cases where it is impractical to comply with the recommended I-INCE limits due to the state of the technology.

The low-noise machinery and equipment may simply not be available to permit compliance at a workstation. In this case, a complete and effective hearing-conservation program²⁵ will have to be initiated. Not only is the protection against hearing loss more uncertain, but a larger staff will also be required to implement the program.

Protection against hearing loss is uncertain because the nominal performance of hearing-protective devices is less-reliably achieved than are engineering actions to reduce noise at its source. More people with a variety of skills will be needed. If engineering action fails to eliminate hazardous exposures to noise at workstations, hearing protectors are the only physical resource available to reliably reduce workers' noise exposure to noise. Hearing protectors are part of world trade and require international standardization of their performance. Depending on the size of the enterprise,

full-time or part-time staff will be necessary to provide the following specialties: safety, education, industrial hygiene, medicine (nurses and physicians), and audiology. For these reasons, the use of hearing protectors should be implemented only as a secondary measure.

Many engineering controls will fail with time if they are not maintained properly and may be deliberately voided with time if they interfere with production or inconvenience employees. Hence, proper maintenance is part of any program to reduce noise at its source by engineering action.

11 SUMMARY OF I-INCE RECOMMENDATIONS REGARDING EXPOSURE TO OCCUPATIONAL NOISE

- The most important element for a worldwide policy on occupational noise is the harmonization of quantities for the description of noise *immissions* and noise *emissions*, and their use in prescribing uniform limits that are accepted internationally. This result can be achieved by international agreements negotiated by the United Nations or one of its agencies.
- Engineering control of noise should be the *primary* consideration and the single, most important element in any international or national program for protection of hearing in occupational situations.
- Within a jurisdiction, the same upper limits on exposure to noise in the working environment as well as hearing conservation measures should be applied to all industries, all workers, and all employers. The jurisdiction should coincide with the geographical boundaries of a country.
- A statement of international or national noise policy should include a prefatory sentence such as: *The policy of the 'issuing authority' is to reduce the risk and magnitude of permanent hearing damage to a minimum for those individuals habitually exposed to high levels of noise in their working environments.*
- This I-INCE report recommends, in consonance with the earlier I-INCE report,¹ the following for international or national noise policies:
 - ✓ The 8-hour limit for the A-weighted exposure to noise in a workplace shall be 1 Pa²h, and hence the corresponding limit for the 8-hour-average, A-weighted sound level is 85 dB. The recommended limit on peak C-weighted sound level shall be 135 dB for impulsive sounds that occur within a work period of any duration.

- ✓ Engineering noise control measures shall be applied to all relevant sources of noise to ensure there is no exceedance of the limit of 1 Pa²h for an 8-hour exposure to noise and no exceedance of the limit of 135 dB for peak C-weighted sound level.
- ✓ An exchange rate of 3 decibels shall be used to evaluate exposure to noise. Limits on exposure to noise in a working environment shall not be linked to the use or non-use of hearing protection devices.
- ✓ For some widely used mobile equipment, legal emission limits shall be expressed in terms of A-weighted sound power levels.
- ✓ For work locations inside the cabins of trucks, tower cranes, farm machines, ground-moving machines, and similar equipment, legal noise *emission* limits in terms of the A-weighted sound level at the operator's position¹⁷ shall be implemented.
- ✓ When the recommended I-INCE limits of 85 dB/135 dB cannot be achieved by engineering means, the use of hearing protective devices as part of an effective hearing conservation program shall be implemented as a secondary measure.

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A global approach to noise control policy; Part 3: Community noise

1 INTRODUCTION

People have been annoyed by sources of community noise for centuries. The introduction of jet-propelled aircraft in the 1950s and the growth of traffic on streets and highways in the following decades led to serious concerns about community noise. As a result, a wide range of legislation to combat community noise has been developed in a number of countries, including Japan, Germany, France, Switzerland, the United States, the United Kingdom, and The Netherlands.¹ In many countries, however, such legislation does not exist, is only partially available, or if available has failed to achieve its purpose. The net result is a world in which there is probably more exposure to community noise now than there was in the 1960s and 1970s. Different countries use different noise policy approaches with varying results, and there is no internationally-coordinated Global Noise Control Policy to reduce the wide-spread effects of this exposure in a consistent and effective manner.

In countries with a comprehensive legislative approach, community noise control is typically organized in such a way that different authorities tackle different parts of the problem. Such “shared responsibility” is emphasized in the European Union (EU) “Green Paper on Future Noise Policy”¹ and in many national noise policies. The division of responsibilities varies from country to country. In countries with comprehensive noise legislation, it is generally acknowledged that certain elements of noise control should be handled at a higher level than the national one, preferably at the global level. The most obvious element is the control of noise emission by products (machines, equipment, etc.).² There are, however, other aspects that could benefit from a worldwide approach. These “global” aspects are analyzed and discussed in this Part 3 of the I-INCE report on A Global Approach to Noise Control Policy.

Global noise control policies can only be realized with the support of national authorities. National authorities have to agree on a direction to proceed and should be prepared to support supra-national organizations in order to realize common goals for reducing exposure to community noise. To some extent, such

agreements are already in place and a foundation exists for the eventual development of Global Noise Control Policy. The following sections of this report give an overview and assessment of the present situation, followed by recommendations for improvement and extension.

In some countries there is a question as to whether community noise is a quality-of-life issue or a public-health matter. While the World Health Organization focuses on the “health” effects of exposure to community noise,⁵ in many countries noise in communities is considered to be a “quality-of-life” issue. Other countries have developed noise policies to protect the “public health and welfare.” Global policies for control of community noise should take appropriate account of issues related to quality-of-life as well as health for those people exposed to sources of noise in their communities.

As is the case with other environmental considerations, control of noise in a community cannot be accomplished without the active participation of industry. In this context the international industrial lobbies play, or should play, an important and constructive role. The international environmental organizations and consumer organizations should play another potentially important role. Implementation of the policies on the local level should include active participation by residents of a community.

2 TERMS AND DEFINITIONS

Definitions of terms related to community noise are given in other Parts of this report. Additional definitions important to Part 3 are given below.

sustainable development development that meets the needs of the present without compromising the ability of future generations to meet their own needs.⁶

sustainable transport a transportation system that allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations; is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy; limits emissions and waste within the planet’s ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise.⁷

noise label a visible, legible, and indelibly-affixed

¹An International Institute of Noise Control Engineering (I-INCE) Technical Study Group (TSG 3) on “Noise Policies are Regulations” is currently developing a searchable database and a descriptive report on community noise policies in 21 countries.^{2,3}

Table 1—Reception locations and noise sources covered by the concept “community noise”

Category	Persons and reception locations	Noise sources	Remarks
1	Residents in their homes, in their gardens, or on their balconies	Road, air, rail and water traffic, industry, construction machines, street-cleaning and gardening machines, recreation and sports, shooting ranges, discos, shops, restaurants	Widespread problem
2	As above	Noise from neighboring houses, including gardens and balconies	Air conditioning noise from neighboring houses and noise from a neighbor’s gardening machines are included. Noise from a garden machine as heard in the garden where the machine is used is included in the scope of “consumer product noise.”
3	Persons taking recreation in public parks, at camping places, beaches and other recreational areas	Road, rail, air and water traffic, industry, construction machines, street-cleaning and gardening machines, music, and noises made by other visitors to the recreational area	For employees working in parks, at camping places, etc., noise from all sources is included in the scope of “occupational noise”
4	Pupils in schools, patients in hospitals, guests in hotels, theater goers	All noise sources not belonging to the facility itself as described for category 1	For pupils, patients, or customers, the noise from machines in the building itself is included in the scope of “consumer product noise.” For employees, all noise inside the buildings is included in the scope of “occupational noise.”

marking on a piece of equipment, showing the amount of noise emission

product noise declaration information on the noise emissions of a particular consumer product that may be published on the manufacturer’s website or in applicable printed literature available to purchasers. The format of a product noise declaration is usually governed by a standard or industry test code.

declared sound power level the upper limit of the A-weighted sound power level declared for a product below which a specified large proportion of the A-weighted sound power levels are expected to lie when the product is new

(Unit: decibel; unit symbol: dB)

NOTE 1 Declared sound power levels have also been termed “stated sound power levels” and “guaranteed sound power levels.”

NOTE 2 Declared sound power levels are sometimes given in bels instead of decibels.

3 DESCRIPTION OF COMMUNITY NOISE

A brief definition of community noise is given in Sec. 3 of Part 1 as “unwanted sound in a non-occupational setting, indoors or outdoors, caused

by sources over which an individual has little or no control, including sounds produced by neighbors.” In some literature, community noise is called “environmental noise” to include noise in national parks and wilderness areas, race-track noise, and shooting ranges. In other literature and in some existing legislation, “community noise” does not include the noise from neighbors.

Two aspects of community noise always have to be considered: (1) the location of the noise receiver and (2) the source of the noise. Table 1 indicates which reception locations and which sources are included within the scope of community noise.

In this report, most attention is given to noise sources in Category 1 because for this category the concerns for community noise are the greatest and Global Noise Control Policy could contribute significantly to alleviating the concerns. Category 2 is important, but the solution for this problem is much more a personal and local matter than it is for the other categories; Global Noise Control Policy can contribute little to resolution of the noise problems for Category 2. Categories 3 and 4 are important because they highlight the need to specifically address unique situations and the concerns of special categories of people

for which more-stringent criteria are needed to minimize exposure to community noise, such as children, the aged, and the infirm.

4 EFFECTS OF COMMUNITY NOISE

The effects of community noise are various and can be described in different ways. This section describes the potential effects of community noise on health, quality-of-life, and finances.

The following quotation is from the Constitution of the World Health Organization (WHO): “human health is a state of complete physical, mental, and social well-being, not merely the absence of disease and infirmity”.⁵ In its “Guidelines for Community Noise”,^{9,10} WHO identified and discussed the following specific effects that may be caused by community noise:

1. Annoyance and effects on social behavior
2. Interference with communication
3. Sleep disturbance
4. Cardiovascular and psycho-physiological effects
5. Noise-induced hearing impairment
6. Job and task performance effects

Some of these effects have long-term components that are irreversible. There are indications that the effects mentioned under Item 4 may contribute to mortality related to the indicated diseases.¹¹

The frequency of occurrence and the severity of the effects vary greatly. Effect 5 is rare. The scale of Effects 1 and 6 is considerable, but data are too scarce for a worldwide estimate.

Annoyance is sometimes inferred from field surveys in which questions about noise annoyance are presented to (a sample of) individuals in a community. Usually these questions allow 5 to 7 answers ranging from ‘not at all annoyed’ to ‘very much annoyed.’ Generally the quantities “percentage Annoyed” (%A) and “percentage Highly Annoyed” (%HA) are presented as final outcomes, where the percentage is of the population included in the sample.

It can be estimated that for Category 1 of Table 1, between 20 and 40 percent of the European population is Highly Annoyed by sources of community noise.^{1,9,12} On the basis of this large percentage in European and other countries, general annoyance is often seen as the most important effect of community noise.

The concept of annoyance has problems. One is the lack of standardization regarding its definition and its determination. Another problem is the different meaning of the translations of the word “annoyance” into different languages, resulting in slightly different results for different language groups.¹³ Nevertheless,

annoyance is widely used as the basic effect to be controlled. Reducing annoyance caused by community noise reduces all corresponding specific effects as well. Nevertheless, in addition, in several present policies (for example in Germany and the European Union), sleep disturbance is added as a second item for control.

In 2001 several of the above issues were discussed in a WHO “Technical Meeting on Aircraft Noise and Health”.¹⁴ To some extent the conclusion of this meeting that aircraft noise is associated with a variety of human health effects is also valid for road-traffic and railway noise, although the literature on human health effects resulting from exposure to community noise is still quite controversial and inconclusive,⁹ depending on how human “health” is defined. Results from other relevant WHO technical meetings are also available from the WHO website.¹⁵

Although many governments around the world have signed the WHO Constitution, some of these governments do not fully accept the WHO definition of “health,” or do not accept the consequence that annoyance describes a condition of reduced health. Even if annoyance and the specific effects of exposure to noise are recognized as health effects, the political and financial consequences of such recognition are sometimes unacceptable, making it difficult for some countries to adopt adequately-protective noise policies. On the other hand, some of these countries do accept community noise as a “quality-of-life” issue and have adopted noise policies based on this perspective.

Authorities and companies often consider the effects of community noise in terms of the character and number of complaints they receive. Complaints can be useful for communication between authorities and citizens for the solution of short-term problems and in relation to deviations from normal patterns. However, they do not reflect the long-term health and quality-of-life effects in a stable or slowly-changing situation and are closely tied to residents’ socio-economic status.

Global and national noise policy for community noise should have a long-term general basis aiming for the reduction of the number of annoyed people and improvement in the overall health and quality-of-life of the population, accompanied by local noise ordinances and building codes as well as short-term local measures such as actions by appropriate authorities based on complaints. Global noise policies can contribute significantly on a long-term basis but little on a short-term time scale. Table 2 provides an overview of the subjects that should be considered in a Global Noise Control Policy.

Adverse financial effects of noise for residents, owners of houses, local authorities, and employers are generally considered to be potentially large. The

Table 2—Potential elements of a global policy on community noise

Element	Subject	Remarks
1	Declaration of intent	Provides a common basis for planning and actions; see Sec. VI
2	Standardization and harmonization of key quantities and assessment methods	Absolutely necessary; see Secs. V, VII, and VIII
3	Regulations for noise emissions by products	A key element; see Sec. VIII
4	Inclusion of industry and the public	Necessary when making noise policies and decisions on limits for noise-exposure
5	Noise immission policy concepts and noise exposure limits at receiver locations	See Sec. VII
6	Incentive programs	Tax policy; industry-government partnerships; low-noise products
7	Action plans and action tools for reducing noise	More effort is needed to better develop these concepts (e.g., Ref. 16)

best-documented adverse effect is the effect on sellers of property as a result of the reduction of housing prices in noisy areas in the European Union.¹⁷ Estimates of the total yearly loss in the value of houses in the European Union because of noise range from 13 to 38 billion euros,¹⁸ that is, on the order of 100 euro per inhabitant. The money spent by governments and industry to alleviate this damage is much less than the costs of community noise to society. Types of financial damage include medical costs and the costs of lost labor days for health effects, as well as the costs of reduced possibilities for land use, although reliable data on these costs are not available.

5 ORGANIZATIONS INVOLVED IN DEVELOPING NOISE POLICIES

5.1 Introduction

The following authorities and organizations are important for the development of a global policy on community noise:

- The United Nations World Health Organization (WHO)
- The International Civil Aviation Organization (ICAO)
- The United Nations Environment Program (UNEP)
- The World Trade Organization (WTO)
- The Organization for Economic Cooperation and Development (OECD)
- The World Bank Group.
- The United Nations Economic Commission for Europe (UNECE)
- The European Union (EU)

- National governments
- International industrial lobbies
- International environmental and consumer related lobbies
- The International Organization for Standardization (ISO)
- The International Electrotechnical Commission (IEC)
- Other international standardization organizations
- The International Institute of Noise Control Engineering (I-INCE)
- The International Commission on Biological Effects of Noise (ICBEN).

Tables 3a and 3b provides an overview of the membership and tasks of these authorities and organizations relative to community noise.

The next subsections describe the function of each authority or organization listed in Tables 3a and 3b.

5.2 WHO

The **World Health Organization** (WHO) of the United Nations “works to assist its Member States and their populations in achieving a sustainable basis for health for all by ensuring an environment that promotes health and by making individuals and organizations aware of their responsibility for health and its environmental basis”.¹⁵

The activities of WHO in this area include an active program on noise issues. For community noise, the main activity of the WHO was the publication in 2000 of “Guidelines for Community Noise”.⁹ The intention of the Guidelines is to assist authorities with the devel-

Table 3a—International organizations that are important for the development of worldwide policies regarding community noise.

Authority/ organization	Members	Tasks relative to community noise
WHO	UN Member States (nations)	Raise awareness of the effects of noise and various noise policy approaches to reduce exposure to community noise. Stimulate the development of community noise policies around the world. Assist Member States in the development of national and local noise policies.
ICAO	More than 185 States ("Contracting States" or nations)	Harmonization of legislation and rules related to noise produced by civil aviation.
UNEP	UN Member States (nations)	Encourage international cooperation on care for the environment, improvement of the quality of life, sustainable development
WTO	148 countries	Enforce global rules for trade between nations. Ensure that trade flows as smoothly, predictably and freely as possible. Promote sustainable development.
OECD	30 nations	Provide guidance to its member countries with development of community noise policies
World Bank Group	Member countries	Provide financial support for economic development, taking into account environmental conditions, including noise
UNECE	European UN Member States (nations)	Public access to information on community noise. Pan-European cooperation for achieving transportation sustainable for health and the environment, including community noise. Prepare European harmonization of noise-emission requirements for motor vehicles.

opment of community noise policy, both by presenting recommendations for criteria to limit exposure to community noise (covered in Sec. 7 of this report) and in making recommendations for community noise policy concepts and approaches. It is important to recognize that WHO does not intend that their recommended exposure criteria be interpreted as being required in the short term as regulatory criteria. Rather, they are intended as long-term ideal exposure goals. According to WHO, "Unless legal constraints in a country prescribe a particular option, the evaluation of control options must take into account technical, financial, social, health, and environmental factors. The speed with which control options can be implemented, and their enforceability, must also be considered. Although considerable improvements in noise levels

have been achieved in some developed countries, the financial costs have been high, and the resource demands of some of these approaches make them unsuitable for the poorer developing countries", see Ref. 9, p. 54.

WHO has an active program to improve international understanding on a variety of issues related to "noise and health" (see: <http://www.euro.who.int/Noise>) and is also cooperating with the UNECE in an initiative on sustainable transport. The WHO is dependent on the support of its Member States and non-governmental international organizations, since its own budget for development of noise control policy is very limited. In spite of this limitation, WHO is committed to working on efforts to consolidate scientific knowledge on the effects of noise on people and to

Table 3b—National authorities, international lobbies, international standards developers, and professional organizations.

Authority/ organization	Members	Tasks relative to community noise
Authority/ organization	Members	Tasks relative to community noise
EU	25 European Member States	Implement European Directives on community noise and noise emission from products. Cooperate with WHO, UNECE and other organizations on initiatives for sustainable transport.
National authorities	Individual nations or states in the case of a federal government.	Differs with each country's national noise policies
International industrial lobbies	National or regional lobbying organizations	Follow and participate in international policy developments
International environmental and consumer-related lobbies	National or regional lobbying organizations	Follow and participate in international policy developments
ISO	National standards institutes from participating or observing nations	International standards for procedures for measurement and assessment of noise
IEC	National standards institutes from participating or observing nations	International standards for acoustical measuring instruments
I-INCE	44 Member Societies: acoustical societies and noise control societies	International development and promotion of noise control engineering(technical aspects, effects of noise, the role of legislation, associated costs)
ICBEN	Individual scientists	Promote a high level of scientific research concerning noise-induced effects on human beings and on animals. Promote appropriate noise regulations and standards.

the development of adequate noise policies. The overall WHO concept for controlling noise exposure can best be understood through the following statement from “Guidelines for Community Noise”:

“Successful noise management should be based on the fundamental principles of precaution, the polluter pays and prevention. The noise abatement strategy typically starts with the development of noise standards or guidelines, and the identification, mapping, and monitoring of noise sources and exposed communities.... Noise control should include measures to limit the noise at the source, to control the sound transmission path, to protect the receiver’s site, to plan land use, and to raise public awareness. With careful planning, exposure to noise can be avoided or reduced. Control options should take into account the technical, financial, social, health, and environmental factors of concern. Cost-benefit relationships, as well as the cost-effectiveness of the control measures, must be

considered in the context of the social and financial situation of each country. A framework for a political, regulatory, and administrative approach is required for the consistent and transparent promulgation of noise standards.”, see Ref. 9, p. 68.

5.3 ICAO

The **International Civil Aviation Organization** (ICAO) was founded in 1944 and came officially into existence in 1947.¹⁹ A relationship agreement was concluded between ICAO and the United Nations of the kind concluded with other specialized agencies. One of the consequences of this agreement was the participation of ICAO in the 1992 Earth Summit in Rio de Janeiro and its cooperation with the United Nations Environment Program (UNEP) and other international bodies to determine the contribution of civil aviation to global environmental problems. At present ICAO has

about 185 “Contracting States” as its members.

The aims and objectives of ICAO¹⁹ are “to develop the principles and techniques of international air navigation and to foster the planning and development of international air transport so as to accomplish the following objectives:

- a) ensure the safe and orderly growth of international civil aviation throughout the world;
- b) encourage the arts of aircraft design and operation for peaceful purposes;
- c) encourage the development of airways, airports, and navigation facilities for international civil aviation;
- d) meet the needs of the world for safe, regular, efficient, and economical air transport;
- e) prevent economic waste caused by unreasonable competition;
- f) ensure that the rights of Contracting States are fully respected and that every Contracting State has a fair opportunity to operate international airlines;
- g) avoid discrimination between Contracting States;
- h) promote safety of flight in international navigation; and
- i) promote generally the development of all aspects of international civil aeronautics.”

The **International Air Transport Association** (IATA), the **Airports Council International** (ACI), the **International Federation of Airline Pilots’ Associations** (IFALPA), and the **World Tourism Organization** are represented as observers at many of the meetings of the ICAO bodies.¹⁹

“In fulfilling its role of fostering all aspects of international civil aeronautics, the Organization is giving special attention to the impact civil aviation has on the environment with the aim of ensuring maximum compatibility between safe and orderly development of civil aviation and the preservation and enhancement of a wholesome human environment.... The main environmental problems associated with civil aviation are aircraft noise and aircraft engine emissions, as well as various problems of a local nature that may arise at airports”.¹⁹ The ICAO Council through its **Committee on Aviation Environmental Protection** (CAEP)¹⁹ largely undertakes the Organization’s environment-related activities.

“In 2001, the ICAO Assembly endorsed the concept of a ‘balanced approach’ to aircraft noise management (Appendix C of Assembly Resolution A33-7). This concept consists of identifying the noise problem at an airport and then analyzing the various measures available to reduce noise through the exploration of four principal elements, namely noise reduction at the

source (quieter aircraft), land-use planning and management, noise-abatement operational procedures, and operating restrictions, with the goal of addressing the noise problem in the most cost-effective manner. ICAO has developed policies on each of these elements, as well as on noise charges”.²⁰

ICAO’s achievements on each of the above elements of the ‘balanced approach’ for airport noise control are given in Ref. 20. These achievements are summarized as follows:

- a) ICAO contributed considerably to the reduction of noise emission by developing and implementing noise-certification standards.²¹ In 2001 June, the Council adopted a new ‘Chapter 4’ noise-certification standard for ICAO Annex 16; the ‘Chapter 4’ standard was more stringent than the noise-certification standard contained in ‘Chapter 3’.²² Commencing 2006 January 01, the new standard will apply to newly-certified airplanes and to ‘Chapter 3’ airplanes for which re-certification to ‘Chapter 4’ is requested.
- b) A manual was issued on “Land Use and Environmental Control.”
- c) A “Recommended Method for Computing Noise Contours around Airports” was prepared.
- d) A manual was issued with noise-abatement flight procedures.
- e) Restrictions on aircraft operations are a controversial subject in ICAO and with its Contracting States and other members. The 2001 ICAO Assembly “urged states not to introduce any operating restrictions at any airport on ‘Chapter 3’ aircraft before fully assessing available measures to address the noise problem at the airport concerned in accordance with the balanced approach.”
- f) Practical advice on noise-related charges is given in a manual.

ICAO has given and continues to give important contributions to worldwide noise control around airports. In particular, the noise-certification of aircraft is an important element in the design and development of new civil aircraft of all types. The choices for changes to the certification noise-level limits are a matter of great dispute.

The members of the ICAO Council and the various committees are primarily recruited from the civil aviation authorities, the aircraft manufacturers, the airlines, and aviation-related research institutes, and consultants. Representatives of airport authorities also participate. Direct representation from the environmental sector (ministries of the environment, environmental organizations, and affected cities) is absent.

5.4 UNEP

The **United Nations Environment Program** (UNEP) is an agency of the United Nations.²³ The mission of UNEP is: *“To provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.”* These activities cover all aspects of the environment, but not noise!

The activities of UNEP are closely related to the “Multilateral Agreements” on the atmosphere, biodiversity, chemicals and waste, land, oceans, seas, and waters.

UNEP has a special Division for Environmental Policy Development (DEPI) which *“is responsible for the implementation of environmental policy in order to foster sustainable development at global, regional and national levels.”*

Another UNEP division is the Division of Technology, Industry, and Economics (DTIE). One of the many activities of this division concerns *“Economics and Trade: A program of research, consensus building, assessment of trade-related policies, and capacity building on integrating trade, environment and development policies. Activities range from country projects to international meetings which enhance synergies between multilateral agreements and the World Trade Organization.”*

UNEP could be considered for selection as the suitable UN agency for the organization of a UN convention on community noise and for the implementation of a future Global Noise Control Policy based on a multilateral agreement resulting from such a convention.

5.5 WTO

The **World Trade Organization** (WTO) is an international organization founded in 1995 and headquartered in Geneva, Switzerland, that deals with the rules of trade between nations as well as disputes that may arise about trade.²⁴ Within this context it is, according to its website, in favor of sustainable development and environmental protection.

Up to the date of this report, WTO has not played an active role in the area of noise control. In principle, the lack of action by the WTO regarding noise could change because harmonization of noise-emission standards for products is certainly beneficial to worldwide free trade. Thus the WTO is potentially an important partner in discussions and negotiations on worldwide harmonization of such rules.

In the past, industrial lobbies supported by one or more governments have threatened other governments

with interference by the WTO in attempts to block more-stringent legislation on community noise. An example is the proposal for EU legislation on the limitation of the use within the EU of aircraft equipped with a hush-kit for the engines in order to conform to the noise-certification requirements of ICAO ‘Chapter 3,’ a proposal that was successfully opposed by the international aviation sector and the U.S. government. Another example concerns the noise-emission requirements on lawnmowers in the new EU directive on noise emissions from equipment for use outdoors,²⁵ which was opposed by some members of the international lawnmower industry.

5.6 OECD

The **Organization for Economic Cooperation and Development** (OECD) is an international organization headquartered in Paris, France, that helps governments tackle the economic, social, and governance challenges of a global economy.²⁶ It has 30 member countries sharing their commitment to democratic government and the market economy with links to 70 other countries and non-governmental organizations. Concerns about the environment and health are part of its program. *“The OECD provides governments with the analytical basis to develop environmental policies that are effective and economically efficient through performance reviews, data collection, policy analysis, and projections.”* Important for the development of Global Noise Control Policy are the OECD’s special reports on community noise,^{27–30} its program on sustainable development and general studies, and workshops and conferences on the principles of environmental policies.

The OECD has developed an Environmental Strategy consisting of the following five objectives; most of which can be applied to considerations of community noise:

- a) *“Maintaining the integrity of ecosystems through the efficient management of natural resources;*
- b) *De-coupling environmental pressures from economic growth;*
- c) *Improving information for decision making: Measuring progress through indicators;*
- d) *The social and environmental interface: Enhancing the quality of life; and*
- e) *Global environmental interdependence: Improving governance and cooperation.”*

The following is a quote from the OECD brochure on its environmental program for 2003-2004.³¹

*“Sustainable Development at the OECD
In 2001 ... the OECD Ministerial Council Meeting*

reviewed the results of a major three-year cross-organizational program on the economic, social, and environmental dimensions of sustainable development. The Ministers agreed that sustainable development was an overarching goal of OECD governments and the OECD itself.

They recognized that OECD countries bear a special responsibility for leadership on sustainable development because of their effect on the global economy and environment.

OECD thus committed to advancing the international agenda on sustainable development by closing the gap between policy design and implementation and working with non-OECD countries to jointly enhance economic growth, promote human and social development, and protect the environment. Work began immediately to develop indicators that measure progress across all three dimensions of sustainable development and to incorporate them into OECD's peer review processes. Work is also being undertaken on overcoming barriers to policy reform—in particular to the better use of market-based instruments and the phasing-out of environmentally harmful subsidies—and on the social aspects of sustainable development. The results of this organization-wide program on sustainable development will be reviewed by OECD Ministers in mid-2004 and the next steps determined. Community noise is part of this program.”

The remark on the better use of market-based instruments is interesting. The following are examples of market-based instruments:

- a) The introduction of an acoustical quality system for dwellings.
- b) Labels for the noise emission of machines.
- c) Subsidies or tax reductions for relatively quiet products. Usually such measures should only be valid for a limited time.
- d) Extra taxes for relatively noisy equipment.
- e) A combination of c and d.

Although such market-based instruments should be promoted, they can provide only a limited contribution to the control of community noise.

The OECD is an organization that could play a major role in the development of worldwide policies on community noise. Global Noise Control Policy should coincide as much as possible with the principles developed by the OECD and described on the OECD website.²⁶

5.7 The World Bank Group

The World Bank Group was established in 1944. In 2004, the World Bank Group consisted of 184 member countries as a specialized agency of the United Nations

and is headquartered in Washington, DC, USA. “The World Bank Group consists of five closely-related institutions, all owned by member countries. Each institution plays a distinct role in the mission to fight poverty and improve living standards. The World Bank pursues its work through vice-presidential units that focus on a particular region or sector to fight poverty and encourage economic development.”³² The five institutions are:

- The International Bank for Reconstruction and Development (IBRD)
- The International Development Association (IDA)
- The International Finance Corporation (IFC)
- The Multilateral Investment Guarantee Agency (MIGA)
- The International Center for Settlement of Investment Disputes (ICSID).

For control of community noise, the IBRD is the most important institution because it promotes sustainable development.

In cooperation with the United Nations, the World Bank Group developed guidelines in a publication, “Pollution Prevention and Abatement Handbook 1998”. The guidelines in the Handbook cover community noise. The Handbook recommends limits of an A-weighted daytime average sound level of 55 dB and an A-weighted nighttime average sound level of 45 dB, at the residential, institutional, or educational location nearest to a noise source. These Guidelines represent a de facto noise policy with global reach for projects that are funded by the World Bank Group.

5.8 UNECE

The **UN Economic Commission for Europe (UNECE)** “...was set up in 1947. It is one of the five regional commissions of the United Nations. Its primary goal is to encourage greater economic cooperation between its Member States. It focuses on economic analysis, environment and human settlement, statistics, sustainable energy, trade, industry and enterprise development, timber, and transport. UNECE activities include policy analysis, development of conventions, regulations and standards, and technical assistance. UNECE has 55 Member States. However, all interested UN member States may participate in its work. Over 70 international professional organizations and other non-governmental organizations take part in UNECE activities.”³³

In the area of community noise, UNECE runs three important activities:

- Promotion of the Aarhus Convention.
- Joint UNECE-WHO activities on transport, environment, and health.

- WP.29/GRB - Working Party on Noise (GRB) of the World Forum for Harmonization of Vehicle Regulations (WP.29).

The UNECE “Convention on Access to Information, Public Participation in Decision-Making, and Access to Justice in Environmental Matters” (the “Aarhus Convention”) was adopted on 1998 June 25 in the Danish city of Aarhus at the Fourth Ministerial Conference in the “Environment for Europe” process.^{34,35} The Convention went into effect on 2001 October 30; and by 2002 December, 22 European countries had ratified it, and more ratifications are underway at the time of this report. The Convention is the basis for much of the current and still evolving EU environmental policies, including both the extensive set of existing noise-emission Directives and the Environmental Noise Directive (see Ref. 36 for an overview).

The Aarhus Convention has the following three pillars.

- The first pillar gives the public the right of access to environmental information.
- The second pillar gives the public the right to participate in decision-making processes.
- The third pillar ensures access to justice for the public.

Community noise is explicitly mentioned in Article 2 of the Aarhus Convention. The European Directive on environmental noise issued in 2002⁸ includes the above elements and explicitly refers to the Aarhus Convention.

At Aarhus, Denmark, in 1998 Kofi Annan, the Secretary-General of the United Nations, declared³⁷:

“Although regional in scope, the significance of the Aarhus Convention is global. It is by far the most impressive elaboration of Principle 10 of the Rio Declaration, which stresses the need for citizens’ participation in environmental issues and for access to information on the environment ... As such it is the most ambitious venture in the area of ‘environmental democracy’ so far undertaken under the auspices of the United Nations.”

A worldwide agreement in the sense of the Aarhus Convention should be considered as a possible element of a worldwide policy on community noise.

The United Nations Third Ministerial Conference on Transport, Environment, and Health, held in London on 1999 June 16-18, had as one of its main outcomes the adoption of the Charter on Transport, Environment, and Health dealing with the development of sustainable transport. This charter (called the London Charter) includes community noise as well as all modes of transport. As a follow-up to the London Charter, the Secretariats of UNECE and the Regional Office of WHO for Europe convened a high-level meeting on 2001 May 04 and a second one on 2002 July 05. Delegates from

about 40 member countries of UNECE and WHO/Europe attended these meetings, including nine ministers or deputy ministers, and many inter-governmental and non-governmental organizations, including worldwide organizations. At these meetings priority areas were identified, various actions were undertaken, and a number of reports were issued.³⁸ The consensus was that as far as possible existing international legislation and policy tools should be used to implement the concept of “sustainable transport.” The list of priority actions which were discussed at the meeting in 2002 July contains many elements; the following are relevant to community noise:

- Development of national strategies or action plans.
- Definition and adoption of health targets, identification of indicators for monitoring purposes, and development of reporting mechanisms.
- Dissemination of information and good practices.
- Development of institutional mechanisms for integration of environmental and health concerns into transport policies, with participation of health and environment representatives in the decision making process.
- Development and implementation of administrative, regulatory, and financial instruments in the European countries.
- Establishing and ensuring the functioning of a national certification system for vehicles in accordance with the provisions of UNECE Regulations, EU Directives, ISO standards, and normative documents of ICAO and other organizations that concern pollutant emissions, noise, and safety.
- Promotion of transportation modal shift (if useful for the purpose), for example from road to rail transport.
- Development of promotion programs for ultra-low noise vehicles.

Several of the above elements are already part of the various existing EU noise policy Directives.⁸ The above list of priority actions was stimulated by two developments in Europe:

- a) The Amsterdam Treaty of the European Union,³⁹ which included the agreement that in the EU the environmental and health policies should be integrated with transport and industrial policies.
- b) The requirement that when new Member States join the EU, these additional nations shall adopt and implement the existing EU legislation, including the directives related to environmental or community noise.

In response to the UNECE-WHO program ICAO has presented two reports on sustainable transport.³⁸ In these reports ICAO presented its actions on the reduction of the effects of civil aviation on health and environment (particularly engine exhaust emissions and noise). It also emphasized its leading worldwide role in these areas.

The third important activity of UNECE concerns its Working Party on Noise (WP.29/GRB).⁴⁰ Working Party 29 has the task to develop improved regulations for type testing of the noise emitted by road vehicles. Representatives of UNECE Member States and the automotive industry participate in the activities of WP.29/GRB.

WP.29/GRB intends that the results of its work will form the basis for a revision of the EU Directive for testing the noise produced by road vehicles. Other countries, including those outside Europe, are expected to adopt the procedures developed by WP.29/GRB. The automotive industry anticipates worldwide harmonization of market-access legislation and sees WP.29/GRB as an instrument toward that objective.

For the development of improved measurement standards, WP.29/GRB is dependent on the ISO. So far the automotive industry tends to dominate this development, resulting in less than adequate ISO standards and weak legislation. According to the I-INCE Working Party on Noise Emission of Road Vehicles (WP-NERV), *“One of the major reasons for the poor efficiency of the limits is that the lack of any significant effect on tire/road noise of the type-approval procedure for vehicles until after 1995 in Europe has left tire/road noise with no substantial improvement. In the worst case, it may even have increased over the time period studied. In too many cases, tire/road noise has limited the achievable overall noise reductions, since no matter how much power-unit noise has been reduced, there is still tire/road noise remaining and unaffected.... The Working Party has shown that it is very important to monitor the effect of regulations, in order that poor effectiveness and other problems be identified at an early stage and corrective actions be taken without too much time inertia. Had this been done, one would have realized much earlier that the present regulations must be supplemented with a limitation directed towards the tire/road system and that the measurement method, based on ISO 362, should be replaced or modified. Authorities are therefore advised to engage independent technical and scientific expertise to estimate in advance the effects of new noise legislative actions, and then to monitor and evaluate regularly the actual effect.”*, see Ref. 41.

5.9 European Union

The **European Union** (EU) is a union of 25 European nations (Member States). More nations are expected to join in the future. The EU has developed a comprehensive policy on environmental noise that is, to a large extent, comprised of European Directives, which are binding on its Member States. New Member States must adopt and implement the existing Directives before joining the EU. The EU noise policy^{8,36,42-45} has the following seven elements:

- Harmonize noise indicators and assessment methods that pertain to applications of the EU Directives. (Member States are free to apply other indicators and assessment methods for additional measurements.)
- Encourage Member States to set upper limits for appropriate noise indicators. (The consequence of this policy is that there are no EU limits on noise immission levels!)
- Prepare maps of existing and projected levels of noise and make action plans for major agglomerations of residents, major roads, major airports, and major railways using information provided to and consultation with the public.
- Publish the results of the above noise mapping and action plans.
- Propose measures to reduce noise emissions.
- Stimulate research.
- Develop strategic plans for the EU with appropriate adaptation of directives.

The set of EU Directives on noise emission covers most machines that are important sources of community noise (see also Sec. 8 below); other machines will be covered as necessary.

The general directive on environmental noise⁸ uses the concepts of annoyance and sleep disturbance to describe effects of community noise on the quality of life and health. Human-response relations are developed to estimate the number of people annoyed and sleep-disturbed by noise sources in certain areas.³⁸

The EU Environmental Noise Directive introduced noise policy in several EU Member States that did not previously have such a policy. For the other Member States, the Directive added new elements. Several Member States are expected to adapt their existing legislation by adopting the EU noise indicators and assessment methods.

According to the Amsterdam Treaty,³⁹ the EU environmental noise policy is to be integrated with the EU transportation policy and the EU industrial policy. The EU environmental policy will be developed in a similar way as the policies on other environmental subjects such as air pollution and water pollution. The

UNECE-WHO program on sustainable transport (see the discussion in Sec. 5.8), which must be in harmony with EU policy, reflects this. That is also the case with the membership of the committees and working groups supporting the development of the EU noise policy.³⁶

The EU, represented by the European Commission, has an unusual position on aircraft noise. On the one hand, it is a major legislator in this area (emission, flight restrictions, noise indicators, noise mapping, and action plans), it runs a major research program on the reduction of noise emission, and it is trying to coordinate other aspects (such as land-use planning and noise charges). On the other hand, the EU is not a member of ICAO, but is represented by its Member States and attends ICAO meetings as an observer.

The EU tries to use the results of international standardization for the definition of quantities and assessment methods. If those definitions and methods are not available, it defines such quantities and methods in its Directives. Examples of such definitions are immission quantities (noise indicators), possible health effects (annoyance, sleep disturbance), computational methods for noise indicators, relations between noise level and human response, and measurement methods on noise emission. In the future, CEN (the EU standardization body)⁶⁷ will probably implement many of these definitions and procedures in European Standards.

In principle, the work done by ICAO and UNECE/WG.29/GRB fully fits within the EU framework. Several EU directives on noise emission are based on the activities these organizations.

5.10 National Governments

In addition to the European Union, the United States of America (USA) and Japan are crucial for the development of a worldwide noise policy. Many other national governments play a role, particularly in the various international bodies, but discussion of their positions is outside the scope of this report.

In 2002, Finegold, Finegold, and Maling⁴⁶ prepared an overview of the historical development of noise policy in the USA. The following is a quote from that overview:

“Throughout the late 1960s and 1970s, the U.S. was considered to be a world leader in the development of national noise control policies, including regulations to control the sound produced by civilian aircraft (noise emission), occupational noise exposures, and guidelines on environmental noise impacts (noise immission). During this period, the Department of Housing and Urban Development (HUD) and the Federal

Highway Administration (FHWA) also began developing their noise policies.

“Initially, the enactment of the Noise Control Act of 1972 was regarded internationally as an excellent beginning of a comprehensive program to control environmental noise. However, while the Federal Aviation Administration’s (FAA’s) aircraft-source noise-control program resulted in very significant reductions in aircraft noise emissions and international cooperation in the development of requirements for these noise emissions, the Environmental Protection Agency (EPA) program to control noise emissions from non-aircraft sources was largely ineffective and is generally considered to be a public-policy failure. Very little progress has been made in keeping many of the U.S. noise policy regulations and guidelines current over the past 20 years, with the notable exception of policies for aircraft noise emissions. In contrast to EPA’s lack of success with product noise emission policies, the EPA did develop valuable environmental noise exposure guidelines, introduced useful concepts such as the Environmental Impact Analysis Process (EIAP) and land use planning, and supported the development of a strong scientific foundation for national noise immission policies.

“At the present time, however, U.S. national noise programs are not adequately coordinated among the various federal agencies involved with noise policy issues. There are discrepancies in exposure criteria and noise-control approaches between the various federal agencies, and there are no federal community-noise-exposure (immission) regulations. Because of a lack of coordination at the federal level, different noise criteria exist within various federal agencies, and much of what exists is out of date. In contrast to the current status in the U.S., individual countries in Europe and Japan, for example, are making rapid progress implementing modern noise-control policies. At the same time the European Commission is rapidly developing stringent product-noise-emission criteria, which will be very difficult for U.S. manufacturers to meet in the near future. Also, community-noise-immission criteria are being contemplated for use in the still-evolving European Community environmental noise directive. In addition, the World Health Organization (WHO) has recently published community-noise-exposure guidelines, which contain noise exposure criteria much more advanced than those required by most U.S. noise regulations. Thus, U.S. noise-control policies are sorely in need of revision and updating.”

The above quote makes clear that, at present, the policies of the U.S. federal administration are inadequate for most sources of community noise,

except aircraft. This lack of a coherent national noise policy has its effect, not only in the USA, but also worldwide.

For aircraft noise the U.S. Federal Aviation Administration plays a significant role in ICAO and other international bodies. This role is in strong contrast with the position of the EPA, which still has the authority but lacks the manpower and necessary funding to do anything for the control of any source of community noise. Consequently the current U.S. administration is severely hampered in the development of new noise policies for community noise issues other than aircraft noise. U.S. industry is not absent, however, from the discussions of noise policy. Some U.S. industrial lobbies are attempting to influence the international scene, directly or through the U.S. administration; see the discussion of UNECE in Sec. 5.8.

The inadequacies of the current U.S. position with regard to community-noise policy are clearly a great handicap for the development of a well-balanced worldwide policy on community noise. Stimulated by the developments in the European Union (see Sec. V H), the Institute of Noise Control Engineering of the USA (INCE/USA) established a Study Team on National Noise Policy with the ultimate goal of making recommendations for adoption of an updated U.S. national noise policy. Its task was to assist the citizens of the USA by providing recommendations to the Congress, to the federal agencies, and to other organizations on how to move forward. Within this context in 2003, a special issue of the *Noise Control Engineering Journal* was dedicated to this subject.⁴⁷ In 2004, Maling and Finegold provided another overview of the current U.S. Noise Policy.⁴⁸

Overviews of the noise legislation in Japan are given in Refs. 3, 49, and 50. The following quote is from Ref. 50:

“In Japan, laws and standards are prepared for almost all essential noise problems as described above but they have been established respectively for each problem and collective view is lacking. This might be attributed to the fact that various environmental pollution problems happened promptly especially during the period of rapid economic growth and the government had to cope with each of these problems. In the future, laws and standards must be established and revised from a collective and global viewpoint. In the discussion on environmental noise problems, the concepts of ‘emission’ and ‘immission’ are apt to be confused. For the establishment of laws and standards regarding environmental noise problems, the concepts of “emission control” and “immission observation (monitoring)” have to be clearly distinguished. As another point, noise assessment methods effective for both of monitoring

and prediction have to be developed as environmental impact assessment will become increasingly important for urbanization and industrialization.”

Community noise control is clearly an important issue in Japan. There is a considerable amount of legislation, which, however, is not very cohesive. Ideas for improvement are being developed. Regarding this situation and regarding the position of Japan as an exporting country of motor vehicles, construction equipment, lawnmowers, and much other equipment, it should be expected that the Japanese national administration will be interested in the development of a worldwide noise policy that supplements and supports the national policy.

5.11 International Industrial Lobbies

5.11.1 General industrial unions/associations

In many countries there are unions of sector-specific industrial organizations. Such organizations promote the interests of the industries they represent as well as the interests of their members nationally and internationally. Sometimes the unions are members of a regional organization that promotes the interests of industry in a particular region. Such organizations operate alongside the regional Economic Commissions of the United Nations (see Sec. 5.8).

An example of a regional union is UNICE, the Union of Industrial and Employers’ Confederations in Europe.⁵¹ Part of its mission is “... to inform the decision-making process at the European level so that policies and legislative proposals that affect business in Europe take account of companies’ needs.” To achieve its objectives, UNICE focuses its action in four main areas:

- encouraging entrepreneurship,
- creating space for business,
- improving labor-market flexibility, and
- promoting a balanced and sustainable development.

The following work priority is related to the last point: “...balanced integration of economic, societal, and community concerns.” In this context, UNICE has an interest in the EU legislation on noise and in programs concerning sustainable development.

There is no worldwide union of regional or national industrial unions. The worldwide interests of industry are, to a large degree, covered by the WTO; see Sec. 5.5.

5.11.2 Sector-specific industrial unions and associations

In many countries companies working in the same sector have formed associations to promote their

common interests. Sometimes such national associations are, in their turn, members of a regional or worldwide union of associations.

For subjects related to aircraft noise, the following worldwide organizations merit attention:

- **IATA**, the International Air Transport Association⁵²
- **ACI**, the Airports Council International^{53,54}
- **ATAG**, the Air Transport Action Group⁵⁵

IATA is an association of approximately 280 airlines, including the world's largest. According to its website, the environment is one of its priorities and these environmental issues include community noise.

ACI is the only worldwide professional association of airport operators. It represents about 1400 airports in 170 countries. It is organized in six regions, each with its own board of elected airport representatives. Aircraft noise is an important issue for ACI. Some of its regional organizations play an active role in this area—see, for example, the position papers of ACI-Europe about proposals for EU noise legislation.⁵⁴

ATAG is an independent coalition of organizations and companies throughout the air-transport industry that have joined together to support aviation infrastructure development and capacity improvements in an environmentally friendly manner. Funding members of ATAG are ACI, Airbus, Boeing, Snecma-CFMI, IATA, and Rolls-Royce. (Airbus and Boeing are aircraft manufacturers, Snecma-CFMI and Rolls-Royce are manufacturers of aircraft engines.)

With these three organizations and others, the aviation industry is able to play its role in discussions on policy development at the national, regional, and worldwide level.

The worldwide “road traffic industry” is not as well organized as the aviation sector. Manufacturers of road vehicles, suppliers for the automotive industry, road construction companies, and professional transport companies have national and regional organizations but no worldwide operating lobbying organizations. Nevertheless, the worldwide automotive industry has a considerable influence on important activities that are presently underway as noted by the following examples:

- Experts from the International Organization of Motor Vehicle Manufacturers (OICA)⁸⁷ play an important role in UNECE/WP.29/GRB on the type-testing method for noise emission from road vehicles; see Sec. V H.
- Experts from OICA participate in joint Working Group 42 of ISO/Technical Committee 43/SubCommittee 1 “Noise” and ISO/Technical Committee 22 “Road Vehicles.” The joint

Working Group develops ISO standards in this area.

- The European Automobile Manufacturers Association (ACEA)⁵⁶ maintains close contacts with the European Commission regarding new directives on noise emissions and on revisions of existing European Directives.
- SAE, the Society of Automotive Engineers,⁵⁷ organizes congresses on noise and vibration issues for the automobile industry worldwide and, in other ways, stimulates the development of less noisy vehicles.

Thus, in practice, the worldwide automotive industry operates in a reasonably well-coordinated fashion. Formal contacts are limited between industry representatives and others involved in the area of road traffic noise (road construction agencies, road construction companies, road transportation companies, and local authorities). Hence, community noise is seldom considered a common problem for all involved parties.

For the rail transport industry the International Union of Railways (**UIC**), is the main worldwide association of railway companies.⁵⁸ Additionally, there are regional organizations for manufacturers of railway stock and for goods-transport companies. For discussions on worldwide noise policy related to railways, the UIC is the most appropriate organization.

The UIC has officially declared that noise control is a top priority for the railways because noise is an important factor in relation to the competitiveness of railways with road and air traffic. The UIC and many national railway companies are very active regarding noise control, often in close cooperation with the authorities. A recent overview of the contributions of the railway industry is given in Ref. 59.

The machinery industry has numerous national and regional associations for specific sectors. Additionally, there are general lobbying organizations like the American Engineering Association (**AEA**)⁶⁰ and the Liaison Group of the European Mechanical, Electrical, Electronic, and Metalworking Industries (**ORGALIME**).⁶¹ ORGALIME and several other European Associations had close contacts with the European Commission during the development of the Directive on the noise emission of outdoor equipment.²⁵ Most of these associations provided data and participated in the setting of economically reasonable and technologically practical upper limits on noise emission. This spirit of cooperation was, however, not the case for the lawnmower industry, which did not provide data on the state of the art for noise control; but instead launched an international campaign against adoption of the Directive when it was close to acceptance. During the development of EU Directive

2000/14/EC, there was significant support from a large U.S. manufacturer of construction machinery; see Ref. 62.

5.12 International Environmental and Consumer-Related Organizations

There are numerous local and national Non-Governmental Organizations (NGOs) that have community noise as an issue of concern. In Europe there are also unions of such organizations at the continental level. The most important of these is probably the European Environmental Bureau (EEB),⁶³ which is a major discussion partner for the European Commission.

5.13 International Standardization Organizations

5.13.1 ISO

Most international standards in the field of noise control are developed by technical committees of the **International Organization for Standardization (ISO)**. ISO Technical Committee 43, "Acoustics," has an extensive program to develop standards in the field of noise and noise control.^{64,65} ISO/TC 43 currently has 24 countries that serve as Participating ("P") Members and 16 countries that are Observer ("O") Members.

In the context of community noise the following five efforts by ISO/TC 43 are important:

- basic standards for measurement of noise emission by machinery and equipment,
- standards for measurement of noise emission from transport vehicles (cars, trucks, motorcycles, trains, and ships),
- standards for assessing the acoustical performance of noise barriers, silencers, and other noise-control devices,
- standards for the prediction of community noise levels, and
- standards for the measurement of community noise and its effects (e.g., annoyance).

For most standards dealing with methods and procedures for measurement of noise emission, there is cooperation between ISO Technical Committee 43 and an ISO technical committee for a type of vehicle or product, for example, in the form of a joint working group.

Standards for measurement procedures are often adopted as the basis for legislation on testing to demonstrate compliance with requirements. Because of the economic consequences of failure to comply, the uncertainty of the method needs to be small (preferably not larger than ± 0.5 dB for a 95% level of confidence). Very likely none of the present methods has such a low

uncertainty and some also have other fundamental problems.^{12,41} Several test procedures are under revision, but completion of the revisions is not imminent. Thus, strictly speaking, many of the test methods that have been standardized are not suitable for regulatory purposes. This fact is, however, neglected by nearly all regulatory or certifying authorities. They accept the methods without much criticism and do not initiate a program for improvement.

ISO/TC 43 works continuously to improve basic standards for the measurement of the sound power levels emitted by machinery and equipment. Technical Committee 43 has produced some standards for specific families of machines (e.g., earth-moving machinery), but usually a machinery-specific ISO technical committee or a committee from another standardization organization undertakes this task. In this context, the cooperation between ISO and CEN, the European Standardization Organization,⁶⁶ is very important. CEN has the task of providing the European Commission with standards on health and safety for every product included in its extensive market-access legislation.⁶⁷ The Directive on the noise emission by equipment for use outdoors²⁵ is one example of such legislation; see the discussion in Sec. 5.9 and the material in Tables 5a and 5b.

Standards for characterization of noise-control measures are important for the professionals working in the field of noise control. Their direct role in legislation is limited.

The prediction of noise in the environment is very important for immission-oriented legislation and for implementation of actual noise control measures. ISO/TC 43 has produced two standards in this area: ISO 9613-1:1993 describes procedures to calculate the absorption of sound by the atmosphere over propagation paths that may be several kilometres long; ISO 9613-2:1996 describes general methods to calculate the attenuation that occurs when sound propagates to the location of a receiver.^{68,69} The general methods are not really applicable to traffic noise and are outdated because the standard is based on the state of the art of the 1970s (although the standard was published in 1996 and reaffirmed in 2001). Many countries have developed their own computational methods.

The uncertainty of many national prediction methods for community noise is not known but is likely to be large. For positions close to the source in geometrically simple situations the total uncertainty of a predicted noise level may be as small as ± 1 dB at a 95% level of confidence, though it may well be larger. For many cases, the uncertainty is greater than ± 2 dB, perhaps ± 4 dB. Nevertheless, results of computations are usually presented to a tenth of a decibel; and

compliance with legislated limits is strictly assessed. ISO should help to create a more realistic approach to the determination of actual prediction and measurement uncertainty as well as establishing maximum allowed values of the uncertainty of a prediction or a measurement relative to noise limits.

In 1982, ISO published the first edition of International Standard ISO 1996 dealing with environmental noise. This standard historically existed in three parts but is currently being reduced to two parts.^{70,71} The new standard provides important guidance to the development of community noise control, but is not conclusive regarding the choice of noise descriptors and exposure-response relations.

There was an attempt within ISO Technical Committee 43 to develop a standard for the determination of annoyance, but the result was not adopted by the Technical Committee and has only been published as a Technical Specification.⁷²

A basic problem for ISO/TC 43 is the lack of support from governments for experts to participate in the development of international standards, particularly for the development of better standards for community noise and for specific noise sources. Governments interested in developing a Global Noise Control Policy need to provide much larger budgets to support the participation of experts from various countries in the development of improved international standards.

5.13.2 IEC

Technical Committee 29 “Electroacoustics” of the **International Electrotechnical Commission (IEC)** was formed in 1953 and is responsible for international standards for the performance of acoustical instruments and hearing aids. Important for community noise control are the IEC standards on sound level meters, sound calibrators, and bandpass filters.⁷³⁻⁷⁵ Other technical committees of IEC are responsible for noise-emission standards for electrical machinery.

5.14 I-INCE

The following text is from the I-INCE website⁷⁶:

*“The **International Institute of Noise Control Engineering (I-INCE)**, founded in 1974, is a worldwide consortium of organizations concerned with noise control, acoustics, and vibration. The primary focus of the Institute is on unwanted sounds and on vibrations producing such sounds. I-INCE is the sponsor of the INTER-NOISE Series of International Congresses on Noise Control Engineering held annually in leading cities of the world. I-INCE co-sponsors symposia on specialized topics within the I-INCE field of interest. The quarterly magazine, NOISE/NEWS International,*

reaching more than five thousand specialists within the I-INCE field of interest around the world, is jointly published by I-INCE and the Institute of Noise Control Engineering of the USA (INCE/USA). In 1992, I-INCE instituted a program to undertake technical initiatives on critically-important issues of international concern within the I-INCE field of interest.”

This report is the result of one of the I-INCE technical initiatives. I-INCE is aware of the fact that noise control is not entirely a technical matter, and it therefore also considers the effects of noise on humans and noise-related legislation. I-INCE is actively trying to stimulate the development of worldwide noise policy.

5.15 IC BEN

The **International Commission on Biological Effects of Noise (ICBEN)** is an organization of scientists and experts.⁷⁷ An excerpt from the ICBEN website states that “... *the main goal of ICBEN is to promote a high level of scientific research concerning all aspects of noise-induced effects on human beings and on animals, including preventive regulatory measures, and to keep alive a vivid communication among the scientists working in that field. The means to achieve this ambitious goal are mainly based on its unique structure.*”

An important part of the ICBEN structure is the International Noise Teams. At present there are eight noise teams: six teams deal with different effects of noise on humans, one with effects of noise on animals, and one with regulations and standards related to noise. ICBEN organizes an international congress every five years in various countries around the world to provide an update on the current status of scientific knowledge on the effects of both occupational and community noise in its congress proceedings. Finegold, et al.⁷⁸ have published an overview of the most recent ICBEN Congress held in Rotterdam, the Netherlands in 2003.

ICBEN plays an important role concerning the development of knowledge on the effects of noise and because of its links with some national and international authorities. Many members of ICBEN are also active in I-INCE (i.e., at INTER-NOISE congresses and on various I-INCE technical study groups).

5.16 Discussion

At the present time, important actions are taking place in the development of worldwide noise policies. Some of these actions are for one category of noise only and are mainly driven by the interests of a specific branch of industry. The best-developed area for Global Noise Control Policy is aviation where ICAO has the lead. Somewhat similar developments are underway for

the automotive industry, but not for road transport as a whole, and for rail traffic where UIC has the lead. Developments in these three sectors are uncoordinated.

The situation is somewhat different in Europe where coordinated actions are underway that are either valid for all means of transport (for example, by the work of UNECE-WHO) or for all sources of community noise, such as the large number of noise Directives discussed earlier. Furthermore, in Europe the developments on community noise are part of a strong general approach to environmental issues. I-INCE Technical Study Group 5 concluded that worldwide development of noise policies should, as far as reasonable, reflect a philosophy similar to the European approach, while still incorporating useful noise policy concepts and approaches from other organizations, such as OECD, WHO and others, as well as various national noise policies which have been useful over the past several decades. Both emission and immission noise policies will need to be incorporated in the development of a Global Noise Control Policy and should be coordinated with each other.

In general, based on the review given in previous sections, one can say that the organizations, which could play a part in the development of a worldwide noise policy, are either in place or could rather easily be oriented towards such development. The needed noise policy concepts already exist within these organizations. However, a worldwide policy on community noise also needs a strong foundation in international standards for quantities, measurement methods, measuring instruments, computational methods, and procedures for determining the uncertainty of a measurement or prediction. More work is needed to provide these international standards at an acceptable level of quality.

6 DECLARATION OF INTENT

6.1 Introduction

A clear declaration of intent is the starting point for a noise policy at the worldwide or national level. This section presents an inventory of existing declarations and some related issues, and then formulates a proposal.

6.2 Existing Declarations

A good example of an existing declaration can be found in the preamble of the U.S. Noise Control Act of 1972⁷⁹:

“The Congress declares that it is the policy of the United States to promote an environment for all Ameri-

cans free of noise that jeopardizes their health and welfare.”

The notions of “health” and “welfare” are not precisely defined but in combination it is clear that the U.S. Congress intended to promote an environment for all Americans in which at least negative physical health effects (principally hearing damage and stress) are limited and in which a reasonable “quality of life” could be enjoyed.

A second example of an existing declaration is found in the European Directive 2002/49/EC on environmental noise.⁸ Article 1 of this Directive expresses the following objectives:

1. *“The aim of this Directive shall be to define a common approach intended to avoid, prevent or reduce on a prioritized basis the harmful effects, including annoyance, due to exposure to environmental noise. To that end the following actions shall be implemented progressively:”*
 - a) *“the determination of exposure to environmental noise, through noise mapping, by methods of assessment common to the Member States;”*
 - b) *ensuring that information on environmental noise and its effects is made available to the public;”*
 - c) *“adoption of action plans by the Member States, based upon noise-mapping results, with a view to preventing and reducing environmental noise where necessary and particularly where exposure levels can induce harmful effects on human health and to preserving environmental noise quality where it is good.”*
2. *“This Directive shall also aim at providing a basis for developing Community measures to reduce noise emitted by the major sources, in particular road and rail vehicles and infrastructure, aircraft, outdoor and industrial equipment and mobile machinery. To this end, the Commission shall submit to the European Parliament and Council, no later than 18 July 2006, appropriate legislative proposals. Those proposals should take into account the results of the report referred to in Article 10(1).*

This declaration of intent has similar elements to those of the U.S. declaration, together with the outlines of an implementation plan: noise mapping, action plans, information to the public, noise control at the source, and common methods of assessment. The rest of the Directive describes this approach in detail.

The matter of informing the public is in line with the Aarhus Convention; see Sec. 5.8. The objective of the Aarhus convention is given in its Article 1^{34,35}:

In order to contribute to the protection of the right of

every person of present and future generations to live in an environment adequate to his or her health and well-being, each Party shall guarantee the rights of access to information, public participation in decision making, and access to justice in environmental matters in accordance with the provisions of this Convention.

Public participation in decision making is covered by Article 8.7 of EU Directive 2002/49/EC. Furthermore, there is reference to Council Directive 90/301/EC that implements the Aarhus convention in the European Union.

The above quote from the Aarhus Convention has a link with Articles 8 and 13 of the European Convention for the Protection of Human Rights and Fundamental Freedoms.

Article 8 of the Aarhus Convention provides, in so far as is relevant to community noise, as follows:

1. "Everyone has the right to respect for his private and family life, his home."
2. "There shall be no interference by a public authority with the exercise of this right except such as in accordance with the law and necessary in a democratic society in the interests of ... the economic well-being of the country ... or for the protection of the rights and freedoms of others."

Article 13 provides:

Everyone whose rights and freedoms as set forth in this Convention are violated shall have an effective remedy before a national authority notwithstanding that the violation has been committed by persons acting in an official capacity.

In 2001 eight UK citizens suffering from the noise from aircraft operations at London Heathrow Airport won a lawsuit against the British government regarding these articles of the Aarhus Convention.⁸⁰ Later this ruling was reversed.⁸¹

6.3 Noise Control for Supportive Sound Environments

On 2000 August 24, Berglund and Lindvall organized a workshop at INTER-NOISE 2000 in Nice, France, on the subject of noise control for supportive sound environments that resulted in the following consensus statement:

"A supportive sound environment should promote health and is therefore characterized not only by the absence of disease or infirmity, but is an environment that provides complete physical, mental and social well being.

"It should trigger good feelings, safety, and positive and desirable activities. All groups of people and their respective environments should be of concern.

"It should support sustainable development and generate benefits such as:

- improved health, productivity, and performance;
- lower health-care costs;
- improved educational conditions;
- better sleep;
- enjoyable perceptions of natural and man-made environments and music;
- orientation in space and time; and
- less aggressiveness.

"A supportive sound environment should strengthen sustainable development and promote:

- health and rehabilitation;
- safety;
- social interaction as well as privacy;
- sleep, rest, recreation, and psychological restoration;
- education, learning, and creativity;
- performance and productivity;
- esthetic values and perception; and
- orientation and personal confidence.

"In order to guarantee these rights to everyone, a supportive sound environment should support vulnerable groups such as hearing-impaired persons, and infants; it should not be in conflict with other demands on health and well being.

"It should be emphasized that the present situation in most places is far from ideal, but a "good" sound environment is within reach. Its achievement is a long-term project. The ideal situation can be reached at low or no additional costs through careful planning."

6.4 Proposal for a Declaration

The basis for a declaration at the global level could be patterned on the U.S. declaration, extended with elements from the EU Directive:

"(a nation signing the convention) declares that it is its policy to promote an environment for all its citizens free of noise that jeopardizes their health, their quality of life, or both."

To that end, the following actions shall be taken:

- a) Provide support for the development and implementation of harmonized, effective legislation on the reduction of noise emitted by products.
- b) Support the development of harmonized quantities to describe noise in relation to its effects on humans.
- c) Inform its citizens about the noise in their environment.
- d) Support the development of international standards for all aspects of community noise control.

Table 4—Guidelines for community noise (environmental noise) according to the World Health Organization.⁹

Location	Critical effect	Time-average, A-weighted sound level (dB)	Averaging time (hours)	Maximum F-time-weighted, A-frequency-weighted sound level in time period (dB)
Outdoor living area	Serious annoyance, daytime and evening	55	16	—
Outdoor living area	Moderate annoyance, daytime and evening	50	16	—
Dwelling, indoors	Reduced speech intelligibility and moderate annoyance, daytime and evening	35	16	—
Inside a bedrooms	Sleep disturbance, nighttime	30	8	45
Outside a bedrooms	Sleep disturbance, window open (outdoor noise sources)	45	8	60
School, class rooms and pre-school, indoors	Reduced speech intelligibility, disturbance of information exchange, message comprehension	35	During classes	—
Pre-school bedrooms, indoors	Sleep disturbance	30	Sleeping times	45
School playground outdoors	Annoyance (external source)	55	During play	—
Hospital, ward rooms, indoors	Sleep disturbance, nighttime	30	8	40
Hospital, ward rooms, indoors	Sleep disturbance, daytime and evening	30	16	—
Outdoors in parkland and conservation areas	Disruption of tranquility	^a	—	—

^aThe sound level in existing quiet outdoor areas should be maintained. The level of sources of background sounds should be kept low.

- e) Enact measures to reduce the transmission of sound from a source to the domestic environment, if necessary.
- f) Exchange information with the other nations that signed the Convention of which this Declaration is a part.

7 IMMISSION SPECIFICATIONS

A growing number of countries have requirements for the allowable upper limit of community noise. An I-INCE report, in preparation by Technical Study Group 3, will provide an overview of community noise policies and limits in more than 20 countries.^{3,4} In most cases, there are separate limits or target levels for noise from air traffic, road traffic, rail traffic, and industry. Often there is also a distinction between the character of the living environment, different land uses, new and existing situations, small and large roads or airports, and different seasons of the year. There are various

legal contexts in which the limits are applied. There are many different quantities to measure exposure to noise (noise indices or noise indicators) and methods for their assessment. For these reasons noise immission requirements in different countries can seldom be directly compared.

The WHO “Guidelines for Community Noise”^{9,10} recommend limits for various effects of noise in different acoustical environments; see Table 4.

Data in Table 4 are based on exposure-response relationships, which are, however, not published in the WHO Guidelines because of many existing uncertainties and differing points of view. More effort needs to be devoted in the future to achieving international consensus on exposure-response relationships for sources of community noise. The WHO can play a major role in leading this effort. Although progress in standardization has been made by organizations such as ISO and various national standards authorities, the present level of standardization and harmonization on

the effects of noise, the exposure quantities (noise indicators), and the ways in which the effects and exposures are to be determined all need to be improved to support international progress in this area. For “annoyance,” for example, it is necessary to harmonize the procedure for its determination and to make a choice among the different possibilities.

It is also necessary to make choices between the different possibilities for the description of exposure to sources of community noise. The following are examples of pertinent questions that need to be addressed:

- Should the noise descriptor (noise index) be a 1-h-average sound level, a day-night average sound level (DNL with letter symbol L_{dn}), a day-evening-night average sound level (DENL with letter symbol L_{den}), or some other descriptor or combination of descriptors?
- If the preferred noise descriptor is the day-night average sound level or the day-evening-night noise level, what shall be the weighting factors to be added to the sound levels in the evening and nighttime periods?
- For what positions or locations shall the noise descriptor be predicted or measured?
- For what periods of a 24-hour day shall the noise descriptor be predicted or measured?
- If the preferred noise descriptor is to be averaged over certain periods of a year, how shall those periods be specified and how shall the averaging be performed?
- For predictions or measurements of outdoor sound levels, shall reflections from the façades of buildings be included?

Furthermore, it is necessary that the computation and measurement methods for the selected exposure quantity shall be harmonized. Only when all this harmonization has taken place, can exposure data, human-response data, and exposure-response data from different countries be directly compared. So far ISO has made progress but needs to do much more work to provide the necessary standards on which the critical international harmonization can be based.

Although there are different approaches available for predicting the effects of noise on people, especially for community annoyance and sleep disturbance, the question remains whether or not worldwide immission limits (i.e., exposure criteria) can be recommended at this time. I-INCE does not have a formal position on adoption of such limits for regulatory applications. Various policy issues related to adoption of exposure criteria in “regulations” versus “guidelines” still need to be discussed. Political and economic conditions are so different around the world that adoption of uniform

limits in regulations or laws may not be possible because of differences in available financial resources, required noise-control technologies, and differences in values and priorities between countries.

On the other hand, the use of exposure criteria as “guidelines” instead of “regulations” makes enforcement legally difficult. As indicated earlier, improvements in international standardization on measurement procedures and other technical issues are also needed. Therefore, I-INCE recommends that efforts for worldwide standardization be intensified so that future discussions on the usefulness of global noise immission limits may proceed on a realistic and scientific basis.

Another matter of concern is the possibility of setting national or local limits on exposure to noise. In practice, there are market forces that have the effect of wealthier living areas being in quieter locations and wealthier people leaving areas that become noisy. This mechanism is insufficient, particularly if community noise is seen as a public health hazard where the intention is to provide all citizens with equal protection. Thus, whether or not immission requirements are set in regulations or guidelines is very much a political issue. Nevertheless, I-INCE Technical Study Group 5 has the opinion that for densely populated countries, agglomerations, and cities, national or local immission limits are necessary to maintain (or create) an acceptable environment for living. Preferably, such limits should be based on the same exposure quantities and the same assessment methods so that limits and data can be compared. However, simply adopting noise-exposure limits without consideration of either the cost or technical feasibility of the required noise-control techniques, would be naïve and not in the best interest of the public. In attempts to achieve the desired long-term goals for exposure to community noise, reduction of the noise emitted from the sources is the first choice.

The Environmental Impact Analysis Process was developed decades ago as a tool for analyzing the potential impacts of new or increased levels of noise in a community and for making trade-off analyses of various noise-mitigation options. Ideally, the public is also involved in the community-noise decision-making process and is provided with adequate noise-exposure information. Land-use planning and urban-design tools exist to realize the benefits from their use on noise issues in many cities around the world.⁸⁴ The possibilities of these tools are further elaborated by a special I-INCE Technical Study Group (TSG 6, “Community Noise: Environmental Noise Impact Assessment and Mitigation”). They seem particularly important for

local and national noise policy, supported by global policy regarding the harmonization or standardization of quantities and assessment methods.

Improvements are needed in obtaining adequate human-response data to support the knowledgeable development of noise-exposure criteria. Concentrated efforts are required in the areas of standardization and harmonization. The success of such efforts will greatly depend on guidance and coordination from an international organization, such as the United Nations or one of its agencies.

8 EMISSION SPECIFICATIONS

It is generally acknowledged that on a macro scale (worldwide or national), noise control at the source is far more cost-effective than noise control along the transmission path or at the location of a receiver. Control of noise at the source shifts the costs to the producers of the noise. These costs are usually then passed on to users or consumers.

The most powerful legal measure is market-access legislation that permits the sale of a machine only when compliance with certain requirements on noise emission has been demonstrated. Applicable requirements can consist of the following:

- No exceedance of noise emission limits for a model of a machine as demonstrated by tests performed and reported in a standardized manner.
- A label (mark) or documentation showing the average level of noise emitted by samples of a model of a machine.

Additionally, there may be legislation on the “phase-out” of noisy old machinery, i.e., legislation that forbids the use of such machinery after a certain date within some geographic region.

For worldwide noise control, market-access legislation is vital. Market-access legislation is already common for aircraft, cars, and trucks, but considerably less common for other sources of community noise. Noise legislation provides the possibility to control the noise emission from industrial sites and noisy establishments by requirements on licensing (new or renewal).

Voluntary noise labeling and the use of licenses can be useful local additions. In some countries, for example, Germany, there is a system of voluntary noise labeling.

The form of noise labeling is important. There are strong indications that noise labels showing sound power levels in decibels are not understood by the public and that a qualitative label similar to the EU energy label is more effective.⁸⁵ It is important however

that the actual data are also available in supplementary information on the product. The availability of such data provides the opportunity to use the data as input for predictions.

At present, the European Union has the most extensive market-access legislation on noise emission and more legislation is underway. The EU legislation on noise emission is part of a much larger program on market-access legislation related to safety, health, and environmental aspects of products. Tables 5a and 5b provides an overview of the European noise-emission legislation.

For all machines in Table 6, it is essential that a good measurement method be available to demonstrate compliance with a requirement. In many cases, the legal documents refer to international standards (from ISO, CEN, or other organizations). Sometimes the method is described in the legal document itself, or in a related legal document. Ideally, the latter should be avoided and international standards should provide all necessary measurement methods.

Good measurement methods would satisfy the following requirements (in order of importance from the point of view of community noise control):

- The compliance test method shall be relevant for the reduction of noise in the environment; a relevant noise-emission quantity shall be measured under relevant operating conditions.
- The results of the measurements shall have a limited uncertainty (ideally less than ± 0.5 dB at a 95% level of confidence); the uncertainty of the results should be determined from the uncertainty contributed by the measuring instruments, the environment in which the measurements are performed, and by normal variations of production.
- The test method shall be as simple as possible in order to avoid unnecessary costs and to allow routine checks by simple means.

Unfortunately, at present, few of the legal measurement methods satisfy all three requirements. Some do not satisfy the first requirement, few satisfy the second, and the only requirement that is satisfied by the majority of the methods is the third one. The measurement uncertainty of most present methods is ± 3 dB, or more. The total uncertainty of several test methods is not better than ± 5 dB. Reducing the uncertainty of measurement usually requires a much greater effort and may threaten the simplicity of the method. This Part 3 report cannot analyze and present this situation in detail, but I-INCE recommends that a special study on this issue be undertaken to provide input for improvement of the related international standards. For

Table 5a—EU legislation on noise emission; Transportation and construction: crosses in columns 3, 4, and 5 indicate the character of the legislation.

Noise sources (for requirements, see the documents mentioned in column 2)	Document(s)	Noise limits	Marking (labeling)	Phase out
Civil subsonic jet airplanes	80/51/EEC 89/629/EEC 92/14/EEC	X		^a
Cars, trucks, and motorcycles	70/157/EEC 73/350/EEC 84/372/EEC 96/20/EC 97/24/EC	X		
Tires for motor vehicles	2001/43/EC	X		
High-speed trains	Directive 96/48/EC with Commission Decisions 2002/735/EC and 2002/732/EC	X		
Conventional trains	Directive 2001/16/EC with Commission Decision 2004/446/EC	X		
Recreational craft (boats)	2003/44/EC	X		
Builders' hoists, combustion engine driven	2000/14/EC	X	X	
Compaction machines	2000/14/EC	X	X	
Compressors	2000/14/EC	X	X	
Concrete-breakers and picks, hand-held	2000/14/EC	X	X	
Construction winches (combustion engine driven)	2000/14/EC	X	X	
Dozers	2000/14/EC	X	X	
Dumpers	2000/14/EC	X	X	
Excavators	2000/14/EC	X	X	
Excavator-loaders	2000/14/EC	X	X	
Graders	2000/14/EC	X	X	
Hydraulic power packs	2000/14/EC	X	X	
Landfill compactors	2000/14/EC	X	X	
Lawnmowers	2000/14/EC	X	X	
Lawn trimmers and lawn edge trimmers	2000/14/EC	X	X	
Lift trucks	2000/14/EC	X	X	
Loaders	2000/14/EC	X	X	
Mobile cranes	2000/14/EC	X	X	
Motor hoes	2000/14/EC	X	X	
Paving finishers	2000/14/EC	X	X	
Power generators	2000/14/EC	X	X	
Tower cranes	2000/14/EC	X	X	
Welding generators	2000/14/EC	X	X	
Aerial access platforms	2000/14/EC		X	
Brush cutters	2000/14/EC		X	
Builder's hoists with electric motor	2000/14/EC		X	
Building site band-saw machines	200/14/EC		X	
Building site circular-saw benches	2000/14/EC		X	

^aLegislation in 92/14/EEC for civil subsonic jet airplanes provided that as of 2002 April 01 jet-transport airplanes operating from airports within the Member States of the EU and having a maximum takeoff mass of 34,000kg or more, or fitted with 19 or more passenger seats, shall be certificated as complying with the "Chapter 3" noise-certification requirements of ICAO Annex 16.

Table 5b—EU legislation on noise emission—Other machines: crosses in columns 3, 4 and 5 indicate the character of the legislation

Noise sources (for requirements, see the documents mentioned in column 2)	Document(s)	Noise limits	Marking (labeling)	Phase out
Chain saws, portable	2000/14/EC		X	
Combined high pressure flushers and suction vehicles	2000/14/EC		X	
Compaction machines	2000/14/EC		X	
Concrete or mortar mixers	2000/14/EC		X	
Construction winches with electric motor	2000/14/EC		X	
Conveying and spraying machines for concrete and mortar	2000/14/EC		X	
Conveyor belts	2000/14/EC		X	
Cooling equipment on vehicles	2000/14/EC		X	
Drill rigs	2000/14/EC		X	
Equipment for loading and unloading silos or tanks on trucks	2000/14/EC		X	
Glass recycling containers	2000/14/EC		X	
Grass trimmers and grass edge trimmers	2000/14/EC		X	
Hedge trimmers	2000/14/EC		X	
High pressure flushers	2000/14/EC		X	
High pressure water jet machines	2000/14/EC		X	
Hydraulic hammers	2000/14/EC		X	
Joint cutters	2000/14/EC		X	
Leaf blowers	2000/14/EC		X	
Leaf collectors	2000/14/EC		X	
Lift trucks, combustion-engine driven	2000/14/EC		X	
Mobile waste containers	2000/14/EC		X	
Paving-finishers	2000/14/EC		X	
Piling equipment	2000/14/EC		X	
Pipe layers	2000/14/EC		X	
Piste caterpillars (ski-slope groomers)	2000/14/EC		X	
Power generators (>400 kW)	2000/14/EC		X	
Power sweepers	2000/14/EC		X	
Refuse collection vehicles	2000/14/EC		X	
Road milling machines	2000/14/EC		X	
Scarifiers	2000/14/EC		X	
Shredders/chippers	2000/14/EC		X	
Snow-removing machinery with rotating tools	2000/14/EC		X	
Suction vehicles	2000/14/EC		X	
Trenchers	2000/14/EC		X	
Truck mixers	2000/14/EC		X	
Water pump units	2000/14/EC		X	

some standards the weaknesses are known and revision is underway. Furthermore, ISO and IEC have started a general action to improve the clauses on uncertainty in all future international standards produced by their technical committees.

A major problem regarding the uncertainty of the results is the very limited interest of governments in this issue and the tendency of industry to hide or ignore

the uncertainties of the measurement procedures and production variations. ISO provided a very useful standard on the presentation of results in the form of a “declared” (or “stated” or “guaranteed”) sound power level in which these uncertainties are taken into account.⁸⁶ Unfortunately, implementation of this standard in machinery-oriented standards and regulations is strongly opposed by large segments of industry.

One of the few regulations in which the principles were adopted (without referring to the ISO standard) is the European Directive 2000/14/EC.²⁵

As stated in the introduction of this Part 3 report, worldwide harmonization of noise emission legislation in the form of market-access legislation is necessary for community noise control and for international trade. For civil aircraft, such harmonization is already in place (by ICAO and the national certification authorities of the manufacturing countries). For road vehicles, harmonization is underway in the context of the developments in UNECE. For many other machines, the European Union is active in noise emission legislation as shown in the Tables 5a and 5b.

A significant problem for noise-emission legislation is the opposing interests of community and industrial groups. A positive sign is that the OECD is trying to find a balance between the two (see Sec. 5.5).

For the past few years, the European Commission has been preparing its new Directives with an integrated approach in which all stakeholders are represented. But this approach has yet to provide good measurement methods and realistic limits. Nevertheless, the integrated approach (with negotiations between parties during the preparation process) is the only way to reach well-balanced results. For this reason, those involved with efforts to harmonize noise-emission legislation should strongly consider adopting this integrated approach.

At present there are two major bottlenecks in emission noise control: tire-road noise and aircraft noise. The community noise problem cannot be solved without further research on these subjects. Because of their importance and difficulty, I-INCE recommends international stimulation and coordination of research and development on these subjects. For tire-road noise it is important that future research is organized in an integrated way, so that tires and roads are both considered. So far this was usually not the case.

The above mainly focuses on the noise emission from complete, new machines. In order to maintain its 'noise quality' in practice, for some machines additional measures may be necessary regarding the quality of replacement components like tires, engines and silencers. Global policy on this issue is worth considering.

9 PATH CONTROL SPECIFICATIONS

At the local and national level, path control measures play a major role in the control of community noise. Usually these measures are derived from immission specifications, but they may also be directly prescribed as such. Straightforward examples are the

installation of noise barriers and the improvement of façade insulation. Land-use planning is also an important element of path control. I-INCE believes that these measures are not subjects for worldwide harmonization of legislation and recommends that the international standards dealing with them be improved. In addition, I-INCE recommends that land-use planning be promoted as an essential element of community noise control. The possibilities of this tool are further elaborated by I-INCE Technical Study Group 6.

10 SUMMARY OF I-INCE RECOMMENDATIONS

The following are the positions of I-INCE with respect to community noise that should become subjects of coordinated worldwide action:

10.1 Political Aspects

- I-INCE favors a worldwide agreement on the abatement of community noise, preferably in the form of a 'multilateral agreement' resulting from a UN Convention, although other approaches to implementing a global noise control policy might also be considered. As a first step, closer contacts and agreements between separate nations (including the EU) should be established. I-INCE could stimulate the development of such contacts on a technical level. It is also important that the WHO, UNEP, OECD, ISO, ICAO, and other international organizations that could contribute to the development of global noise policies be actively involved.
- Worldwide cooperation already exists regarding the control of noise from aircraft (ICAO), and greater cooperation is anticipated in the future between those organizations concerned with road traffic noise, railway noise, and noise from outdoor machinery (see the discussion in Sec. 5). I-INCE welcomes these developments and encourages the further coordination of these initiatives for the control of community noise. Consequently, I-INCE is in favor of an approach, driven by national governments, cooperating through the UN. The basis for such cooperation could be a declaration of intent as proposed in Sec. 6.4.
- I-INCE recognizes both the WHO definition of health and the concept of noise as a quality-of-life issue. It is not necessary to force governments or the community-noise professional community to choose between these two concepts. Together, they provide a foundation of

concern for the effects of noise on communities and for the development of a global policy on community noise.

- The OECD has developed a number of objectives for environmental policy and a strategy for sustainable development (see the discussion in Sec. 5.6). I-INCE recommends that these principles be taken into account when developing a global noise control policy.

10.2 Technical and Legal Aspects

- Market-access legislation for machinery and equipment should require noise-emission data in the form of product documentation, some form of noise label, publicly available results of demonstration of compliance with noise-emission limits, or combinations of these approaches.
- Further development of international standards and harmonization of quantities, measurement methods, measuring instruments, and computational methods is needed. Procedures should be developed to evaluate the uncertainty of measurements of noise emission, noise transmission, noise immission, the properties of noise-reducing elements (for example, noise barriers, and the effects of noise on humans). Some of these standards do not yet exist and many existing standards need improvement (see the discussion in Sec. 7). The ongoing activities of ISO, IEC, and other standardization organizations need more international political and financial support.
- Coordination and stimulation of research on road/tire noise, aircraft noise, improvement of standards, exposure-response relations and other subjects should be expanded.
- Market forces for the control of community noise should be further stimulated (see Sec. 5.6).

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A global approach to noise control policy; Part 4: Consumer product noise

1 INTRODUCTION

The I-INCE report on a global approach to noise control policies is issued in four parts of which this is Part 4. This part presents details of policies recommended by the International Institute of Noise Control Engineering (I-INCE) related to “consumer product noise.” Consumer product noise is unwanted sound emitted by products over which the affected person or persons has/have complete or partial control. Examples are refrigerators, dishwashers, hair dryers, food processing appliances, vacuum cleaners, household humidifiers and dehumidifiers, computers and other information technology products, power tools for home use, paint sprayers, compressors, lawnmowers, leaf blowers and other power garden tools, air conditioning units, and means of private transport. Public transport is also included because the user has usually the freedom to select another means of transportation.

Because the user is the primary one who suffers from the noise, it should be expected that market forces will govern this problem, i.e. that consumers will ask for quieter products and that manufacturers will develop and market such products. If this is the case, the role of governments, nationally and globally, can be limited. The following sections provide a detailed analysis and recommendations.

2 DEFINITIONS OF TERMS (ADOPTED FOR THE PURPOSES OF THIS REPORT)

See the definitions in Part 1. Additionally:

noise label	a visible, legible, and indelibly-affixed marking on a piece of equipment, showing the amount of noise emission
product noise declaration	information on the noise emissions of a particular consumer product that may be published on the manufacturer’s website or in applicable printed literature available to purchasers. The format of a product noise declaration is usually governed by a standard or industry test code.

declared sound power level , stated sound power level	the upper limit of the A-weighted sound power level declared for a product below which a specified large proportion of the A-weighted sound power levels are expected to lie when the product is new.
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3 DESCRIPTION OF CONSUMER PRODUCT NOISE

In Part 1 of this report, consumer product noise was defined as “Unwanted sound at the position of a user or bystander of a noise-producing product over which an individual may have some control, including noise in passenger compartments of vehicles, but excluding occupational and community noise.” This definition includes the following noises experienced by the user and his household:

1. Noise from household appliances like vacuum cleaners, refrigerators dishwashers, blenders, food processors, hair dryers, humidifiers, and dehumidifiers;
2. Noise from information technology equipment like computers, printers, fax machines, copiers, scanners, and telephones;
3. Noise from powered gardening equipment for private use, like lawnmowers, leaf blowers, lawn edge cutters, hedge trimmers, and chain saws;
4. Noise from power tools like drills, saws, compressors, paint sprayers;
5. Noise from toys (such as toy cap guns, talking dolls, vehicles with horns and sirens, walkie-talkies, fire crackers, and wind-up toys);
6. Noise from air conditioning and heating units;
7. Noise inside private cars, vans, boats, aircraft, and on a motorcycle;
8. Noise inside public transport vehicles such as buses, trains, ferries, and aircraft.

Consumer products do not include equipment that is designed for the generation of sound (radio, TV, audio equipment). The sound produced by such devices is intended for a user and direct bystanders. Noise that may be experienced by neighbors is included in the category of “community noise” and is covered by Part 3 of this report. The definition of consumer product noise does not include the noise produced by “fun machines” such as motorized carts and jet skis. The

users of these machines usually enjoy the sound of the equipment. The sound from “fun machines” often is perceived as noise by people who have no connection with the use of the machine and is therefore included in the category of “community noise.”

4 ADVERSE EFFECTS OF CONSUMER PRODUCT NOISE

Noisy toys may cause hearing damage in children. Other sources of consumer product noise can also induce hearing damage, but, generally speaking, this possibility does not occur because of the relatively short exposure times, the low noise levels, or both. The most important effects of consumer product noise on listeners are:

- interference with the comprehension of speech communications, including telephone conversations;
- interference with listening to radio, television, and music;
- interference with mental concentration and work productivity;
- interference with sleep; and
- general annoyance and diminution of quality of life.

See Ref. 1 for more details on these effects.

5 ARE MARKET FORCES SUFFICIENT FOR CONTROL?

Market forces are definitely present and influence the design and marketing of household equipment, powered garden equipment, and powered tools. A significant number of the users of such equipment looks for relatively quiet products and for manufacturers producing such products. For some products the market mechanism fails; leaf blowers are a notable example. For some products a more proactive role by appropriate authorities might generate the market forces needed to introduce quieter products, for example, by legislation requiring the affixing of a label with appropriate noise information on the product. Consumer organizations could also take the initiative to promote the design and marketing of quieter products.

For the noise inside vehicles intended for private use, the market situation is similar to that for household appliances with the market mechanism working reasonably well. Usually expensive vehicles are quieter than the cheaper ones. On the other hand, the noise level in many less-expensive vehicles may be acceptably low as a result of market forces.

For vehicles used for public transport, the situation is somewhat different. Transport companies purchase these vehicles, and the companies may or may not

specify maximum allowable noise levels in the passenger compartments of the as-delivered vehicles. When they do, the transport company may offer more comfort for its passengers, which is an important competitive aspect.

Market forces are definitely not sufficient for the control of noise emitted by toys.^{2,3} The European Union⁴ has enacted legislation to control these noises.

Overall market forces are reasonably effective in controlling the noise from consumer products. Their effectiveness can be improved by better procedures for measurement and reporting

6 ISSUING AUTHORITIES AND INTERNATIONAL NON-GOVERNMENTAL ORGANIZATIONS

6.1 Introduction

The following authorities and organizations currently play or could play important roles in the worldwide control of consumer product noise:

- The United Nations World Health Organization (WHO)
- The World Trade Organization (WTO)
- The Organization for Economic Co-operation and Development (OECD)
- The European Union (EU)
- National governments
- International industrial lobbies
- International consumer organizations
- International standardization organizations
- The International Institute of Noise Control Engineering (I-INCE).

Table 1 provides an overview of the membership, missions, and initiatives of the above organizations in the area of consumer product noise.

6.2 WHO

The **World Health Organization** of the United Nations (WHO) “works to assist its Member States and their populations in achieving a sustainable basis for health for all by ensuring an environment that promotes health, and by making individuals and organizations aware of their responsibility for health and its environmental basis.”⁵ WHO activities in this area include noise; its main activity is the publication of *Guidelines for Community Noise*,¹ which deals mainly with community noise. The work of WHO on the effects of noise on people and the measurement of noise is applicable to consumer product noise.

Considering its prior work in the field of noise, the World Health Organization could play a central role in the worldwide recognition of noise as a detrimental

Table 1—Authorities and organizations that are important or potentially important for the worldwide aspects of consumer product noise

Authority/ organization	Members	Potential tasks in the area of consumer product noise
UN WHO	UN Member States (nations)	Assist its Member States in the development of national noise policy and stimulate the development of worldwide noise policy, if necessary.
WTO	144 nations	Develop and enforce rules for global trade between nations. Ensure that trade flows as smoothly, predictably, and freely as possible.
OECD	30 (developed, democratic) nations	Assist its member countries with policy development, including policy on consumer product noise, if necessary.
EU	25 European Member States as of 2005 January; to be enlarged in the future	Promote free trade in the European Union. Prepare EU legislation on noise emission by products. Stimulate worldwide harmonization of rules for noise emission of consumer products.
National authorities	Normally no members; states in the case of a federal structure	Depends on national policies.
International industrial lobbies	National or regional lobbying organizations	Follow and influence development of international policies.
International consumer organizations	National or regional lobbying organizations	Follow and influence development of international policies. Publish data on noise of consumer products.
International standardization organizations	Member Bodies: standardization institutes of member nations	Develop international standards for measurement and evaluation of the noise of consumer products.
I-INCE	Member Societies: acoustical societies, noise control societies	Develop and promote international noise control (considering technical aspects, effects of noise, the role of legislation, and implementation costs)

factor. To do so, WHO must depend on the support of its UN Member States and non-governmental international organizations.

6.3 WTO

The **World Trade Organization (WTO)** is an organization of 144 countries dealing with rules of trade between nations.⁶ Within this context WTO, according to its website, is in favor of sustainable economic development and environmental protection.

As of the date of this report WTO has not played an active role in the control of consumer product noise. In principle that lack of activity could change because the harmonization of noise-emission standards for products is certainly beneficial to worldwide free trade.

Thus WTO is potentially an important partner in discussions and negotiations on worldwide harmonization of such rules.

In the past industrial lobbies supported by one or more governments have threatened other governments with interference by WTO in attempts to block legislation that mandated stringent limits on the noise emissions of products. An example is the noise emission requirements for lawnmowers, lawn trimmers, and lawn edge trimmers in the EU directive on noise emission from equipment for use outdoors.⁷ These requirements were strongly opposed by European and U.S. lawnmower manufacturers with the position that the proposed lowering of the permissible noise levels was not technically feasible. Recent reports showed the opposite to be true.^{8,9}

6.4 OECD

The **Organization for Economic Co-operation and Development (OECD)** is an international organization helping governments tackle the economic, social, and governance challenges of a global economy.¹⁰ OECD has 30 member countries sharing a commitment to democratic government and market economy. Included in its program are matters related to the environment and health. OECD is important for control of consumer product noise because of its performance reviews, data collection, policy analysis, and projections.

The OECD is an organization that could play a major role in the development of worldwide policies on consumer product noise, for example, with a study of possible approaches to the development and implementation of such policies. As of the date of this report, OECD has not given any special attention to the issue of consumer product noise.

6.5 EU

The **European Union (EU)** has developed a comprehensive policy on noise which is comprised of European directives most of which are binding on its Member States. New Member States must adopt and implement the existing directives before joining. The EU has issued three directives dealing with consumer product noise:

- A directive on the noise of household appliances¹¹
- A directive on the safety of toys⁴
- A directive on the noise of equipment for use outdoors⁷

The first directive concerns noise declarations or labeling for household appliances. The directive is not mandatory and has only been implemented by a few EU Member States. Recognizing that "... the public should be informed, in a way which is as readily understandable and uniform as possible, of the level of noise emitted by household appliances ...," the directive specifies the requirements for measuring the noise emissions, publishing the resulting values in noise declarations (or including these on physical labels, if otherwise required), and monitoring and checking the values declared.

The directive on the safety of toys, including noise emission limits, is implemented in all Member States and has a considerable impact. In 1999 the European Commission issued a "Communication" in which it informed the Member States that for toys using percussion caps "... the value set in point 4.20(d) of the harmonized standard EN 71-1:1998 "Safety of Toys – Part 1: Mechanical and Physical Properties is inappro-

priate," and provided indications on how the inappropriate noise level limit can be resolved.⁴

The directive on noise emission by equipment for use outdoors mainly concerns gasoline-powered equipment for professional use. Models used by professionals who are exposed to occupational noise are usually more powerful and durable than the models sold to consumers. The following may also be used by consumers:⁷

- Leaf blowers
- Lawnmowers
- Lawn trimmers/lawn edge trimmers
- Grass trimmers/grass edge trimmers
- Portable chain saws
- Brush cutters
- Leaf collectors
- Water pump units
- Power generators
- Welding generators

The directive requires labeling (called "marking") for all of the above equipment. The quantity to be provided is called the "A-weighted guaranteed sound power level," the definition of which is identical to that of the A-weighted stated sound power level. A reported value for A-weighted sound power level shall also account for measurement uncertainty as well as the uncertainty contributions caused by production variations. The declared value represents a statistical upper limit for the sound power level, below which a stated large percentage (usually 93.5%) of the product noise emission levels can be expected to fall with a high degree of confidence (usually 95%). For more information on the use of statistical upper limits for noise emission declarations, see ISO 7574,¹² ISO 4871,¹³ or ISO 9296.¹⁴ In EU directives that preceded,⁷ the labeling was required in terms of the measured A-weighted sound power level. The shift from measured to stated sound power levels is logical from the consumers' point of view but was strongly opposed by small and medium-sized enterprises; large worldwide operating companies were generally in favor of the change.

The Directive⁴ also requires that, in addition to the stated sound power level, the measured sound power level and information about the uncertainties be provided in the technical documentation for the product.

The EU tries to use international standards for the specification of quantities and assessment methods. If appropriate standards are not available, such quantities and methods are specified in its directives. Gradually CEN (the EU standardization body) will implement these methods in European standards, and the standard-

ization and harmonization results of the EU will also stimulate worldwide standardization in the area of consumer product noise.

The EU directive⁷ prescribes noise emission limits for some products, namely lawnmowers, lawn trimmers and lawn edge trimmers, power generators, and welding generators. These noise level limits were introduced to control community noise and are further considered in Part 3 of this report.

6.6 National Governments

In addition to the European Union, the United States of America and Japan are crucial for the development of a worldwide noise policy. Many other national governments play a role, particularly in the various international bodies.

Finegold, Finegold, and Maling prepared a historical overview of the development of noise policy in the United States of America; see Ref. 15 and Part 3 of this report. This overview made it clear that at present the federal administration in the U.S.A. is not actively pursuing the development of regulations for community or consumer product noise. This lack of action affects the development of noise policies not only in the U.S.A. but worldwide, and means that the current U.S. administration is absent from international discussions related to such policies. However, U.S. industry is not absent from discussions of potential noise regulations. Some American industrial lobbies attempt to influence international activities related to noise control directly or through the U.S. administration. Usually these actions have a constructive character, that is, the industry provides information and proposes useful measures.

On the other hand, market forces in place of noise regulations are not always effective. For example, the manufacture of unit air conditioners in some countries does not reflect the state of the technology in noise control.

An overview of noise legislation in Japan is given in Ref. 16. Noise control is an important issue in Japan. There is a great deal of legislation although it lacks cohesion. Ideas for improvement are being developed, and the Japanese national administration is interested in the development of a worldwide noise policy that supplements and supports the national policy.

6.7 International and Regional Industrial Lobbies

There are many national and regional lobbying organizations for the various industries producing consumer products but not many worldwide organizations for these industries. Among the exceptions are:

- IATA, International Air Transport Association¹⁷

- ICCAIA, International Coordinating Committee of the Aerospace Industries Association¹⁸
- UIC, International Union of Railways¹⁹
- SAE International, Society for Automotive Engineers²⁰

The level of noise in the interior of an aircraft is generally considered a private matter between the aircraft manufacturer and the purchaser. If the buyer insists that the interior noise level not exceed a certain value at passenger-occupied seats, the manufacturer will attempt to accommodate the request but often for an increase in airplane empty weight and possibly an increase in the selling price, with the exception of business and executive aircraft. Hence, IATA and ICCAIA consider noise for passengers to be a contractual matter between manufacturer and purchaser.

UIC (like IATA and ICCAIA) is aware of the fact that comfort is a competitive aspect of rail transport when compared with other modes of transportation (particularly road and air transport), but UIC leaves specific actions to its members.

In its publications and conferences, SAE regularly considers the technical aspects of noise produced by cars, trucks, buses, and other automotive vehicles.

Of the regional organizations, an important one is the European Garden Machinery Manufacturers Federation (EGMF). EGMF was the industrial partner for garden machines during the development of the EU directive on the emission of noise by outdoor equipment.⁷ However, in that position EGMF provided very little technical information but instead negotiated on the matter of upper limits for noise emissions. Following the adoption of the directive, EGMF intensified its contacts with the European Commission and is represented in ongoing discussions about the future EU noise emission limits for garden machines.^{8,9}

6.8 International Consumer Organizations

International consumer organizations often include statements on noise emissions in their quality and performance reviews, thus stimulating market forces to develop quieter products. Often these statements are qualitative, but quantitative information may be available to the public in background reports. As many noise control engineers are aware, some test methods are either not standardized or are poorly standardized. Consequently, it would be logical for consumer organizations to stimulate the development of harmonization of testing methods, which is in the interest of consumers and improves the exchange of information. Improving and harmonizing test methods is a logical subject for the worldwide union of consumer organizations.

Consumers International (CI)²¹ "... links and

represents consumer groups and agencies all over the world. It has a membership of over 250 organizations in 115 countries. It strives to promote a fairer society through defending the rights of all consumers, especially the poor, marginalized, and disadvantaged, by supporting and strengthening member organizations and the consumer movement in general, and campaigning at the international level for policies which respect consumer concerns."

CI aims to stimulate the development of good technical standards. To that end, CI represents consumer organizations on many ISO and IEC technical committees. One of those is IEC TC 59 that handles, among other subjects, noise emission tests for electrical appliances used in the home. CI has, however, no liaison with Subcommittee 1, Noise, of ISO Technical Committee 43 on Acoustics. Therefore, as of the date of this report there are no representatives from CI in any working group of ISO/TC 43/SC 1, or on any working group of IEC/TC 29, Electroacoustics. CI would seem to be a suitable partner for worldwide action on consumer product noise.

6.9 International Standardization Organizations

Most standardization in the field of noise control occurs in the **International Organization for Standardization (ISO)**. ISO/Technical Committee 43/Subcommittee 1 on noise has an extensive program to develop international standards in the field of noise and noise control.^{22,23}

The following standardization activities are important for consumer product noise:

- Measurement of noise in the interior of road vehicles, trains, ships, and aircraft²⁴⁻²⁷
- Basic standards on measurement of sound power level for control of noise emission^{28,29}
- Specific standards for measurement of noise emission from air terminal devices for ventilation systems, computers, chain and brush saws, and garden equipment³⁰⁻³³
- Statistical methods for the determination of stated noise emission of machinery and equipment.¹²

In road vehicles, ships, trains, and aircraft, the A-weighted sound level at locations occupied by passengers and crew is often sufficient for noise control purposes when the objective is to reduce the exposure to damaging or annoying sounds. Most of the international standards call for upper limits on the time-average, A-weighted sound level under specified operating conditions at locations occupied by passen-

gers and crew. For non-stationary noises, measurement of the peak C-weighted sound level may be appropriate.

ISO/TC 43/SC 1 updates and improves the noise measurement and evaluation standards indicated above on a five-year schedule.

Technical Committee 29, Electroacoustics, of the **International Electrotechnical Commission, (IEC)** prepares basic standards for the performance of acoustical instruments, including sound level meters and sound calibrators. IEC Technical Committee 59, Electrical Machinery, prepares standards on such machines.

6.10 I-INCE

Parts 1 and 3 of this report describe activities of I-INCE that is also related to the noise of consumer products. Reference 34 also contains relevant material.

7 DECLARATION OF INTENT FOR POLICY ON CONSUMER PRODUCT NOISE

The issue of consumer product noise is so much governed by market forces that a declaration of intent may be unnecessary for a policy on consumer product noise. Such a declaration could, however, be part of a wider declaration on safety and health aspects for consumer products stating that the issuing authority strives to protect consumers against safety and health problems caused by a product. Another possibility is to combine a declaration of intent for a policy on consumer product noise with a declaration related to community noise.

8 IMMISSION SPECIFICATIONS

For the exchange of information it would be very useful if there was one globally-accepted quantity for evaluating the level of noise in the interior of transport vehicles. At the present time the most widely-accepted quantity is the time-average, A-weighted sound level at locations normally occupied by passengers and crew members.

There is no need to adopt an international limit value for noise immission caused by consumer products nor inside transport vehicles nor in the domestic environment.

9 EMISSION SPECIFICATIONS AND PUBLICATION OF NOISE EMISSION LEVELS

There is clearly a need for harmonized noise emission quantities for consumer products, and there already seems to be general agreement that the

preferred metric should be the A-weighted sound power level, perhaps supplemented by the A-weighted emission sound pressure level, if appropriate. Just as importantly there is a need for harmonized requirements for the presentation of noise emission data in product information available to consumers. Here, too, there is general agreement. International standards directly addressing this need, such as ISO 7574,¹² ISO 4871,¹³ and ISO 9296,¹⁴ have been in existence for the past two decades.

For a machine or piece of equipment, the preferred way of presentation is the declared (or stated) value (See 6.5.) of the quantity concerned (usually the A-weighted sound-power level). From the point of view of the consumer, dual-number presentation, providing the (average) measured value and the uncertainty,^{12,13} is confusing and unnecessary. The situation is different, however, when the data are also to be used for community or occupational noise control—see Parts 2 and 3 of this report.

In today's world the primary medium for information flow is the worldwide web. Therefore, if asked: What is the most efficient way to get information to consumers concerning the noise emission levels of the products they buy?, the obvious answer would be to publish the information on the manufacturer's website. The product noise declaration, prepared and formatted in accordance with the international standards mentioned above, can appear on the particular product's web page along with other information routinely made available on-line to consumers. Details and examples of such a web-based approach for product noise declarations in the information-technology family can be found in Ref. 35.

For certain types of consumer products, providing noise emission information by affixing a physical label to the product itself may be a viable alternative to publishing the information in a noise declaration. Noise labels have been applied to certain products in many countries including Australia, Brazil, Japan, the European Union, South Africa, and Russia.³⁴ Preliminary results from a worldwide survey indicated that there are doubts about the effectiveness of noise labels for consumer products. There is less doubt for industrial products. If labels on consumer products are to be used, a qualitative label similar to the EU energy label³⁵ may be appropriate.

In the past, before the advent of the Internet, the need for a physical noise label on the product was seen as greater than it is today. The choice was between having the information attached to the product itself or having the information published in a document packaged inside the box or otherwise not available to the buyer until after the product was purchased. But

today more consumers are routinely going to the web for product information and comparison shopping before going to the store to purchase the product. In fact, more consumers are simply purchasing the products on-line; a physical label is less valuable in these cases; however, it may serve as a reference when the link to the Internet information has been lost.

If efforts are now focused on convincing manufacturers to include product noise declarations on their websites instead of asking them to affix physical labels to their products, the likelihood that consumers could see and benefit from these declarations will be greater. From the manufacturer's point of view, the logistical effort and cost associated with affixing a physical label to each product shipped are much greater than those for publishing a single electronic noise declaration for that product. Recognizing that noise information will not get to the consumer without the manufacturer's cooperation, I-INCE recommends that efforts be focused more on encouraging web-based noise declaration programs and less on physical labeling programs for consumer products.

10 PATH CONTROL SPECIFICATIONS

In the context of consumer product noise, worldwide rules on path control are not relevant.

11 SUMMARY OF CONCLUSIONS AND I-INCE RECOMMENDATIONS

- Although market forces are generally effective for the control of noise from consumer products, improve the procedures for measurement and reporting.
- Improve the efficacy of market forces by international harmonization of the quantities used to describe noise emission, preferably by the A-weighted sound power level produced by machines and equipment under standardized operating conditions.
- Publish standardized product noise declarations, primarily in electronic form on company websites, but also in hard-copy technical documentation and product information brochures, where appropriate.
- For toys, prepare and publish globally-harmonized noise emission upper limits, similar to those adopted for toys sold in the European Union.
- Develop international support for improvement of international standards related to consumer product noise, including procedures for evalua-

tion of the total uncertainty of a measurement and appropriate upper limits on allowed uncertainty.

- Focus efforts more on encouraging on-line web-based noise declaration programs and less on physical labeling programs for consumer products.

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A global approach to noise control policy Part 5: Summary of I-INCE positions

1 INTRODUCTION

The primary aim of this report is to identify the elements of noise policy that can better be handled at the global level than at national or local levels and to present recommendations for global implementation of these elements. A secondary aim is to support national and local authorities in the development of noise control policies. The International Institute of Noise Control Engineering (I-INCE) commissioned this study and approved the positions that are summarized here.

Demand for noise control depends on the extent and severity of the harmful effects of noise and on the parties involved. An important part of this report was dedicated to an analysis of these effects and to the attitude of the public, the authorities, and industry.

Design and implementation of noise control measures are primarily engineering problems. During the last decades of the 20th century, engineers played a minor role in the formulation of noise policy. In these first years of the 21st century, engineers have begun to undertake a proactive role. This report is one of the results of the efforts by many engineers who specialize in the technological aspects of noise control engineering.

2 OCCUPATIONAL NOISE

The principal effect of exposure to high levels of noise in the workplace is that such exposure may result in damage to the hearing of some of the workers so exposed. The scientific evidence of the possibility of hearing damage is incontrovertible. The following are the positions of I-INCE with respect to occupational noise.

- The most important element for a worldwide policy on occupational noise is the harmonization of quantities for the description of noise *immissions* and noise *emissions*, and their use in prescribing uniform limits that are accepted internationally. This result can be achieved by international agreements negotiated by the United Nations or one of its agencies.
- Engineering control of noise should be the *primary* consideration and the single, most important element in any international or national program for protection of hearing in occupational situations.

- Within a jurisdiction, the same upper limits on exposure to noise in the working environment as well as hearing conservation measures should be applied to all industries, all workers, and all employers. The jurisdiction should coincide with the geographical boundaries of a country.
- A statement of international or national noise policy should include a prefatory sentence such as: *The policy of the 'issuing authority' is to reduce the risk and magnitude of permanent hearing damage to a minimum for those individuals habitually exposed to high levels of noise in their working environments.*
- This I-INCE report recommends, in consonance with the earlier I-INCE report¹, the following for international or national noise policies:
 - ✓ The 8-hour limit for the A-weighted exposure to noise in a workplace shall be 1 Pa²h, and hence the corresponding limit for the 8-hour-average, A-weighted sound level is 85 dB. The recommended limit on peak C-weighted sound level shall be 135 dB for impulsive sounds that occur within a work period of any duration.
 - ✓ Engineering noise control measures shall be applied to all relevant sources of noise to ensure that there is no exceedance of the limit of 1 Pa²h for an 8-hour exposure to noise and also that there is no exceedance of the limit of 135 dB for peak C-weighted sound level.
 - ✓ An exchange rate of 3 decibels shall be used to evaluate exposure to noise.
 - ✓ Limits on exposure to noise in a working environment shall not be linked to the use or non-use of hearing protection devices.
 - ✓ For some widely used mobile equipment, legal emission limits shall be expressed in terms of A-weighted sound power levels.
 - ✓ For work locations inside the cabins of trucks, tower cranes, farm machines, earth-moving machines, and similar equipment, legal noise *emission* limits in terms of the A-weighted sound level at the operator's position² shall be implemented.
 - ✓ When the recommended I-INCE limits of

85 dB/135 dB cannot be achieved by engineering means, the use of hearing protective devices as part of an effective hearing conservation program shall be implemented as a secondary measure.

3 COMMUNITY NOISE

The effects of community noise are usually described in terms of (non-specific) "annoyance." Annoyance is strongly coupled to specific effects such as sleep disturbance and interference with communication, and thus is not purely a psychological reaction. Worldwide, a large fraction of the population is highly annoyed by sources of community noise. Highly-annoyed people experience a reduced quality of life and, according to the World Health Organization, a reduced state of health. The following are the positions of I-INCE on community noise that should become subjects of coordinated worldwide action:

3.1 Political Aspects

- I-INCE favors a worldwide agreement on the abatement of community noise, preferably in the form of a 'multilateral agreement' resulting from a UN Convention, although other approaches to implementing a global noise control policy might also be considered. As a first step, closer contacts and agreements between separate nations (including the EU) should be established. I-INCE could stimulate the development of such contacts on a technical level. It is also important that the WHO, UNEP, OECD, ISO, ICAO, and other international organizations that could contribute to the development of global noise policies be actively involved.
- Worldwide cooperation already exists regarding the control of noise from aircraft (ICAO), and greater cooperation is anticipated in the future between those organizations concerned with road traffic noise, railway noise, and noise from outdoor machinery (see the discussion in Sec. 5 of Part 3). I-INCE welcomes these developments and encourages the further coordination of these initiatives for the control of community noise. Consequently, I-INCE is in favor of an approach, driven by national governments, cooperating through the UN. The basis for such cooperation could be a declaration of intent as proposed in Sec. 6.4 of Part 3.
- I-INCE recognizes both the WHO definition of health and the concept of noise as a quality-of-life issue. It is not necessary to force governments or the community-noise professional

community to choose between these two concepts. Together, they provide a foundation of concern for the effects of noise on communities and for the development of a global policy on community noise.

- The OECD has developed a number of objectives for environmental policy and a strategy for sustainable development (see the discussion in Sec. 5.6 of Part 3). I-INCE recommends that these principles be taken into account when developing a global noise control policy.

3.2 Technical and Legal Aspects

- Market-access legislation for machinery and equipment should require noise-emission data in the form of product documentation, some form of noise label, publicly available results of demonstration of compliance with noise-emission limits, or combinations of these approaches.
- Further development of international standards and harmonization of quantities, measurement methods, measuring instruments, and computational methods is needed. Procedures should be developed to evaluate the uncertainty of measurements of noise emission, noise transmission, noise immission, the properties of noise-reducing elements (for example, noise barriers) and the effects of noise on humans. Some of these standards do not yet exist and many existing standards need improvement (See the discussion in Sec. 7 of Part 3). The ongoing activities of ISO, IEC, and other standardization organizations need more international political and financial support.
- Coordination and stimulation of research on road/tire noise, aircraft noise, improvement of standards, exposure-response relations and other subjects should be expanded.
- Market forces for the control of community noise should be further stimulated (see Sec. 5.6 of Part 3).

4 CONSUMER PRODUCT NOISE

The following are the recommendations of I-INCE with respect to consumer product noise.

- In general, market forces are effective for the control of noise from consumer products, but improved procedures for measurement and reporting are recommended.
- Improve the efficacy of market forces by international harmonization of the quantities used to describe noise emission, preferably by the

A-weighted sound power level produced by machines and equipment under standardized operating conditions.

- Publish standardized product noise declarations, primarily in electronic form on company websites, but also in hard-copy technical documentation and product information brochures, where appropriate.
- For toys, prepare and publish globally-harmonized noise emission upper limits, similar to those adopted for toys sold in the European Union.
- Develop international support for improvement of international standards related to consumer product noise, including procedures for evaluation of the total uncertainty of a measurement

and appropriate upper limits on allowed uncertainty.

- Focus efforts more on encouraging on-line web-based noise declaration programs and less on physical labeling programs for consumer products.

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