A Short Review of Jamaican and International Noise Standards

This review of international noise standards is part of a 25-day desktop study to develop national noise standards for Jamaica.

Part A: NOISE

The Effects of Noise

Reliable estimates of the direct costs due to ill-health from noise pollution put this figure at as much as 2% of the gross domestic product of a country.

The psychological and social cost is difficult to assess. What price-tag can be placed on an environment where conversation is easy and where children are able to read quietly and are free to concentrate on their school work? An important investigation by V. Kiernan of Cornell University shows that children brought up in noisy areas have poorer reading skills and find it more difficult to recognize and understand human speech than those brought up in quieter areas.

Nervousness and depression are common psychological reactions to noise. The eye has a very effective means of adjusting to light, but people never get "used" to noise. Instead, they usually adjust their mental attitude rather than hearing compensation. Subconscious frustrations can result when noise is endured, but the body system cannot adjust to it.

Sound level is one of the most important parameters when predicting performance effects. The level of noise necessary to produce adverse effects is greatly dependent upon the type of task. Simple tasks remain unaffected at noise levels as high as 115 dB (very loud) or above, while more complex tasks are disrupted at much lower levels. Until fairly recently, the level at which the effects are first seen was thought to be quite high for most conditions, but a summary of recent research points to effects at much lower levels, even as low as 80 dB (a loud television) for intermittent noise.

The ears provide two warning signs for overexposure to noise: temporary

threshold shift and ringing in the ears (tinnitus). After leaving a noisy area or piece of equipment, many people commonly experience both of these symptoms. The temporary hearing loss is difficult to detect unless a hearing test is performed.

Hearing usually returns almost completely in 12 to 14 hours if there is no more noise exposure. Any amount of hearing that does not return becomes a permanent threshold shift or permanent noise induced hearing loss (NIHL). With repeated exposure, the effects are cumulative.

The permanent damage that occurs from overexposure to noise results in a hearing loss that is most annoying and deceptive. In general, most noises damage the hair cells near

the base of the cochlea, where high-frequency information is processed. High-frequency hearing loss creates several problems:

Under ideal listening conditions, speech may still sound mumbly (especially women's and children's voices). The listener is aware that someone is speaking but cannot understand the message.

The ability to identify the source of sound is greatly reduced and the listener seems inattentive. When there is background noise, the listener with a high-frequency hearing loss cannot separate one voice from another. Since all the voices are jumbled together, he or she understands no one. Social functions and group meetings become a chore, and the individual begins to avoid them. With noise-induced hearing loss, there is often a reduced tolerance for loud sounds. Thus the level of a sound must be high before it is understood, but if it is slightly higher, it may be intolerably loud. With noise-induced hearing loss, hearing aids can help, but they do not totally restore the quality of hearing that was present before the loss.

Noise-induced hearing loss is a major problem because people are unaware of its warning signs and effects until it is too late.

(Parts of the above description of the physiological effects of noise were adapted from a recent article by D. E. Baker which was recently published by the U.S. Center for Disease Control.)

Noise in Jamaica

Jamaican towns and cities are regarded as "noisy" by international standards. A number of travel guidebooks describe both Kingston and Montego Bay in this way and occasional messages on the internet and letters in the local newspapers from visitors and from returning residents support this view. This perception could perhaps dissuade the more mature or peace-loving tourists from holidaying in Jamaica.

Many Jamaicans agree with this view. A strong statement in the *memorandum of objects and reasons* which accompanied the recent Noise Abatement Act states: "The level of noise in Jamaica both by day and by night has become truly appalling and it is affecting the health and welfare of the nation." However, Martin Henry writes in the Daily Gleaner of May 22, 1999, that "the Noise Abatement Act … is bringing little relief from noise because of non-enforcement". In informal conversations, Jamaican police officers suggest that the law is probably too strict and welcome the idea of a more objective means of assessing noise.

Noise Pollution

Two kinds of noise pollution are generally recognized and are often tackled with quite different kinds of legislation. Firstly there is "occupational noise" which affects workers in the course of their jobs and is due to the work environment and/or to the machinery which they must operate. Secondly there is "environmental noise", such as traffic noise or noise from a loud radio, and which is not job related.

Where workers are unionized in Jamaica occupational noise is already recognized as a problem and union agreements commonly address the issue. Some further education on noise induced hearing loss (NIHL) would however be worthwhile to encourage the use of whatever protective head-gear (usually ear muffs) is provided by the employer. For non-unionized workers on the other hand, the use of protective devices is minimal and some form of general legislation is desirable to set noise standards.

The second kind of noise is more difficult to deal with and appears to be a major problem in Jamaica, as identified above. The actual sources of the noise pollution are, possibly in order of importance: heavy traffic, stationary sound systems, mobile sound systems ("boom-box" cars), radios etc.(both stationary and portable), churches, public meetings, motorbikes, mobile loudspeakers, car horns, garages, vehicle repairs, construction work, factories, loud voices, gardening, dogs, airplanes, motor boats and others. A full environmental audit would be required to place these in their proper order of importance, but the above seems fairly accurate having been arrived at in consultation with various stakeholders in the community.

To generalize, Jamaicans are largely unaware of the dangers of noise pollution and often unmindful of the annoyance that loud noises can cause, particularly in residential and commercial areas. The new "noise abatement act" (1997) addresses some concerns but is too narrow in scope and relies on a subjective criterion. (See below.) The aim of the present study is to recommend wider and more objective criteria in accord with international trends and standards but tailored to Jamaica’s conditions and culture.

- **The Noise Abatement Act 1997 (Sometimes called the "night noises act".)**

THE SUBSTANCE

(1) Subject to subsection (2) and section 5, no person shall, on any private premises or in any public place at any time of day or night-

(a) sing, or sound or play upon any musical or noisy instrument; or

(b) operate, or permit or cause to be operated, any loudspeaker, microphone or any other device for the amplification of sound, in such a manner that the sound is audible beyond a distance of one hundred metres from the source of such sound and causes annoyance to persons in the vicinity.

(2) No person shall operate a loud speaker-

(a) later than 11o'clock in the night at a public meeting; and

(b) later than midnight at a political meeting held between nomination day and the next day but one before election day, both days inclusive.

(3) Any person who contravenes the provisions of sub- section (1) shall be guilty of violating the public peace, and shall be liable, on summary conviction in a Resident Magistrate's Court-

(a) in the case of a first offence, to a fine not exceeding fifteen thousand dollars or, in default of payment, to imprisonment for a term not exceeding three months; or

(b) in the case of a second offence, to a fine not exceeding thirty thousand dollars or, in default of payment, to imprisonment for a term not exceeding six months; or

(c) in the case of a subsequent offence, to a fine not exceeding fifty thousand dollars or, in default of payment, to imprisonment for a term not exceeding twelve months and, in addition, the Court may, upon the application of the prosecution, order the forfeiture of the specified equipment used in the commission of the offence

ALSO FROM THE ACT:

(1) Where a person intends to operate any specified equipment to provide music for dancing or any other form of entertainment in a public place in circumstances where such music is reasonably capable of disturbing any person occupying or residing in any private premises, such person shall make a written application to the Superintendent of Police in charge of the division in which the activity will be held for permission to do so, not later than ten clear days before the date on which it is proposed to hold such activity.

The act represents a laudable attempt to introduce an easily understood subjective criterion, "audible beyond a distance of one hundred metres", which does not require the use of a sound meter or other measuring device. However, it has not so far had the desired effect in generally quieting the loud sources, and also cannot be applied to most of the sources of noise pollution which are listed above.

The objective measurement of sound

The human ear is an incredibly sensitive instrument for the detection of sound. Unfortunately, the ear is not very good at measuring sound levels. Its response, even in a healthy young person, depends on what it has been subjected to in the past; particularly in the recent past. After listening to loud music for three hours, for example, the ear is then fairly deaf for some time thereafter. Another limitation of the human ear is that its response to a particular sound depends on the level of the background noise. A crying baby may be easily heard in a quiet house, but not if there are loud traffic noises on a nearby road.

Legislation in most countries, and certainly in all of the industrialized countries, is therefore based on sound measurement using a sound meter and which gives a reading in decibels (dB). Unfortunately this unit is a logarithmic one, used in an effort to closely match the response of the human ear. In terms most easily understood,

$$\text{Sound Level (dB)} = 10\log_{10}\left(\frac{I}{I_o}\right)$$ where I is the intensity of the sound being measured and I_o is a constant, supposedly equal to the minimum audible intensity. Please note that a slightly different and more complicated definition (in terms of air pressure) is often given, but the two definitions are equivalent.

One consequence of this logarithmic scale is that sound levels (in dB) do not add together in a simple way. So two sounds, each measured separately as 50 dB, do not produce a sound of 100 dB when measured together. Instead they would together produce a sound of only 53 dB. In practice this is not usually a problem since the person measuring the sound is not generally interested in adding or subtracting sound readings. It does mean however that most people regard sound readings as difficult to interpret and something that should be analyzed only by experts.

Another source of confusion is the use of a "weighting" factor in sound measurements. This simply gives different weights to the different frequencies which together make up the sound which is being measured. The one in common use is the "A-weighting" which requires a certain electrical circuitry in the sound meter and readings on this scale are designated either as dB(A) or dBA. Again the use of the A-weighting is an attempt to mimic the response of the human ear. When setting noise limits the A-weighting is generally used, although this is sometimes not explicitly stated.

A brief analysis of the 100m limit

If noise is emanating from a small source such as a radio or loudspeaker the sound *intensity* will drop by a factor of four when the distance from the source is doubled. (This follows from a simple application of the principle of "energy conservation".) Thus, from the above definition, a doubling of the distance from the source will result in a new *sound level* which is 10log(4) or approximately six (6) decibels lower than the previously measured sound level.

Now, for the sound from a loudspeaker to be easily audible at the edge of a crowd it would need to be perhaps 65 dB at a distance of 25 m from the speaker. So at 100 m the sound level would be 53 dB. Here lies the problem. This 53 dB is approximately the sound level of a radio or television in an average living room and at normal listening distance. So, in order for a speaker to be heard by a reasonably quiet crowd of average size, the law must be broken. It seems then that the police officers are quite right and the law is too restrictive. But there is also no doubt that, at this volume, the speaker would disturb a resident whose living room is 100 m from the source of the noise and would be easily audible even at a distance of 200 m.

The above analysis reveals a difficulty that has our policemen in trouble from both sides and which may never be solved in Jamaica by legislating maximum noise levels. The problem is simply that Jamaica is an open-air and open-window society. The only way for any meeting or dance not to emit sounds loud enough to annoy those in nearby houses

is for it to be held in an enclosed area. According to the U.S. Environmental Protection Agency's "Levels Document" the difference between the sound levels inside and outside would be approximately 12 dB. So in the above example, if the meeting were in an enclosed area then the required 65 dB at 25 m from the source would be only 53 dB just outside the building and a fairly quiet 41 dB (roughly) at a distance of 100 m, thus resolving the problem.

Another alternative is simply to ban such noisy functions from anywhere near to a residential area.

PART B : INTERNATIONAL STANDARDS

General Summary:

Internationally the legislation on the control of noise pollution is in a state of flux as there are (i) increasing population densities, (ii) increasing use of noisy electronic and other equipment and, on the other hand, (iii) increasing public awareness of environmental matters. This clash has put pressure on governments all over the world which have responded with new legislation or often with *promises* of new legislation to address the concerns. In the more developed countries the present legislation was mostly enacted during the present decade and represents revisions and often extensions of existing laws. A number of the less developed countries, such as Jamaica, have recently introduced new legislation while others, such as Barbados and Trinidad, are planning to introduce new legislation before the end of the millennium.

The legislation in the more developed countries which were surveyed, Australia, Canada, Europe (EC), the United Kingdom and the United States, is generally more mature since the earlier laws (which have now been replaced) had been tried and tested for a number of years and certain defects/limitations have now been remedied. By contrast, the legislation in the less developed countries is often fairly new and/or quite limited in scope. In many of the poorest and smallest nations there is absolutely no environmental legislation now in place.

It should also be noted that legislation in the less developed countries is often derived from international standards, the research and development of the standards having been performed in the industrialized countries.

The following is a brief summary of some of the standards found.

It should be noted that a review of the standards in some of the larger countries may be complicated by the particular country having more than one set of legal noise standards. In the United States for instance there are National (Federal) Standards, State Standards and often Municipal or County Standards as well. In such a case, only sample legislation at the lower levels (or particularly good examples of the same) will be presented here.

- **A brief survey of international noise standards**

Some information on the noise control standards and/or legislation was found for each of the following countries : Australia, Canada, United Kingdom, United States, European Community, Brazil, Barbados, Trinidad, Dominica, Mauritius, Malaysia, India, Singapore, Hong Kong, Japan, Uganda, Thailand, Taiwan, Israel.

Comprehensive legislation exists for the more industrialized countries with most of the third-world countries having either very limited noise standards (as in Jamaica) or none at all. In the countries with few or no regulations however there are stated intentions to introduce legislation in the near future. Some of these countries, such as Taiwan, are now engaged in extensive studies of noise pollution with a view to introducing appropriate laws.

Despite the limited duration of this study, more than enough information was obtained for a comparative analysis to be carried out. Indeed some very extensive legislation has been obtained from which only the relevant data on noise standards have been extracted and are presented here. A fairly simple set of regulations, without a plethora of exceptions and special situations, would be more easily managed and certainly more easily enforced in Jamaica.

A. NOISE AT WORK

Australia: (Australia National Occupational Health and Safety Commission.)

Maximum permissible = 85 dBA for an 8-hour work day.

Maximum permissible impulse = 140 dB

Guidelines emphasize the employer's responsibility to educate the workers in NIHL and to provide protection where necessary.

Canada: (from Canadian Centre for Occupational Health and Safety)

Limits vary slightly throughout the various Provinces of Canada. Ranges are given.

Maximum permissible = 85 to 90 dBA for an 8-hour work day.

(The Federal limit is 87 dBA for 8-hours.)

Maximum permissible impulse = 135 to 140 dB

India: (Rules of the Factories Act)

Maximum permissible = 90 dBA for an 8-hour work day.

Maximum permissible impulse = 140 dB

No prolonged exposure permitted for levels in excess of 115 dBA

Singapore: (Department of Industrial Health)

Maximum permissible = 85 dBA for an 8-hour work day.

Thailand: (Ministry of Interior)

Recommended Maximum = 80 dBA for an 8-hour work day.

Maximum permissible = 90 dBA for an 8-hour work day.

Trinidad: (Environmental Management Authority)

Maximum permissible = 90 dBA for an 8-hour work day.

This is advice "as a precursor to legislation".

United Kingdom: (Noise at Work Regulations.)

Recommended Maximum = 85 dBA for an 8-hour work day.

Maximum permissible = 90 dBA for an 8-hour work day.

Maximum permissible impulse = 140 dB

United States: (Occupational Safety and Health Administration, U.S. Department of Labour.)

Maximum permissible = 90 dBA for an 8-hour work day.

Maximum permissible impulse = 140 dB

It can be seen from the above figures that there is general agreement on occupational noise standards The main difference between the countries lies in the different measures that are recommended to the employers in terms of action to be taken when the maximum level is exceeded. Most countries simply require that adequate ear protection be provided while some go further in requiring measures to quiet noisy machines or in requiring NIHL education programmes for workers or "quiet areas" where workers can rest.

It should be noted that the U.S. OSHA standards provide reasonable levels, include various recommendations for noise management and are already used in some local industries, such as Desnoes and Geddes. The OSHA guidelines are under review at the moment, but a draft of the new guidelines does not indicate any major changes.

B. ENVIRONMENTAL NOISE

The control of environmental noise requires two different types of legislation. One type is needed to govern the noise-making properties of equipment which is sold and/or operated locally, while another, such as our noise abatement act, is needed to control specific noise-making activities.

The first type would require (i) laws prohibiting the sale of equipment which is capable of generating more than X dBA when measured at a distance of Y metres and (ii) laws requiring the noise inspection and licensing or confiscation of certain equipment, mainly motor vehicles. The second type is usually based on the zoning of land for residential, commercial or industrial use and requires the establishment of time periods within which a particular noise limit is set for each zone. In each case procedures must also be established for the measurement of the offending noise.

Noise control legislation in different countries tackle these difficulties in different ways. For example, in the Australian Capital Territory, seven different area zones and four different time periods are used in the noise section of their "Environment Protection Regulations" and fourteen different noise-generating activities are governed by special "conditions". Other places use regulations which are equally complex but with quite different subdivisions and quite different special conditions (often "exceptions" to the regulations rather than special rules) while still others, such as Mauritius, use very simple regulations.

In an attempt to simplify things and to avoid presenting both "apples" and "oranges" for comparison, the noise control standards which most nearly fit Jamaica's needs are presented first (below) and, as far as possible, the other regulations are examined within this framework. The selection of this one set of standards as a tentative model for the environmental noise part of Jamaica's regulations is based mainly on the need to strike a balance between simplicity (for easier acceptance initially, and easier management and enforcement in the long run) and comprehensiveness. It is thought that, as environmental awareness improves and as the regulations come to be more rigidly enforced, then particular cases will be presented and exceptions and/or special provisions can be considered. Also, after considering the special cases identified in Australia's Capital Territory regulations and similar cases elsewhere, it is not anticipated that the relative simplicity of the selected standards could cause any immediate problems.

The selected framework for standards : (from India)

Area Zone	Daytime Limits (dBA)	Nighttime Limits (dBA)
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

A silence zone is defined as areas up to 100 metres around such premises as hospitals, educational institutions and courts. Certain activities (e.g. the use of car horns and loudspeakers) are banned in a silence zone.

Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

The Central Pollution Control Board of India also specifies noise limits for vehicles and some domestic appliances and construction equipment as follows:

Equipment	Noise Limit (dBA)
Small motorbike or scooter	80
Passenger Car	82
Small Bus or Commercial Vehicle	85
Medium Bus or Commercial Vehicle	89
Large Bus or Commercial Vehicle	91
Domestic Air Conditioner	68
Refrigerator	46
Domestic Generator	85
Compactors (rollers), Front Loaders, Concrete Mixers, Cranes (moveable)	75

Special Provisions : (Code of practice.)

Public Address System:

License must be obtained by all parties intending to use loudspeakers or public address system for any occasion. Public address system and loudspeakers should not be used at night between 9 p.m. to 6 a.m. except in closed premises. Loudspeakers should be directed at the audiences and not away from audience (i.e. not towards the neighbourhood). Loudspeakers should not be allowed for advertisement and commercial activities. The permitted strength of power amplifier should be just adequate to cover the audience, and noise level beyond the boundary limit of the noise source premises should not be increased by more than 5 dB(A) above the ambient noise level.

Aircraft Operations:

Aerodrome should be located away from the city and growth of the city should not be allowed to extend up to the Aerodrome. Aeroplanes should take off in direction radially away from the city. During boarding and unboarding operations the plane should be sufficiently away from the airport buildings. Night-time operations should be minimised. During maintenance and repairs of the aeroplane, workers should use ear muffs. Portable silencers should be used in the plane intake as well as exhaust during idling period at the airport.

Railway Operations:

Erection of acoustic barrier, reducing speed and avoiding whistling within and along the municipal limits and habitation zones are recommended for adoption to the extent possible.

Construction Activities:

Acoustic barriers should be placed near construction sites. The maximum noise levels near the construction site should be limited to 75 dB(A) Leq (5 min.) in industrial areas and to 65 dB (A) Leq (5 min.) in other areas. There should be fencing around the construction site to prevent people coming near the site. Materials need not be stockpiled and unused equipment to be placed between noisy operating equipments and other areas. Constructing temporary earth bund around the site using soil etc, which normally is hauled away from the construction site.

Burning of Crackers:

Manufacture and sale of crackers having an impulsive noise of more than 90 dB at 5 meters distance from the site of bursting should be banned. Manufacture and bursting of joined crackers should be banned. Bursting of crackers during night between 9 p.m. and 6 a.m. should be banned. Bursting of crackers may be permitted only during public festivals.

Comment

Some of the above, particularly parts of the "special provisions", are obviously not directly applicable to Jamaica as India has quite different customs and priorities. As examples: *sound systems* are not specifically mentioned in the special provisions and nighttime there is defined as 9 p.m. to 6 a.m.. (Other countries use nighttime as 10 p.m. to 7 a.m., a definition which would probably be more acceptable in Jamaica.

However, the general framework of the above regulations is sound with a concise day-night split, the identification of four zones, a short list of special provisions and a table of noise limits to be applied to particularly noisy equipment and to vehicles.

The regulations from other countries are adapted to fit this framework, with interpolations and approximations made as necessary. A meaningful comparison will then be possible and suitable values (and special provisions) arrived at for Jamaica.

Noise standards from other countries

Country	Industrial Area	Commercial Area	Residential Area	Silence Zone
	Day / Night	Day / Night	Day / Night	Day / Night
Australia(1)	65 / 55	55 / 45	45 / 35	45 / 35
Australia(2)	65 / 65	60 / 60	50 / 40	45 / 35

Canada(1)	60 / 55	60 / 55	55 / 45	-
Canada(2)	65 / 60	65 / 60	55 / 45	-
India	75 / 70	65 / 55	55 / 45	50 / 40
Israel	70	55	50	45
Japan	60 / 50	60 / 50	50 / 40	45 / 35
Mauritius	60 / 55	60 / 50	60 / 50	-
U.S.(1)	75 / 75	65 / 65	60 / 60	-
U.S.(2)	65 / 65	65 / 65	65 / 55	-
U.S.(3)	70	62	55 / 50	-
U.S.(4)	80 / 75	65 / 60	55 / 50	-
U.S.(5)	60 / 55	60 / 55	55 / 50	-
U.S.(E.P.A.)	70	60	55	45
W.H.O. & E.C.	65	55	55 / 45	45 / 35

The last two rows give recommended values (not legislated) from the United States Environmental Protection Agency and from the World Health Organization respectively. The European Community endorses those of the World Health Organization.

In the table,

Australia(1) = Australian Capital Territory

Australia(2) = Australian Northern Territory

Canada(1) = District of North Vancouver

Canada(2) = District of Burnaby

U.S.(1) = State of Minnesota (from Pollution Control Agency)

U.S.(2) = State of Delaware (from Department of Natural Resources)

U.S.(3) = Huntsville, Alabama

U.S.(4) = Denver, Colorado

U.S.(5) = Davis, California

U.S.(EPA) = Environmental Protection Agency

notes

Data were also obtained from Brazil, Holland, Singapore and the United Kingdom, but were insufficient for inclusion in the table.

In the United Kingdom, as in other developed countries, the actual limits are set by local authorities but here they use an interesting method which could be rather more difficult to measure and enforce. The suspect noise and the background (ambient) noise level are both measured and the noise is deemed offensive if the difference is more than 10 dBA.

In some countries a penalty is awarded for music or any other noise which has a *tonal* quality. This is generally found to be more annoying to afflicted residents and so must be 5, 10 or even 15 dBA quieter than the limits given above.

The above figures must be treated with some caution since the method of measurement is important and is often not explicitly stated. The fairly good agreement between most of the figures suggests however that a similar method was employed in most cases (perhaps all). Briefly, this involves the use of a sound meter set to give an A-weighted reading and located at the boundary of the property from which the noise is emanating.

Special situations are identified in most of the regulations from which the above table was derived. Some are obviously influenced by the particular culture, e.g. in Israel no singing or music is allowed outdoors between 2:30 and 4 p.m.. Others, which are fairly common or of special interest, are listed below.

N. Vancouver, Burnaby, Denver and Delaware all impose a nighttime ban on both construction work and power lawnmowers.

Japan cites higher noise limits for areas facing a road. The limits vary depending on the width of the road.

Davis bans impulse noises at a maximum level of 20 dB above the tabulated values.

Davis also deals with multiple dwellings on the same property, stating that measurements should be made inside a closed dwelling in such a case.

India and Delaware also ban loud impulse noises, at levels of 110 dB and 100 dB respectively.

Australian Northern Territory gives different limits for music and for other sounds with "tonality", "impulsiveness" or "modulation". The limits for music are normally 10 dBA higher than those tabulated, but15 dBA higher if the music is impulsive.

Australian Capital Territory treats a long list of special cases including security alarms, garbage collection, non-amplified noise from a church, repair work and New Year's eve parties. Of particular interest is a requirement that alarms have an automatic 20 minute cut-off.

N. Vancouver, Denver, Delaware and Australia(1) and Australia(2) all require permits, or the equivalent, for the use of public address systems and other systems which produce amplified sound which may exceed the tabulated limits.

Huntsville requires that amplified sound (e.g. from car radio) in a public place must not be audible at a distance of 25 feet.

In some instances the law is framed in such a way that a general principle is stated first. Israel and N. Vancouver state it in almost identical terms: "A person shall not cause any considerable or unreasonable noise, from any source whatsoever, if the same disturbs, or is likely to disturb, a person in the vicinity or a passerby. "

The regulations which follow are then regarded as subsidiary to this general statement of law.

Traffic

Regulations governing noise from vehicles are twofold: One set of regulations is required for the licensing authority to administer under controlled conditions at the appropriate testing depot, while another is required to allow traffic police to take offending vehicles off the road. Apart from the mechanical condition of the vehicle itself, there is also the problem of "boom-box" cars.

Internationally, (the tabulated limits are in dBA)

	Distance	Type of test	Small/Large Motorbike	Motorcar	Small Bus, Truck	Medium Bus, Truck	Large Bus, Truck
EC	?	S	75 / 80	74	78	78	80
India	?	?	80	82	85	89	91
New York	15.2 m	M	82	79	79	90	90
New York	7.6 m	M	88	85	85	96	96
Huntsville	15.2 m	M	84	84	84	90	90
Albuquerque	15.2 m	M	82	76	76	86	86
Albuquerque	various	S	88	95	95	93	93
Larimer Co.	7.6 m	M	80	80	80	86	86
Denver	7.6 m	M	80	80	80	88	88
Thailand	7.5 m	S	85	85	85	85	85
Canada	?	M	77 / 82	82	82	85	85

The type of test in the above table is either one with the vehicle moving (M) or with the vehicle stationary(S). The **?** indicates that no information was given.

The approximate agreement of most of the sound levels in this table is quite surprising since the methods of measurement vary considerably. Some measurements are with the vehicle stationary with the engine racing at half-maximum revs. and using a slow-response setting on the sound meter. Some measurements are at 7.5 m from the centre line of the road and using the fast-response setting as the vehicle goes past. Others are the same but at 15 m from the road centre of the road. For some, unfortunately, the method of measurement is not even stated.

The most detailed descriptions of the measurement techniques used in obtaining the above values are those from the U.S. cities and involve moving vehicles. New York gives values for both 15.2 m (50 feet) and for 7.6 m (25 feet) which are simply 6 dB different in accord with the doubling of the distance. From this it can be seen that the New York regulations (and those of Albuquerque and Huntsville) are rather lenient in comparison to those of Larimer County or those of Denver.

It is difficult to compare the values for stationary vehicles since the measurement distances are not stated for the values given in the European Commission's Green Paper and the distances for Albuquerque are non-standard. (The Albuquerque distances are 20 inches from the exhaust outlet for a normal passenger car or small truck, 15.2 m for a motorbike and 7.6 m for a larger truck.) Using the 6 dB conversion for the motorbike it would seem that Albuquerque is rather more lenient than Thailand for most vehicles, but the values for motorcars cannot be compared at all. It is quite likely that the EC values really do represent a tougher standard altogether.

Other Equipment

Although India does specify standards for other equipment, the details of the measuring procedures are not given, making it impossible to assess the levels given. Other countries mostly ignore this category, with just an occasional reference to a particularly noisy item, often one which has local significance such as the "leaf blower" and for which a *special condition* might be specified. It seems that *other equipment* can therefore be safely omitted except under such circumstances. In any case, the use of such equipment will be subject to the general environmental noise standards and will be controlled in this way.

Appendix 1 Some Useful Definitions

Sound Level

This is the sound meter reading expressed in decibels (usually designated dB if read on the C-scale of the meter or dBA if read on the A-scale).

The *sound level* is sometimes referred to as the *sound pressure level*.

Equivalent Sound Level (L_{eq})

This the equivalent steady state sound level in A-weighted decibels for a stated period of time which contains the same acoustic energy as the actual time-varying sound level for the same period of time.

For example, an L_{eq} of 55 dBA indicates that the total amount of sound energy in the given period, where the sound level might vary between say 40 dBA and 58 dBA, is equivalent to the energy in a continuous sound of 55 dBA during the same period.

Maximum Permissible Sound Level

This is the maximum sound level which would be allowed in a particular *zone*. (See below.)

Impulsive Sound

This refers to a sound of short duration, much less than one second, with an abrupt onset and rapid decay and which significantly exceeds the ambient environmental sound level. Impulsive sounds should separated in time by at least one second.

Tone

A pure tone is any sound which can be distinctly heard as a single pitch or a set of single pitches. A whistle is very nearly a pure tone and most music has the property of *tonality*, containing a number of recognizable tones.

Modulation

In this context, *modulation* means a discernible and repetitive variation in the *intensity* of the sound. Again this would be a property of most music but could also apply to other sounds which might not have the property of *tonality*.

Industrial Zone

Lands designated *Industrial Zone* shall generally be industrial where protection against damage to hearing may be required, and the necessity for conversation is limited.

The land uses in this category would include, but not be limited to, manufacturing activities, transportation facilities, warehousing, mining, and other lands intended for such uses.

Commercial Zone

Lands designated *Commercial Zone* shall generally be commercial in nature, areas where human beings converse and such conversation is essential to the intended use of the land.

The land uses in this category would include, but not be limited to, retail trade, personal, business and professional services, government services, amusements, agricultural activities, and lands intended for such commercial or institutional uses.

Residential Zone

Lands designated *Residential Zone* shall generally be residential areas where human beings sleep or areas where quiet is essential to the intended use of the land.

The land uses in this category would include, but not be limited to, single and multiple family homes, hotels, prisons, religious facilities, cultural activities, forest preserves, and land intended for residential or special uses requiring such protection.

Silence Zone

Lands designated *Silence Zone* shall generally be special areas where peace, tranquility and extreme quiet is essential to the intended use of the land.

The land use in this category would include, but not be limited to, hospitals, educational institutions and courts. In order to ensure silence at such premises the zone should extend to an area of 100 metres around such institutions. Certain activities (e.g. the use of car horns and loudspeakers) are banned in a silence zone.

Appendix 2 **<u>The Addition of Sounds</u>**

Some understanding of how sounds add together can help in the appreciation of the *decibel* scale which is in general use.

The definition of *sound level* (measured in decibels) is :

Sound level, $L = 10\log_{10}\left(\frac{I}{I_o}\right)$ where I is the intensity of the sound being measured and I_o is a constant such that a *sound intensity* of $I = I_o$ gives a sound level of $L = 0$, thus defining the zero point on the decibel scale. Intensities add directly so that two sounds of intensities I_1 and I_2 will add together to give an intensity equivalent to that of a single sound of intensity I_R where $I_R = I_1 + I_2$.

The resultant *sound level* is therefore $L_R = 10\log_{10}\left(\frac{I_1 + I_2}{I_o}\right)$.

$$L_R = 10\log_{10}\left(\frac{2I_1}{I_o}\right)$$

For example, if $I_1 = I_2$ then which gives $L_R = L_1 + 3.0103$ where L_1 would be the sound level from either source by itself. This oft-quoted result is usually approximated by saying that two equal sources would together produce a sound level which is 3 dB greater than that produced by either one of them. Thus two sources which each produce a sound level of 70 dB will together produce a sound of 73 dB.

The above equations could be used in the same way to determine the resultant sound intensity which would be produced by any number of sources (of the same or of different intensities) when they are added together. The mathematics is fairly tedious however and such additions are usually done by using a pre-calculated table instead, as follows.

The following table is used to determine the cumulative noise level produced by two or more sources. In combining more than two Sound Levels (stated in dB or dBA), the two highest Sound Levels should first be combined. This total should then be combined with the highest remaining level. Continue with this method until all levels are combined.

Difference between levels - dB(A)	Number of dB(A) to be added to the higher level
0	3.0
1	2.5
2	2.1
3	1.8
4	1.5
5	1.2
6	1.0
7	0.8
8	0.6
9	0.5
10	0.4
12	0.3
14	0.2
16	0.1

ADDITIONAL EXAMPLE:

To determine the total sound pressure level of a facility with a blower noise level of 85dBA, a fan noise level of 74dBA, and a compressor noise level of 84dBA: Start with the two highest levels; blower @ 85dBA and compressor @ 84dBA. Looking at the chart we see that a 1dBA difference means 2.5dBA is added to the higher level.

85dBA - 84dBA = ldBA; ldBA then converts to 2.5dBA.

85dBA + 2.5dBA = 87.5dBA for blower and compressor noise.

Finally, fan noise @ 74dBA must be added to the subtotal. The difference between 87.5dBA and 74dBA is 13.5dBA. Look at the chart: 13.5dBA converts roughly to 0.2dBA and is added to the higher level.

87.5dBA ~ 74dBA = 13.5dBA; 13.5dBA then converts to 0.2dBA

87.5dBA + 2dBA = 87.7dBA for total facility noise.

This would then usually be rounded to the nearest decibel. So the resultant sound level would be quoted as 88 dBA.

Note that, for the addition of just two sounds where one has a sound level which is greater than the other by 10 dB or more, then the lower value adds so little to the resultant sound level that it can be simply ignored. Thus two sound levels of 63 dB and 75 dB will produce a resultant sound level which is simply 75 dB (to a good approximation).