NOISE MANAGEMENT GUIDELINES

(DRAFT)

ACT PLANNING AUTHORITY

1996

PREFACE

This draft Guideline is one of a series of Environmental Planning Guidelines being prepared to guide decision making on relevant matters pertaining to development proposals in accordance with those listed in Appendix 1 of the Territory Plan.

The Guidelines are primarily intended for use by ACT Planning Authority (ACTPA) staff in carrying out their responsibilities. However they are also intended to provide advice to applicants for approvals on the best mechanisms to achieve the overall environmental goals. Provisions in the guidelines are consistent with the relevant parts of the *Noise Control Act 1988*, administered by the Pollution Control Authority.

The ACT Government is a signatory to the Intergovernmental Agreement on the Environment (IGAE) and has enacted legislation to implement Schedule 4 of that agreement by providing for the establishment of a National Environment Protection Council (NEPC). The NEPC which came into being in 1995 has the powers to establish measures for the protection of the environment for the benefit of the people of Australia, for noise related to protecting amenity where variations in measures would have an adverse effect on national markets for goods and services. Any such national measures will have the force of law in the ACT.

Where requirements touch upon the functional responsibilities of other agencies relevant legislation and/or procedures have been mentioned. Please note that applicants will need to approach the relevant agencies to ensure that legislative requirements and procedures referred to in these guidelines are those in current use.

The Guidelines are intended, as far as possible, to provide a consistent and objective approach which ACTPA will follow when assessing whether development proposals meet the environmental principles and objectives in the Territory Plan. However, the range of principles and matters for consideration specified in the *Land (Planning and Environment) Act 1991* and the Territory Plan mean that in some cases applications which do not fully comply with the guidelines may be approved.

Nothing in these Guidelines implies an approval under the *Land (Planning and Environment) Act 1991,* or removes the requirement to comply with the *Noise Control Act 1988.*

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1. INTRODUCTION

Noise from traffic and commercial, social and industrial activity is an unavoidable aspect of life in a city. It may also cause concern for those who live and work near major noise sources. Excessive noise has been widely recognised as a major cause of disturbance to living and working environments and therefore as a key determinant of urban amenity. This document sets out guidelines for desirable and maximum levels of noise from traffic and land use activity, and advises on methods to prevent or reduce excessive noise levels. The guidelines do not remove the requirement to comply with the *Noise Control Act 1988*.
The objectives of the noise management guidelines are to ensure that:

. developments with the potential to introduce new noise sources, whether a road or a land use activity, are designed to ensure that noise in adjacent areas is kept within acceptable limits; and
. new noise-sensitive developments are protected from unacceptable noise levels generated by existing sources.

Mechanisms available for management of noise levels include:

. regulation of noise emissions at the source (*Noise Control Act 1988* administered by the Pollution Control Authority);
. planning control over land use and set-back distances, and design of buildings, necessary to separate noise generating activities from noise sensitive land uses;
. planning and development requirements for provision of noise attenuation measures, including building design, materials used and construction techniques/practices.

From a planning perspective, Appendix I1(c) of the Territory Plan notes that in exercising discretion, consideration may be given to additional matters which may be relevant to a proposal, including the effects on the amenity of surrounding land uses of the level of noise generated by the particular land use.

Where not explicitly stated, measurement procedures to determine noise levels must be undertaken in accordance with the Noise Control Manual, published under the *Noise Control Act 1988*. The relevant Australian Standards can be used for those procedures not covered by the Manual.

2. ENVIRONMENTAL QUALITY OBJECTIVES - NOISE

2.1 Planning Objectives

The aim of these guidelines is to ensure, as far as possible, that the level of community disturbance occasioned by noise is minimised and that decisions are made in light of consideration of the provisions of the *Noise Control Act 1988.*

Noise from any identifiable source is audible to many people when that noise exceeds the background noise level by more than 5dB(A). Thus, any noise source which produces noise levels at a potentially sensitive receiver (eg a residence or a community facility such as a child care centre) may be offensive to the occupants and require control measures to be applied. Background noise beyond certain levels may also cause distress, discomfort and affect amenity. Accordingly, outdoor background noise levels for various land uses in the ACT are set out in Table 2.1.

In considering the effects of noise likely to be produced from existing land uses, as well as for new uses, ACTPA will take into account the time of day during which noise occurs, particularly in relation to potential for sleep arousal during night-time hours. Table 2.1 includes background noise levels for day-time (0700 - 2200) and night-time (2200 - 0700) periods. The *Noise Control Act 1988* similarly provides for different levels of noise during these times.

While planning in the ACT has generally been successful in separating potentially noisy industrial and commercial land uses from residential land uses, and for adequately separating roads carrying high traffic volumes from residential areas, some residential and other noise sensitive land uses are located close to busy roads. This is particularly so in parts of North Canberra and South Canberra, and to a lesser extent in Woden and Belconnen.

The direction of planning to minimise noise impact on noise sensitive areas includes the following objectives:

. to continue to plan for, and control, growth of new residential areas and minimise the adverse effects of noise on those areas as far as possible, using the acceptable background noise levels in Table 2.1 as planning goals
. to continue to plan for, and control, growth in industrial and commercial areas taking account of the potential effects of noise generated in those areas on the nearest residential areas, as well as noise-sensitive land uses located within such industrial and commercial areas
. to achieve, as far as is practicable, progressive reduction of noise levels in established suburbs where existing noise levels exceed, or future forecast noise levels are likely to exceed, the relevant planning levels used in the design of individual suburban areas.

These objectives seek to ensure that any non-residential land use (other than major roads) permitted in a residential area complies with the requirements of the *Noise Control Act 1988* (i.e. it does not produce noise levels of more than +5dB(A) above background noise between 0700 and 2200 or above the background level between 2200 and 0700). In relation to traffic noise, separate requirements apply, and these are set out in Section 3 of this guideline.

In the case of commercial and industrial areas, background noise levels higher than for residential areas are generally acceptable. Guidelines for the acceptable and maximum desirable background noise levels which apply to various land use classes or zones are set out in Table 2.1.

If the maximum background (L_{90}) noise level exceeds the 'action' level set out in Table 2.1, the relevant ACT Government agency responsible for planning and/or administration of these guidelines will investigate means to ameliorate the effects of the noise, where this is practicable, and where significant improvement in the amenity of the area can be achieved.

2.2 Objectives In Relation To Traffic Noise

Under the former NCDC policies, a requirement existed for noise levels from traffic on roads not to exceed 65dB(A)$_{L10\ (18\ hour)}$ at a point one metre (1m) in front of the facade of a residential building (or a proposed building) nearest the road which was the main source of noise, with higher levels allowable for commercial and industrial uses and for pedestrian precincts.

A number of countries have noise guidelines which require levels for traffic noise affecting new dwellings not to exceed an equivalent continuous sound level of 60dB(A) L_{Aeq} (which approximates a noise level not to be exceeded more than 10% of the time period (usually 0600 - 2400) of 63dB(A) - the L10 (18 hour) value). NSW planning goals for traffic-related noise in new areas include a maximum value of 60dB(A)$_{L10\ (18\ hour)}$, with a maximum of 65dB(A)$_{L10\ (18\ hour)}$ in existing areas, but it is understood that these are currently being reconsidered. Victoria has introduced a traffic noise criterion for freeways and arterial roads not exceeding 63dB(A)$_{L10\ (18\ hour)}$ at one metre in front of the nearest residential building facade.

Following a review of the earlier ACT noise guideline, and taking into account the general downward trend in noise limits in NSW and Victoria and in other countries, the criterion for maximum noise levels from traffic on roads at the nearest new residential buildings has been reduced to 63dB(A)$_{L10\ (18\ hour)}$ at one metre in front of the facade or the proposed facade closest to the road which is the main source of traffic noise. If this is not achievable through appropriate set-back distances from the nearest major road, the applicant will be required to demonstrate that, by the use of external noise attenuation features or by appropriate noise attenuation treatments incorporated within the structure, the internal noise levels will meet those in *Australian Standard 2107: Acoustics - Recommended design sound levels and reverberation times for building interiors*.

To protect the amenity of residential areas and to allow residents relatively quiet enjoyment of their private open space (i.e. backyards, courtyards, and similar areas), an additional criterion has been set. This provides for a maximum of 58dB(A)$_{L10\ (18\ hour)}$, measured one metre in front of the nearest boundary of the private open space on residential blocks where the front of the residence does not address (face) the road which is the source of the traffic noise. This criterion also applies to medium density development where there are two or more areas of private open space, in which case at least one of the areas of private open space should have a noise level not exceeding 58dB(A)$_{L10\ (18\ hour)}$, measured at one metre in front of the nearest boundary of that area of private open space from the road which is the source of the traffic noise.

Table 2.1 Outdoor Background Noise Levels

Land Use Policy of Affected Area	Predominant land use of receptor area	Time	Objective Level - L_{90} background noise level	Action Level - L_{90} background noise level
Residential area (other than the blocks addressing or backing onto an arterial road)	residential, church, hospital, school, child care centre	Day	40	50
		Night	30	50
	local shopping centre, commercial offices	Day	45	55
		Night	35	45
Residential areas adjacent to arterial (or busy internal suburban) roads, or near a group centre or a town centre	residential, church, school, hospital, child care centre, offices	Day	45	55
		Night	35	45
	group centre shopping areas, entertainment activities	Day	50	60
		Night	40	50
Commercial areas (including Civic and the town centres, and associated service trades areas)	residential, church, school, health facility, child care centre	Day	45	55
		Night	35	45
	retail shopping, commercial and government offices, entertainment activities, hotels, motels	Day	50	60
		Night	40	50
Industrial areas (Fyshwick, Hume, Mitchell and Oaks Estate non-residential)	residential, church, school, health facility, child care centre	Day	50	60
		Night	40	50
	warehouse, factory, light industry	Day	60	70
		Night	50	60

The background noise levels in Table 2.1 have been derived from Appendix B in *Australian Standard 1055 - 2 - 1989: Acoustics - Description and measurement of environmental noise - Part 2: Application to specific situations* and from the table of recommended outdoor background noise levels in Section 21 of the NSW *Environmental Noise Control Manual* published in 1985. The background levels shown represent the level which desirably should not be exceeded, averaged over a fifteen (15) minute period. It is possible for the instantaneous background level to exceed this level. The day and night periods are from 0700 to 2200 and 2200 to 0700 respectively.

3. TRAFFIC NOISE

This section addresses three situations that require consideration of traffic noise impacts:

. new developments on existing roads
. development of new roads in new areas
. upgrading or building of roads in existing areas.

3.1 New Developments on Existing Roads

Of primary concern in this section is the protection of land uses which are sensitive to noise intrusion. Table 3.1 lists potentially noise-sensitive land uses. The level of traffic noise affecting these land uses must be considered in determining whether a noise assessment is required. Maximum external traffic noise levels for noise-sensitive land uses are set out in Table 3.2.

This part of the guideline only applies to development proposals for land uses listed in Table 3.1 located adjacent to roads marked in Diagram 3.1. The Authority has identified these roads as generating, or likely in future years to generate, high levels of traffic noise, such that adjacent developments are likely to require noise attenuation measures to reduce traffic noise intrusion to acceptable levels. It should be noted that in this case "adjacent" refers not only to developments which front these roads but also to situations where these roads pass by the side or rear boundaries of a block.

Proposals for development of potentially noise sensitive land uses adjacent to any of the roads marked in Diagram 3.1 will require an assessment against the guidelines contained in Schedule 3.1. Development proposals must be consistent with the objectives to meet the Guideline. The techniques and criteria are provisions which are accepted without further evidence being required for meeting the relevant objectives. It should be noted that, for dual occupancy developments, the nearest facade to the road which is the main source of traffic noise will be assumed to address that road, irrespective of whether or not the dual occupancy development has direct access to that road.

There are three practical methods for reducing traffic noise to acceptable levels. These are:

. adequately separating sensitive receivers from roads (using set-back requirements or buffer strips),
. the construction of noise mounds or other noise attenuation structures between roads and adjacent buildings, and
. including acoustic features in the building structure.

Indicative figures on noise reductions achievable by using various building constructionmethods are given in Appendix D. In terms of building set-back distances, these aim to achieve a noise level not exceeding 63dB(A)L10 18-hour at a point 1m in front of the

nearest facade to the road which is the source of the traffic noise. It is also assumed that there will be an estimated 25dB(A) reduction in the internal noise level in a brick veneer building when compared with the external noise level, assuming that the building has openable, 3mm glass windows which are closed when internal noise levels are measured, and assuming an average level of construction quality.

Table 3.1 Noise-sensitive land uses

apartment	educational establishment
attached house	guest house
boarding house	health facility
caravan park/camping ground	hospital
child care centre	retirement complex
community activity centre (except community halls)	special care establishment
detached house	special care hostel
	special dwelling

Table 3.2 Maximum external traffic noise level at the development, expressed as $L_{A10(18hour)}$ dB(A)

Land uses	Maximum noise level at a point 1m in front of the building facade[1]
residential and community facilities (from Table 3.1)	63
private open space[2]	58
pedestrian plaza[3]	69
commercial facilities	75

Notes:

1. The acceptable traffic noise levels incorporate an allowance for reflection from the facade of the building under investigation. Measurements should be taken at one metre forward of the building facade. In cases where the building is not yet built, measurements should be taken at a distance of one metre in front of the proposed building facade, and 2.5 dB(A) added to the measurement to allow for future facade reflection. Measurements should be taken at a height of 1.2 - 1.5 metres above ground level.

2. This criterion is also applied to useable private outdoor space of attached houses or apartments. Where the outdoor space is divided into two or more separate areas, at least one of these areas should meet this criterion. Measurements should be taken at a point one metre from the nearest boundary of the area of identified private open space at a height of 1.2 - 1.5 metres above ground level.

3. This standard is expressed as $L_{A10\ 1\text{-hour}}$ calculated between 1230 and 1330 on an average weekday. This should be measured at the edge of the plaza at a distance from the edge of the closest major road equivalent to the standard verge width at adjoining properties.

4. Note that, for second and subsequent levels of a building, additional set-back distance is required to achieve the required criterion value in the table owing to the reduction in the sound energy from ground attenuation over soft ground. A combination of set-back distance and other measures (e.g. use of appropriate insulating materials in construction) to meet the guideline requirements.

Diagram 3.1 - Roads where noise assessment is required for adjacent developments

Schedule 3.1 - Guidelines for developments on existing roads

Objective	Technique	Criteria
To protect occupants of developments from excessive levels of traffic noise	set-back of the building from the road AND/OR acoustic barrier between the building and the road AND/OR building design measures to provide acoustic insulation	} maximum external } traffic noise level at the } development, as set out } in Table 3.2 } } OR internal noise levels as set out in AS 2107

3.2 Development of New Roads in New Areas

When planning new roads in new areas, the final land use adjacent to the roads may not be known, although land use policy area boundaries may already be determined. To facilitate the compliance of future developments with the noise guidelines, care should be taken to see that the layout of the roads and blocks ensures the noise levels (as set out in Table 3.2) at the minimum set-back distances required under the Authority's design and siting policies , can be met. The noise level should be taken as that at:

. one metre forward of the minimum allowable set-back with 2.5dB(A) added to the measured level to allow for future facade reflection (in the case of buildings)
. one metre forward of the nearest private open space boundary (in the case of dwellings which do not address the road under consideration)
. the centre of the area of the identified open space in the case of medium-density dwellings which have more than one area of private open space.

Proposals for new roads in undeveloped areas will require an assessment against the guidelines contained in Schedule 3.2. Proposals must be consistent with the objective to meet the guideline. The techniques and criteria are provisions which are accepted without further evidence being required for meeting the relevant objective.

Generally, the traffic volumes to be used in determining the likely level of traffic noise at any particular location will be the long-term forecasts produced by the Transport Planning Unit in the Metropolitan Planning Section of the ACT Planning Authority. Long term forecasts are presently available for a Canberra/Queanbeyan population scenario of 500000 people. (This is currently thought to be achieved sometime after the year 2026, based on present population growth rates.) The Transport Planning Unit should also be consulted to determine whether the forecast traffic volumes on a particular road are likely to be higher

in the intervening period between now and the long term. Forecasts for most distributor and arterial roads are available for 1996 and for the long term , and preliminary estimates are available for the years 2001 and 2006.

Schedule 3.2 - Guidelines for new roads in new areas

Objective	Technique	Criteria
To protect future occupants of new areas from excessive levels of traffic noise	set-back of buildings from the road AND/OR acoustic barrier between buildings and the road AND/OR building design measures to provide acoustic insulation	maximum traffic noise levels,as set out in Table 3.2, measured at one metre forward of the minimum setbacks required under the Territory Plan, and based on the predicted traffic volumes* when the area is completely developed.

* Long-term traffic forecasts are available from the ACT Planning Authority's Transport Planning Unit.

3.3 Upgrading Existing Roads in Existing Areas

Proposals for upgraded roads in existing developed areas will require an assessment against the guidelines contained in Schedule 3.3. The techniques and criteria are provisions which are accepted as meeting the relevant objective without further evidence being required. Future traffic forecasts from the ACT Planning Authority's Transport Planning Unit should be obtained before an estimate of future traffic noise levels is made (see Section 3.2 above).

Schedule 3.3 - Guidelines for upgraded roads in existing areas

Objective	Technique	Criteria
To protect residents of existing areas from excessive increases in levels of traffic noise	set-back of road from adjacent buildings AND/OR acoustic barrier between buildings and the road AND/OR acoustic treatment of existing buildings	maximum traffic noise levels as set out in Table 3.3 measured at adjacent noise-sensitive land uses and based on the predicted maximum traffic flow* on the new or upgraded road.

* Long term traffic forecasts are available from the ACT Planning Authority's Transport Planning Unit.

Table 3.3 - Maximum traffic noise levels resulting from upgraded roads in existing areas, expressed as $L_{A10(18\ hour)}$ dB(A).

Existing traffic noise level at adjacent buildings[1]	Maximum traffic noise level at adjacent buildings after road works completed
> 63	equal to existing level
58 - 63	63
< 58	not more than 5 dB(A) above existing level

Notes:

1. The maximum traffic noise levels incorporate an allowance for reflection from the facade of the building under investigation. Measurements should be taken at one metre forward of the building facade. In cases where the building is not yet constructed, measurements should be taken at a distance of one metre in front of the proposed building facade, or one metre forward of the minimum set-backs required under the Territory Plan, and 2.5 dB(A) added to the measurement to allow for future facade reflection. Measurements should be taken at a height of 1.2 - 1.5 metres above ground level.

3.4 Development of New Roads in Existing Areas

Proposals for new roads in existing areas will be treated in the same way as proposals for new roads in new areas (i.e. the criteria in Table 3.2 apply in respect of noise-sensitive land uses listed in Table 3.1 which will be affected by such a new road).

4. NOISE FROM LAND USE ACTIVITIES

Excessive noise emanating from a particular building or land use can be a major cause of annoyance. This can be a function of the specific type of land use, eg a motor racing track which will be noisy whenever it is in operation, or of specific activities within a land use, eg the occasional rock concert at a club which is normally quiet at other times, or a noisy party within a residential area.

It is not possible through the development control process to fully control the latter type of noise annoyance, but action can be taken to identify those land uses that are likely to regularly generate high noise levels and to provide a degree of separation between them and noise-sensitive land uses. Excessive noise is subject to the *Noise Control Act 1988*. Planning approval does not exempt a proponent from liability under this legislation.

Where there is any doubt, in terms of noise impact on nearby residential or other noise sensitive land uses, about whether or not a proposal for a potentially noisy land use should be approved, the Environmental Planning and Assessment Section of the ACT Planning Authority should be consulted, together with the relevant section of the Office of the Environment, which reports to the Pollution Control Authority.

In planning terms there are two situations that need to be addressed -

. new noise-generating land uses near existing noise-sensitive land uses
. new noise-sensitive land uses near existing noise-generating land uses

The assessment process for each situation is virtually the reverse of the other. If noise interference between noise-generating and noise-sensitive land uses cannot be remedied by separation distances, it is necessary to look at the detailed design of the proposed land use to determine whether, in the case of new noise-generating land uses, it will limit the projection of noise or, in the case of new noise-sensitive land uses, it can be insulated from excessive noise intrusion. The assessment process is described more fully in Appendix B.

4.1 New Noise-Generating Land Uses

Not all land uses generate high levels of noise. Nor are noise-generating land uses normally sited close enough to noise-sensitive land uses to have an impact. Table 4.1 lists the land uses that will be subject to the noise assessment described in this part. They have been identified as the land uses likely to regularly generate significant levels of noise, such as mechanical noise, music, crowd noise or traffic concentration.

Generally, the land uses which are permitted in residential areas identified in the Territory Plan are not inherently noisy, and will not normally require special consideration of potential noise impacts. The exceptions are the land uses 'home business' and 'home occupation', where excessive noise has the potential to significantly reduce the amenity of neighbouring residential blocks. Noise levels likely to be produced by a home business must not exceed background noise level +5dB(A) at the nearest boundary of adjacent blocks during the day-

time, nor the background noise level during night-time hours. Care needs to be exercised in ensuring that home business activities involving trades, especially those commonly using machinery, demonstrate that noise generated by the activity can be adequately contained, by way of the activity's enclosure within a building or by some other appropriate means.

Some land uses will only have noisy activities as a minor part of the land use, eg when a building is being used by a particular group or for a particular activity. Noise emissions can also be time specific, eg noise from clubs is likely to be loudest in the evenings whereas noise from industry would usually be loudest during day-time. For assessment purposes an examination of the likely "worst case" noise generation is necessary. Care needs to be taken in considering the potential "worst case" effects on the nearest noise sensitive land uses so that, as far as practicable, unnecessary conflicts, leading to enforcement action under the *Noise Control Act 1988,* can be avoided. To minimise interference by noise-generating activities, the background noise level for the purpose of 'worst case' assessments should be taken as the lowest repeatable L_{90} value measured in a particular location where measurements are available.

This part of the guideline only applies to development proposals for land uses listed in Table 4.1. Such proposals will require an assessment against the guidelines contained in Schedule 4.1, and must meet the requirements set out in Table 2.2. The techniques and criteria are provisions which are accepted as meeting the relevant objective without further evidence being required . It is the responsibility of proponents of development to demonstrate that their proposals meet the requirements of these guidelines.

Table 4.1 - Noise-generating land uses

Land Uses	Land Uses
club community activity centre (community halls and Scout/Guide halls only) cultural facility drink establishment hotel indoor entertainment facility indoor recreation facility place of assembly place of worship religious associated use restaurant carpark (where provided for the above land uses)	animal care facility veterinary hospital freight transport facility public transport facility service station industrial trades industry municipal depot motor sports facility outdoor recreation facility playing field

Schedule 4.1 - Guidelines for new noise-generating land uses

Objective	Technique	Criteria
To prevent noise-generating land uses from creating excessive levels of noise at noise-sensitive land uses, as listed in Table 3.1.	separation from noise-sensitive land uses AND/OR acoustic barrier between noise-generating and noise-sensitive land uses AND/OR Building design measures to provide acoustic insulation within the noise-generating land use	background noise level* permissible at the boundary of the nearest noise-sensitive land use not to exceed the 'objective' level set out in Table 2.1 by more than 5dB(A)

4.2 New Noise-Sensitive Land Uses

The purpose of this section of the guideline is to ensure that existing noise-generating land uses are not unreasonably constrained by the location of new noise-sensitive land uses nearby, as well as ensuring that noise-sensitive land uses are not located in inappropriate areas.

This part of the guidelines only applies to development proposals for land uses listed in Table 3.1. Such proposals will require an assessment against the guidelines contained in Schedule 4.2. Development proposals must be consistent with the objective to meet the guideline. The techniques and criteria are provisions which are accepted without further evidence being required for meeting the relevant objective.

Schedule 4.2 - Guidelines for new noise-sensitive land uses

Objective	Techniques	Criteria
To protect existing noise-generating land uses, listed in Table 4.1, from the potential location of noise-sensitive land uses on adjacent blocks or in adjacent areas.	separation from noise-generating land uses AND/OR acoustic barrier between noise-generating and noise-sensitive land uses AND/OR Building design measures to provide acoustic insulation to buildings within the noise-sensitive land use	background noise level at the nearest boundary of the proposed noise-sensitive land use not to exceed the objective level specified in Table 2.1 by more than 5dB(A) AND/OR internal noise levels in accordance with AS 2107

5. SPECIAL CASES

5.1 Canberra Airport

Aircraft operations at, and on approach and departure paths to and from, Canberra Airport, generate significant noise levels. As a designated area under the National Capital Plan, Canberra Airport is subject to controls specified in that plan. The National Capital Plan incorporates a map indicating the currently applicable Australian Noise Exposure Forecast (ANEF) contours around Canberra Airport. (It should be noted that the ANEF for Canberra Airport is being revised by the Department of Defence.)

With the exception of guest houses and motels, the noise-sensitive land uses listed in Table 3.1 are not permitted in areas subject to aircraft noise exposure greater than 25 ANEF. Any proposals involving a change in the existing use of any land in the vicinity of Canberra Airport and any land within the 20 ANEF contour must meet the requirements set out in the table in Appendix B of the Civil Aviation Authority's guideline *The Australian Noise Exposure Forecast System and Associated Land Use Compatibility Advice for Areas in the Vicinity of Australian Airports* (4th Edition, July 1988). Guest houses and motels may be permitted within the 25 - 30 ANEF contours subject to meeting the requirements of the relevant Australian Standard *AS 2021 - Acoustics - aircraft noise intrusion - building siting and construction*.

Some people have higher sensitivity to noise, and they may find the noise exposure in the area between the 20 ANEF and 25 ANEF contours unacceptable. While it is not mandatory, developers should consider incorporation of noise attenuation features in dwellings and other buildings involving noise-sensitive uses in accordance with *Australian Standard 2021 - Acoustics - aircraft noise intrusion - building siting and construction* may be required between the 20 ANEF and 25 ANEF contours.

In areas outside the 20 ANEF contour, most people are not considered to be significantly adversely affected by aircraft noise, but noise-sensitive individuals may still consider themselves to be moderately or seriously adversely affected by aircraft noise.

5.2 Quarries

Quarries generate both intermittent noise and vibration from blasting operations and noise from machinery. The Territory Plan stipulates that existing quarry operations are to be protected from constraints imposed by adjacent development. A buffer zone of one kilometre (1km) is to be maintained around existing quarry sites to ensure protection of adjacent areas from quarrying activities. Within this buffer zone only development free of constraints on quarry operations will be permitted.

Proposals for new quarries are subject to individual assessment by the ACT Planning Authority and the Pollution Control Authority.

5.3 Motor Sports Areas

Motor sport activities produce high levels of noise. For planning purposes, any new motor sport facilities must be designed to ensure that noise levels produced by motor sport activities will not exceed the background noise level +5dB(A) at the nearest affected residence during day-time, nor the background noise level during night-time. Furthermore, to ensure ongoing compliance and to protect the viability of motor sports areas, restrictions apply to the establishment of new noise-sensitive land uses in the vicinity of existing and proposed motor sport sites.

For new noise-sensitive land uses (listed in Table 3.1), there must be:

. adequate separation from a motor sport area so that the ambient noise level at the block boundary of the nearest noise-sensitive land use (or at a measurement point between 30 - 50 metres from the nearest facade of a rural residence where the block boundary is a greater distance from that residence) does not exceed the background noise level by more than 5dB(A) between 0700 and 2200, nor the background noise between 2200 and 0700, and/or

. protection by suitable noise attenuation barriers to achieve background noise levels listed above, and/or

. buildings must be designed in accordance with *Australian Standard 2107 - Acoustics - Recommended design sound levels and reverberation times for building interiors.*

The proponent of any proposal for location of a new noise-sensitive land use within five kilometres (5km) of a motor sport area will need to provide a noise assessment demonstrating that external noise levels will not exceed the background noise level +5dB(A) during day time (0700 - 2200) nor the background noise level during night time (2200 - 0700) at the boundary of the nearest noise-sensitive land use (or, in the case of rural residences, at a point between 30 - 50m from the nearest facade of the residence).

5.4 Mechanical Plant and Equipment

Noise produced by mechanical plant and equipment is subject to control under the *Noise Control Act 1988.* Accordingly, mechanical plant and equipment associated with buildings and land use activities, such as air conditioning units, generators, compressors or pumps (including pool pumps), should be sited and/or acoustically screened to minimise potential impacts on adjacent lessees.

5.5 Construction Activities

Noise from construction activities is not subject to planning approval. The level of noise and times of construction activity are controlled by the Pollution Control Authority.

NOTE

The following appendices are provided to assist proponents and the general public in understanding and applying the guidelines presented in the preceding sections.

These appendices do not form part of the formal guidelines to which the ACT Planning Authority will have regard in accordance with the Territory Plan.

Appendix A Assessment Process for Developments Next to Existing Roads

A.1 Traffic Noise

In relation to the noise level criteria set out in Table 3.2, most roads in Canberra do not generate excessive levels of traffic noise. Based on noise modelling of various traffic volumes, the threshold beyond which road traffic could normally generate excessive noise levels at standard building set-backs on collector and distributor roads (where the average speed of traffic is 60kph or less) is about 5200 vehicles per day. Figure 3.1 in the guideline illustrates those roads in the ACT which carry more traffic than this figure.

This does not mean that every building along these roads suffers from excessive noise intrusion. The individual site and building characteristics, such as set-back from the road, slope of the land, shielding from the road and orientation of the building, must be taken into account in determining whether traffic noise may be a problem.

Along many of the major roads in Canberra, adequate set-backs and/or noise reduction measures have already been provided, including earth mounds, screens or buffer zones along road edges.

A.2 Noise Reduction Techniques

A choice of three noise reduction techniques is available by which a development could be protected from traffic noise intrusion -

. set-back of the building from the road;

. some form of acoustic barrier between the building and the road;

. building design measures to provide acoustic insulation within the building itself.

These techniques form a hierarchy of options, ie if the criterion relating to the first technique cannot be met, then the second technique can still be used to meet the guideline, and so on down the list. This is explained below.

A.3 Set-backs

Building set-back is the simplest technique in both the planning of a development and in the assessment of compliance with the noise level criteria. Given that noise level decreases as the distance from the source increases and that the noise level of traffic can be predicted, it is possible to establish standard set-backs for specified traffic volumes that will ensure compliance with a given noise level criterion. The acceptable traffic noise level criteria to applying to new developments in the ACT are stated in Table 3.2 of the guidelines.

Tables A.1 and A.2 provide examples of the minimum set-back distances (from the nearside kerb of the adjacent road) for given traffic volumes and ground conditions that are sufficient to meet the acceptable levels of 63dB(A)$_{L10\ 18\text{-hour}}$ and 75 dB(A)$_{L10\ 18\text{-hour}}$ respectively (measured at a point one metre in front of the building facade), in the absence of any other noise reduction measures. The set-back distances are indicative, since variations in road grades, percentage of heavy vehicles and proposals for multi-storey buildings will influence the actual set-back distance required in the absence of other measures. In some areas, such as in Civic, where planning policies require specific minimum set-back distances which, by themselves, will not produce an adequate level of noise attenuation, building design to meet the internal noise levels in *Australian Standard 2107 - Acoustics - Recommended design sound levels and reverberation times for building interiors* will be necessary.

In determining the set-backs in Tables A.1 and A.2, it has been necessary to simplify and standardise the conditions under which predictions have been made of likely noise levels at various distances from a road. Consequently the application of the set-back distances on some specific blocks may appear to be very conservative. It should be remembered that, in many established Canberra suburbs, the verge widths vary from 6m to as much as 11m, with dwellings set back a minimum of 6m (rather than the current minimum set-back of 4m from the front block boundary). Thus, from Table A.1, the traffic volume on a particular road or street would need to be 7000 - 8000 vehicles per day (or more) in one of the established suburbs before the current noise guideline value is exceeded. Where the traffic volume is higher than 5400 vehicles per day, this does not preclude development but requires closer examination of the noise levels at the block.

In **multi-level** residential buildings, the **set-back distance** necessary to achieve a traffic related noise level not exceeding 63dB(A) at a point one metre in front of the building facade at each level **increases with height**. This occurs because of progressive reduction in the ground attenuation factor with increasing height.

As an example, using Table A.1, and assuming a traffic volume of 6000 vehicles per day, the set-back distance necessary at the ground floor level is 10m, at the 1st floor level it is 14m and at the 2nd floor level it is 15.5m. **Thus care must be used when estimating the noise levels external to the facade at various levels of a multi-storey dwelling.**

Table A.1 - Indicative set-backs for noise-sensitive land uses (listed in Table 3.1) to achieve 63 $L_{A10(18hour)}$ dB(A) criterion.

Vehicle Flow/Day[1]	Soft ground
<5200	normal design and siting regulations apply
6000	10m
8000	12m
10000	14m
12000	16m
14000	18m
16000	20m
>16000	*

* Set-back distances from roads with higher vehicle flows, where no other form of acoustic protection is provided, are not stated as they are unlikely to able to be accommodated on typically-sized blocks. Similarly, attenuation of noise over hard ground is virtually non-existent, and traffic volumes >3300 vehicles per day cause the guideline values in Table 3.2 to be exceeded at one metre in front of the building line, and assuming standard set-backs. Note also that the distances shown in Table A1 include the one metre between the facade and the measurement point. These set-back distances are measured from the nearside kerb of the road which is the primary source of traffic noise to the building line.

1 Assumes a zoned speed of 60kph (which equates to an average speed of around 57kph), heavy vehicles comprising 4% of traffic and an average grade of 2%.

Table A.2 - Indicative set-backs for commercial land uses likely to achieve 75 $L_{A10(18hour)}$ dB(A) criterion.

	Hard ground		Soft ground	
	Zoned Speed	Zoned Speed	Zoned Speed	Zoned Speed
Vehicle Flow/Day[1]	60 kph	80 kph	60 kph	80 kph
10000	*	5m	*	*
12000	*	7m	*	*
13000	*	8m	*	*
14000	*	9m	*	*
15000	*	9m	*	*
20000	6m	13m	*	6m
25000	8m	17m	*	7m
30000	10m	21m	*	8m
35000	12m	25m	*	9m
40000	14m	29m	6m	10m

* - Set-backs not required for noise mitigation.
[1] Assumes 5% of traffic comprises heavy vehicles, and an average road grade of 2%..

Notes for Tables A.1 and A.2

Vehicle flow is between 0600 and 2400 hours on an average weekday, and for most Canberra roads, this represents average weekday traffic. (Samples of mid-block counts for various road types indicate that the 18-hour flows represent more than 95% of average weekday flows.)

Where vehicle flows fall between the figures in the tables, the set-back distances should be increased pro-rata.

Ground type refers to the nature of the intervening ground between the noise source and the receiver. Hard ground means a majority of hard surfaces such as carparks. Soft ground means a majority of vegetated areas, ie grass, shrubs or trees. The calculated values in the tables assume the existence of a 1.2m wide footpath between the road kerb and the boundary of adjacent blocks.

The distances are from the edge of the nearest carriageway to the facade of the building.

Sloping ground - The distances in the tables are based on a 2% slope. As a guide, these distances should be increased by approx. 10% where the road gradient is between 3% and 5%, and by 25% when the gradient is 6% to 7%. There are few road gradients in Canberra greater than 7%, and in those few cases, the average speed is likely to be rather less than the 60kph zoned speed limit. In situations where the road gradient is more than 7%, a separate assessment should be undertaken after consultation with the ACTPA Transport Planning Unit.

A.4 Acoustic Barriers

Where it is neither possible nor desirable to site a building far enough away from the nearest road kerb to meet the set-backs in Tables A.1 or A.2, the incorporation of some form of barrier between the road and the building to interrupt the path of the sound waves may reduce the noise level at the building line to meet the acceptable levels in Table 3.2.

In the case of medium density development where an acceptable noise level is specified for a private outdoor space, an acoustic barrier may be necessary around that space to provide noise protection, particularly where the space is between the building and the road. Where the private outdoor space is on the side of the building away from the major road, the building itself acts as a form of barrier and this should be sufficient to achieve the acceptable noise levels.

The placement of acoustic barriers will need careful attention, and a high standard of construction will be required, to ensure the desired noise reduction is achieved. As the barrier is an external structure it will also need to meet other design and siting requirements under the Territory Plan. Further advice on barriers is set out in Appendix D.

Although it may be desirable to build closer to the road than the set-back distances set out in Tables A.1 or A.2 through the provision of an acoustic barrier, it should be noted that a minimum set-back may still be required to meet other performance criteria in the Territory Plan, eg. particular design and siting requirements applying to particular precincts.

A.5 Building design

If an acceptable acoustic barrier is still not sufficient for the criteria in Table 3.2 to be met or it is not possible or desirable for other reasons to provide an acoustic barrier, it is still possible to achieve acceptable internal noise levels through the design of the building. This involves the selection of appropriate building materials to provide acoustical insulation, the design of windows, doors and other openings to lessen the entry of noise, and the placement of rooms within the building to keep noise-sensitive activities away from a road or other noise sources. Further advice on building design is included in Appendix D.

Achievement of an acceptable indoor noise level can be determined using the *Australian Standard 3671 - Acoustics - Road traffic noise intrusion - building siting and construction*, which sets out guidelines for determining the type of building construction necessary to achieve acceptable indoor noise levels as recommended in *Australian Standard 2107 - Acoustics - Recommended design sound levels and reverberation times for building interiors.*

The procedure specified in AS 3671 is to calculate the difference between the traffic noise level at the external facade and the recommended indoor noise level from AS 2107 for the room type behind the facade. Depending on the traffic noise reduction (TNR) required, the building construction is categorised into one of four categories -

1. Standard construction with open windows;

2. Standard construction, excluding lightweight materials such as metal cladding and all-glass facades, and windows and other openings closed;

3. Special construction, determined in accordance with the Australian Standard, with windows and other openings closed; and

4. Special acoustic advice should be sought.

The required category is calculated as follows -

if TNR ≤ 10dB(A)	category 1 applies
if 10 < TNR ≤ 25dB(A)	category 2 applies
if 25 < TNR ≤ 35dB(A)	category 3 applies
if TNR > 35dB(A)	category 4 applies

For example, if the noise level external to a residencial building is 69dB(A) and the recommended maximum indoor noise level for a living area is 43dB(A), then category 3 would apply as the TNR is 26dB(A).

Appendix B Assessment Process for Noise From Land Use Activities

The determination of noise impacts from land use activities is usually case-specific and fairly complex to calculate. It is therefore not possible to give simple advice on what situations are likely to comply with the Guidelines. It is recommended that proponents seek professional acoustics advice for development proposals that fall within the scope of Section 4 of the Guidelines.

This section describes the general assessment process for determining whether there is likely to be any noise interference between a noise-generating land use and a noise-sensitive land use. A two stage assessment process needs to be applied in this situation. The first stage is to determine whether the noise-generating land use is sufficiently separated from noise-sensitive land uses to prevent unacceptable noise interference. Given that the possible siting relationships between noise-generating and noise-sensitive activities are more variable compared to the predicability of the road layout, the examination of distances between land uses is necessary rather than just establishing set-backs from block boundaries. If this separation is not possible or desirable, then the likely background noise level at the noise-sensitive land use needs to be assessed to determine whether it would be acceptable.

For new noise-generating land uses in residential areas, it is necessary to compare the level of the new noise source with the existing background noise level to see whether it would be noticeable. For a new noise-generating land use external to a residential area or other noise sensitive land use, the existing background noise level in that area needs to be compared with the objective level in Table 2.1. The noise constraints on the new noise source may be stricter than the criterion in Schedule 4.1 if the existing background noise level at the nearest noise-sensitive land use is already close to or exceeds the objective level. This process aims to ensure that the background noise levels in noise-sensitive areas do not creep up over time.

Noise control techniques which could be used at the noise-generating land use include acoustic barriers between the building and the noise-sensitive land uses, and building design, such as locating the building entries or noisiest rooms on the side of the building away from noise-sensitive land use, and incorporating acoustic insulation into the building during construction. As well as purpose-built acoustic barriers, such as walls or earth mounds, it may be possible to use as barriers buildings which would be unaffected by the likely noise levels, such as a commercial building.

For proposals to locate new noise-sensitive land uses near existing noise-generating land uses, the onus is on the new land use to adapt to the existing noise level. If the background noise level at the noise-sensitive land use is already below the objective level in Table 2.1, then there is no need for further concern. If the background noise level is higher than the objective level, then further noise assessment will be required. Noise control techniques that could be used include placing windows and/or the most sensitive rooms, such as bedrooms, on the side of the building away from the noise-generating land use, or incorporating acoustic insulation material into the ceilings and walls of the building. Generally, however, adequate separation distances from, and/or construction of acoustic barriers between, the existing noise-generating

land use will be necessary to achieve the background noise levels set out in Table 2.1 in the guidelines.

Appendix C Characteristics Of Noise

C.1 Properties

Noise can be defined as unwanted or objectionable sound. Sound is a form of energy detectable by the human ear and is produced when an object vibrates or by air turbulence. The sound energy is transmitted by the surrounding medium, usually air, causing pressure variations or "sound waves" among the air particles. These waves spread outward from the source, and along their path the waves can reflect off surfaces, bend around obstacles and be absorbed by insulating materials. To the human ear, these pressure variations are interpreted as "sound".

The magnitude of variations in air pressure associated with the sound wave results in the quality referred to as "loudness". Human ears respond to a wide range of sound pressures, eg the sound pressure near a powerful jet engine may be a million times the sound pressure of a very quiet whisper. The size of these numbers is awkward to use arithmetically so it has become customary to express sound magnitude on a logarithmic scale. The units of this scale are decibels (dB).

Another characteristic of sound which is included in the measurement is frequency. Frequency refers to the number of times per second the object producing the sound vibrates, from the low frequency of a bass drum or guitar to the high frequency of the whining sound of an aircraft jet. The human ear is most sensitive to mid-band or high frequencies (2-4000 Hz) and less to sound in the lower frequency range. Thus a low-frequency sound of high sound pressure can seem just as loud to the human ear as a high-frequency sound of lower sound pressure. Because of these variations, a system has been developed to weight the sound pressure at various frequencies to more closely correspond with human response. Under this system reflecting human response to noise, sound pressure levels are expressed in A-weighted decibels or dB(A). A quiet bedroom would be about 30dB(A), a busy office could be up to55 dB(A) and some jet aircraft 250m away would produce noise levels of more than 100dB(A).

In general, a 1dB(A) change in sound level can hardly be detected by the human ear; recognition of a change in sound usually occurs when the new sound level changes by about 3dB(A). A 5dB(A) change is clearly noticeable and a 10dB(A) change will be perceived as nearly twice as loud. Thus a noise of 70dB(A) is about twice as loud as 60dB(A) and four times as loud as 50dB(A). A doubling of sound pressure, for example when two identical noise sources are generating sound together, is not experienced as twice as loud and is only 3dB(A) higher than either of the single noise sources. If two unequal noise sources are brought together and the difference between the two sound levels is greater than about 10dB(A), the lesser sound is negligible in terms of affecting the total sound level. For standard atmospheric conditions, sound intensity and sound pressure are equal.

Sound level diminishes as the distance from the source increases. For a point source of sound, the sound level will drop about 6dB(A) if the distance from the source is doubled (assuming that the intervening terrain comprises soft ground). However a stream of vehicles on a road is regarded as a line source of sound and the rate of attenuation is different to sound from a point source. The sound level will drop only about 3-4dB(A) for a doubling of distance from the road. To get a halving of the perceived loudness of the noise from road traffic (ie a 10dB(A) reduction) the distance between the noise source and the receiver must increase over four times.

The propagation of noise from the source to the receiving point is also influenced by the:

. ground profile between the source and the receiver (whether level, sloping up or down, or uneven);
. nature of the ground between the source and receiver (whether vegetated or hard surfaced);
. extent of screening between source and receiver (e.g. mounds or barriers);
. weather conditions (wind, air temperature, humidity).

C.2 Noise Descriptors

Annoyance due to noise is associated not only with its loudness but also with how often the noise is present, what time of day the noise occurs and how long the noise lasts. The noise at any location may fluctuate from quiet one moment to loud the next. To adequately describe a noise environment it is necessary to quantify the variation in noise level over time.

The descriptor adopted for use in the ACT is the *percentile A-weighted sound pressure level* (abbreviated as $L_{A\%,T}$), which is the A-weighted sound pressure level that is exceeded for a percentage of the time interval T being considered. The noise level descriptors used in these guidelines are -

$L_{A10,1hour}$ - the level that is exceeded for 10% of a one hour period. This is used to describe the maximum general noise level allowable in areas which are occupied for only short periods at a time, eg pedestrian areas.

$L_{A10(18hour)}$ - the level that is exceeded for 10% of an 18 hour period. In practice this is calculated as the arithmetic average of the 18 individual $L_{A10,1hour}$ values between 0600 and 2400 hours on an average weekday. This is used to describe the maximum traffic noise level permissible at a point one metre forward of a building facade, but it may also be used to describe ambient noise levels in an area.

$L_{A90,T}$ - the level that is exceeded for 90% of the specified time T. This is used to describe the background noise level of an area over the specified time period, against which the introduction of new noise sources can be compared. For the purposes of these guidelines, it has been assumed that background noise levels set in Table 2.1 relate to day time (0700 - 2200) and night time (2200 - 0700) as defined in the *Noise Control Act 1988*.

Appendix D Methods To Reduce Noise In Buildings*

This part provides general advice on methods to reduce noise in buildings to assist proponents in the design stage of developments. The detailed design of noise reduction measures would need to be based on the particular circumstances of the proposed land use and the chosen site. It should be noted that not all methods will be able to be used in all cases, owing to other considerations, such as design and siting regulations and other development controls.

D.1 Site Planning

Site planning involves the arrangement of buildings on a site to minimise the effect of noise. Some principles are:

- placing as much distance as possible between the noise source, such as a road, and the building;
- placing noise-tolerant areas such as carparks, open space and garages between the noise source and the noise-sensitive areas. On a larger scale, residential areas could be separated from noise sources by open space, recreation areas or commercial facilities;
- using a building or structure as a barrier to protect or shield the areas behind it, eg a dwelling with a courtyard on the side away from the road for private outdoor space. In medium density residential developments, dwellings adjacent to the road can form a barrier for the dwellings behind.
- using natural features such as slopes in the building design, eg cutting the building site into the slope to provide shielding from noise
- using excavated material on site to form mounds around the building to provide protection.

D.2 Noise Barriers

A noise barrier is a solid mass placed between a noise source and a receiver which interrupts the path of the noise and thus reduces noise levels behind the barrier. Barriers can reduce noise levels by up to about 20 dB(A), depending on the relative positions of noise source and receiver. A barrier can take the form of either a screen wall or an earth mound (or a combination of both). Barriers are good for reducing noise levels in outdoor living areas but are not as effective at reducing indoor noise levels as acoustic protection within the building itself.

To be effective, a barrier must block the "line of sight" between the noise source and receiver. A barrier must also be continuous and solid with few, if any, holes, cracks or openings. The higher and longer the barrier the better, although there are restrictions on

* Much of this material is taken from *A guide to the reduction of traffic noise*, Vic. Road Const.Authority, 1985

height, materials and location under the Authority's design and siting policies. The choice of a particular type of barrier will also depend on consideration of available space, cost,

aesthetics and desired level of sound reduction. The visual impact of a barrier as seen from the street is an important aspect of maintaining an attractive streetscape. The incorporation of landscaping such as trees, shrubs and climbers with a barrier will soften its appearance.

Bricks and concrete blocks have the best sound reducing properties for screen walls. Lighter materials such as timber boarding are also acceptable provided that the other conditions of height, length and continuity are met. The wall material should have a mass of at least 10 kg per square metre to have sufficient density to reduce the sound transmitted through the barrier. Fibre-cement and 20mm thick timber are dense enough to meet this requirement.

Screens must be solidly built to be effective as noise barriers. There must be no clearance gap under a fence. If planks or sheets are used they must be tight fitting so there are no cracks, with the design also taking into consideration the future ageing and warping of timber. A 'lapped' treatment, with adjoining elements of the fence or structure overlapping and preventing the formation of gaps over time, is preferable. The driveway or entry path must also be effectively screened or much of the benefit of the screen will be lost. Gates must be of solid construction and as high as the screen, with rebated meeting edges to eliminate gaps. The gap along the base of the gate must be as small as possible. An alternative to having gates across a driveway is to return the fence down the side of the drive to join up with the building, thus excluding the driveway area from noise protection.

Traffic noise is effectively generated from all points on the line of a road as the traffic moves along it. A noise barrier thus needs to be very long if sound is not to reach the receiver around the end of the barrier. The ideal would be to have a continuous fence down the edge of the street, but this is not possible in Canberra for other urban design reasons. An alternative is to return the fence down the side boundaries or to join up with the side of the dwelling, thus creating a "wrap around" effect for the area that requires noise protection, subject to design and siting requirements.

If long solid walls are not desired or allowed, or protection of outdoor space is not desired, a simpler alternative is to screen the window and door openings only in a dwelling, eg constructing fin walls between the opening and the street with a return at the end of the fin to shield the opening.

Mounds provide a similar level of protection to walls but take up more land and are less flexible in their placement. On the other hand it is easier to integrate mounding into the landscape with vegetation plantings on and around the mound. A combination of a small mound with a screen on top of the mound can form an attractive and effective barrier.

Vegetation by itself can absorb and scatter sound waves but is not effective as a noise barrier because it is not solid. To be effective as a noise barrier, a strip of vegetation would have to be densely planted, between 15 to 30 metres wide, and with thick trunks and dense branches. Of course, screening a road with vegetation can reduce people's perception of the local environment and thus reduce the perceived annoyance of a road.

D.3 Building Design

The design of the building in accordance with noise protection principles can significantly reduce noise intrusion into internal areas. This involves such aspects as building height, room arrangement and placement of openings.

Single storey buildings generally have greater potential for protection from noise intrusion than multistorey buildings, as the upper storeys have reduced shielding from noise barriers and other buildings (unless all the buildings in the area are of similar height) and because the level of ground absorption of the sound waves from the source is reduced. In addition, balconies on upper storeys can often act as channels of noise into internal areas.

Rooms should be arranged within the building so that noise-sensitive areas such as bedrooms are placed furthest from the source of noise. Noise-tolerant areas such as bathrooms, laundries, garages and store rooms should be placed closest to the noise source to act as a buffer for the more sensitive areas.

Noise entering the building can be reduced by eliminating, or reducing the size of, windows which face the noise source, and placing windows and doors wherever possible on sheltered sides of the building. For rooms with windows or doors perpendicular to the noise source, the noise impact can be reduced by fin walls next to the opening as described in section D.2.

With all of the above design considerations, it may be necessary to make trade-offs because of the need to comply with the requirements of other guidelines (such as energy guidelines), as well as design and siting policies. careful attention to design should, however, offer potential for significantly reducing internal noise levels in most instances.

D.4 Building Construction

One of the most effective ways of reducing noise is the selection at the design and construction stage of appropriate building materials which provide acoustic protection. In assessing materials it is necessary to distinguish between sound insulation and sound absorption. Insulating material minimises the passage of sound from one side of the material to the other by reflecting most of the sound away. It thus needs to be non-porous, heavy and tightly joined. On the other hand, absorbing material "mops up" the sound that hits it and is composed of porous, fibrous or cellular material with continuous air passages deep into its interior. The best noise barrier for a given total weight is multiple layers of insulating material with air spaces or absorbent material in between.

The overall noise reduction within a building is related to the performance of its parts. The attenuation of sound through a wall area depends primarily on 3 factors:

. the wall mass per unit area;
. the size of the window area;
. the extent of openings or cracks.

There is little advantage in improving the noise reducing properties of one part or component of a building if other parts or components have much lower noise reducing properties. Windows and doors that fit loosely or hollow core doors and thin window glass with

insufficient mass to control noise reduce the insulation effectiveness of walls substantially, even when openings are kept closed.

Walls

The maximum noise reduction of some wall types, assuming no openings, are -

timber stud framing with weatherboards	26 dB(A)
conventional brick veneer	40 dB(A)
double brick	44 dB(A)
poured dense concrete, 100mm thick	50 dB(A)

100mm thick thermal insulation batts placed in the first 3 walls above will improve the acoustic performance by 5 dB(A). Acoustic tiles attached to walls or ceilings will not greatly reduce the sound transmission through the material to which they are attached, but will reduce reflected noise within the room.

Cracks or gaps can significantly reduce the insulation effectiveness of walls. As an example, if a brick wall with a high sound transmission loss of about 44dB(A) has a gap (say a linear crack about 5mm wide) which represents only 1/1000th of the total wall area, the effective sound transmission loss can be reduced by up to one third.

Some points for close attention are: timber jambs around doorways particularly in masonry walls; window frames in masonry walls; sealing of doors and openable windows; cracks under doors; ventilation openings in walls and ceilings; and holes cut for pipes, ducts or conduits. Cracks and gaps can be easily eliminated through the use of sealants and gaskets. Ventilation openings can be lined and surrounded with sound absorbing material or located only on the shielded sides of buildings.

Windows

Building interiors require lighting and ventilation which can be supplied through windows or artificially. A solid wall without windows would be the ideal form of acoustic protection but this is not always the most desirable option. Walls with fixed windows are the next best option, but some form of mechanical ventilation may be required.

The maximum noise reduction of some window types, assuming they are closed, are -

fixed double-glazed, 6mm glass	40 dB(A)
openable double-glazed, 6mm glass	35 dB(A)
openable double-glazed, 4mm glass	30 dB(A)
fixed single-glazed, 12mm glass	35 dB(A)
fixed single-glazed, 6mm glass	30 dB(A)
fixed single-glazed, 3mm glass	25 dB(A)
openable single-glazed, 3mm glass	20 dB(A)

The effectiveness of double-glazing is improved by increasing the distance between the panes. The air space between the panes should be at least 50mm but preferably 100mm or

more. Double-glazing with only about 20mm space is no more effective than a single pane of glass of an equivalent thickness to the 2 sheets of glass in the double glazed unit. Heavy curtains do not greatly affect the amount of noise actually coming in through windows, but will absorb reflected sound within the room by up to 3 dB(A).

Ceilings and roofs

A concrete tiled pitched roof with a plasterboard ceiling reduces traffic noise by about 27 dB(A). Thermal insulation material 100mm thick placed above the ceiling can improve the noise reduction by 5-7 dB(A). Insulation should also be placed in the eaves space to eliminate any gap between wall and ceiling.