Carrying Out Noise Assessments for Proposed Supermarket Developments

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ABSTRACT

Whether they are small independent stores or larger multi faceted complexes, the potential for noise impacts from supermarket developments is considerable. A thorough assessment of all potential noise sources associated with the development should be undertaken. Ideally such an assessment should be conducted at the design stage to assist in minimising the noise impact on the surrounding community, as far as reasonably practicable. The aim of this paper is to discuss the various issues encountered when assessing proposed supermarket and associated developments, the variety of noise sources and mitigation measures.

INTRODUCTION

New supermarket developments can evoke mixed feelings in the community. Whilst offering a new, often more convenient shopping experience they bring with them the potential for significant impacts to neighbouring residents in the immediate vicinity.

To ensure a strong customer base and remain financially viable sites are often chosen close to existing residential areas. Alternatively existing stores near residences may be upgraded and renovated into larger supermarkets, increasing both their size and operating hours.

As well as determining and applying the relevant noise criteria there are a wide variety of potential noise sources associated with these developments to consider. For instance the refrigeration and air-conditioning plant not only for the supermarket but also any specialty shops may run 24 hours per day, seven days per week.

Noise levels from on site waste collection may often cause sleep disturbance. Trucks in the loading bay with or without refrigeration motors running should be assessed in addition to the increase in on-road traffic noise. Will there be cafes or restaurants in the specialty shops?

Consideration may need to be given to alfresco dining patron noise; will they sell liquor and have amplified music? Does the development in-corporate its own residential premises?

The cumulative affect of these noise sources can be significant and may require extensive mitigation measures to meet the relevant noise goals.

SITE SITUATIONS

The location of a proposed development has a significant influence on the success of acoustical aspects of the development application. Generally supermarkets are located within or close to residential areas to ensure their viability. It is good practice to locate noise producing aspects of the development as far away from neighbouring residences as practicable, particularly for example, loading docks.

It is therefore preferable for an acoustical consultant to be involved at the design stage where suggestions can be made to the proponent to minimise noise impacts from the outset. Unfortunately however, in many instances the layout and design of the supermarket development is already determined or the buildings currently exist and are to be upgraded or refurbished before the acoustical consultant becomes involved.

In some instances a noise impact assessment may also be required for an existing development with no proposed alterations, for example, as a result of noise complaints.

The extent of the noise impact will also be affected by the operating hours of the development. From an acoustical point of view the worst-case scenario for a supermarket development is therefore one operating past 10 pm and / or before 7 am with residential neighbours at each of the shared boundaries.

Consideration may also need to be given to any potential new residences associated with the new development. Whilst this may not often occur, some proposed developments may incorporate a supermarket, specialty shops and residential premises,; generally units above the commercial areas. Where this does occur the proposed residential premises may often be closer to noise making aspects of the development than existing residential neighbours.

There is also the potential for existing commercial or industrial neighbours and although noise criteria are less stringent, these too must be considered.

NSW NOISE CRITERIA

The New South Wales (NSW) Government, via the Department of the Environment and Climate Change - DECC (incorporating the Environment Protection Authority - EPA) provides guidelines for many industrial, commercial and domestic types of noise sources.

There are various noise criteria which may be applicable to the various aspects of supermarket developments. This paper covers NSW criteria and criteria for other states or countries can be obtained from the local regulatory authorities.

Protection of the Environment Operations Act

The legal framework and the basis for managing unacceptable noise within the environment is given in the NSW Protection of the Environment Operations Act 1997 (POEO Act) and the Protection of the Environment (Noise Control) Regulation 2008.

The POEO Act identifies and allocates responsibility for regulating noise, provides a range of tools to address noise and identifies offensive noise. Offensive noise is defined in the POEO Act as being noise:

a) that, by reason of its level, nature, character or quality, or the time at which it is made, or other circumstances:

i. Is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or

ii. Interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

b) that, is of a level, nature, character or quality prescribed by the regulations or that is made at a time or in other circumstances, prescribed by the regulations.

Local Council Requirements

Often the local council assessing the development application will have their own Development Control Plan (DCP) that may address noise from commercial premises. It is important to check with the relevant local council or the proponent to determine if such a DCP exists. In many cases noise from commercial premises criteria contained within a DCP is based on the NSW Industrial Noise Policy 2000 (INP), in part, although may be adapted to become more or less stringent.

The following is an example of a typical council DCP noise condition.

> All noise generating equipment such as mechanical plant or equipment, air conditioning units, swimming pool filters, fixed vacuum systems, mechanical ventilation from car parks, driveway entry shutters, garbage collection areas or similar must be designed to protect the acoustic privacy of residents and neighbours. All such noise generating equipment must be acoustically screened. The noise level generated by any equipment must not exceed a LAeq, 15 minute of 5 dB above background noise at the property boundary.

These are usually generic by nature to cover a wide variety of noise sources. In addition to a generic requirement within a DCP, council may set specific development consent conditions for the proposal and again these may be more or less stringent than those given in the INP.

NSW Government's Industrial Noise Policy 2000

The Industrial Noise Policy 2000 (INP) is non-mandatory and designed for scheduled premises (premises where a scheduled activity is undertaken, as defined by the POEO Act 1997). However local government find the policy useful in carrying out its land-use planning responsibilities when setting targets for supermarket developments.

The assessment procedure for industrial noise sources given in the INP has two components:-

- Controlling intrusive noise impacts; and
- Maintaining noise level amenity;

In assessing the noise impact of industrial or commercial noise sources all components must be taken into account for residential receivers, but, in most cases, only one will become the limiting criterion.

The project-specific noise goals (day, evening and night) reflect the most stringent noise level requirement. It is derived from intrusive and amenity criteria and this is used to set a benchmark against which noise impacts and the need for noise mitigation are assessed.

Intrusiveness Noise Impacts

The Industrial Noise Policy (2000) states that:-

> The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the LAeq descriptor) measured over a 15 minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB.' Thus, when considering the environmental consequence of noise from a specific source, any increase above the background sound pressure level, which exceeds 5 dB, may be offensive.

The perception of noise and its level of offensiveness depend greatly on the broader situation within which it occurs. Noise that might intrude into a resting or sleeping place may be found offensive whereas the same noise occurring in a market place or noisy working area may pass unnoticed. The concept of 'background + 5 dB' derives from this consideration.

The NSW Government state that where the existing background noise level at the receptor is less than 30 dBA, as may occur in a quiet suburban or rural area, then 30 dBA should be assumed to be the existing background noise level.

Where the noise source contains characteristics such as prominent tonal components, impulsiveness, intermittency, irregularity or dominant low-frequency, content adjustments to the measured level are applied to allow

for the increase in the annoyance value. These can be seen in detail in the INP, Section 4, Table 4.1.

Protecting Noise Amenity

The INP provides acceptable ambient noise levels that should not be exceeded by industrial sources in order to limit continuing increases in noise levels in given areas. These are shown in the INP, Section 2, Table 2.1. As an example, for residential areas in a suburban area the acceptable noise levels ANL (L_{Aeq}) are 55 dBA daytime, 45 dBA evening time and 40 dBA night time. The maximum allowable noise levels are 60 dBA, 50 dBA and 45 dBA respectively.

In assessing supermarket developments these project-specific noise goals from the INP will apply to noise levels arising from, for example, mechanical plant and loading dock activity.

Sleep Arousal Criteria

The NSW Government recognises that many short-term high-level noises which occur at night may comply with criteria (given in the INP) and yet be undesirable because of the sleep disturbance or arousal effect. Sleep arousal is a function of both the noise level and the duration of the noise. Not all people are affected to the same degree by noise and, at different times, a person will be more or less affected by the same noise.

Even in cases where a person is not awoken by noise, that person's sleep may be affected. The effects of noise on sleep therefore cannot be predicted with any degree of accuracy. Noise control should be applied with the general intent to protect people from sleep disturbance. If the noise level that is exceeded for 1% of any one-minute period ($L_{A1,1\ minute}$) of any specific noise source does not exceed the background level ($L_{A90,\ 15\ minute}$) when the source noise is not present, by more than 15 dB when measured outside of the bedroom window sleep disturbance is unlikely to occur. (Noise Guide for Local Government 2004).

Sleep arousal criteria will only apply to noise that occurs after 10.00 pm or before 7.00 am, for example car park activity and waste collection.

The Noise Guide for Local Government (2004)

In addition, the Noise Guide for Local Government published by the Department of Environment and Climate Change (NSW) states: -

> A noise source is generally considered to be intrusive if noise from the source, when measured over a 15 minute period exceeds the background noise by more than 5 dB.

It is assessed at the most affected point on or within the neighbouring residential property (unless that residence is more than 30 metres from the boundary). Intrusive noise can represent offensive noise. However, it is stated in the Noise Guide for Local Government that this is not always the case and it can depend upon the source of the noise, noise characteristics and cumulative noise levels.

Environmental Criteria for Road Traffic Noise

New supermarket developments invariably require cause an increase in on-road traffic and hence on-road traffic noise. The NSW Government has produced criteria for road traffic noise *'Environmental Criteria for Road Traffic Noise'* (May 1999). This provides criteria for land use developments with

potential to create additional traffic on various roads.

The criterion for developments with potential to create additional traffic on local roads is 55 dBA ($L_{Aeq, 1\ hour}$) for day time (07:00 hours until 22:00 hours) and 50 dBA for night time (22:00 hours until 07:00 hours). For developments with potential to create additional traffic on collector roads, free-ways or arterials the criteria are 60 dBA ($L_{Aeq, 1\ hour}$) for day time and 55 dBA for night time.

Where the criterion is already exceeded the document states:-

> In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB.

These criteria refer to additional traffic created by the development not to the existing traffic or traffic from other developments.

On-road delivery vehicles should be assessed as part of on-road traffic noise predictions against the traffic noise criteria. Once delivery vehicles enter the site to gain access to the loading dock and whilst in the dock they are subject addition-ally to the INP criteria as outlined previously.

Liquor Administration Board

The Liquor Administration Board (LAB) has produced standard conditions for noise emissions from licensed premises as follows:-

> The L_{A10} noise level emitted from the licensed premise shall not exceed the background noise level in any octave band frequency (centred on 31.5 Hz - 8 kHz inclusive) between midnight and 07:00 am at the boundary of any affected residence. Notwithstanding compliance with the above, the noise from licensed premises shall not be audible within any habitable room in any residential premise between the hours of mid-night and 07:00 am.
>
> For the purposes of this condition, the L_{A10} can be taken as the average maximum deflection of the noise emission from the licence premises.

The LAB noise conditions may be applicable to aspects of a supermarket development if any associated shops or commercial premises sell alcohol. For example licensed restaurants or cafes, particularly with potential for alfresco dining and amplified music.

Australian Standard AS 2107

The Australian Standard AS 2107 – 2000 *'Acoustic – Recommended Design Sound Levels and Reverberation Times for Building Interiors'* provides recommended design sound levels for different areas of occupancy in buildings. This includes recommended design sound levels for various areas within residential buildings on either minor or major roads. For example the satisfactory recommended design sound level (L_{Aeq}, dBA) for sleeping areas in residences near minor roads is 30 dBA with a recommended maximum of 35 dBA. For living areas these are 30 dBA and 40 dBA respectively.

Noise Source	Sound Power Level dB Octave Band Frequency (Hz)						Overall 'A' Weighted dBA
	125	250	500	1K	2K	4K	
Air-Conditioning Condenser (High Fan Speed)	85	82	82	80	77	70	85
Refrigeration Condenser (High fan speed)	86	86	83	84	80	74	88

Figure 1: Example of Manufacturer's Sound Power Levels for Air Conditioning and Refrigeration Plant.

In some instances supermarket developments may also comprise residential components. For example a multi-storey development with a supermarket on the ground floor with one or more residential levels above. The recommended design sound levels from AS 2107 may therefore be used for the proposed residences in these instances for noise levels arising from, for example, mechanical plant.

In many cases the INP and Environmental Criteria for Road Traffic Noise may be the only criteria to address in a noise assessment for a new supermarket development. However, depending on the type of development, operating hours and usage of any additional specialty shops consideration may need to be given to the additional criteria above.

BACKGROUND NOISE LEVELS

Background and ambient noise level assessments must be undertaken in accordance with the NSW Industrial Noise Policy 2000. If the supermarket is existing it is important to ensure background noise levels are taken at a location considered representative of the nearest residential receiver whilst being far enough away from the development so as not to be affected by existing noise levels.

SOURCE NOISE LEVELS

There are many and varied potential noise sources associated with supermarket developments and they must all be considered, as well as the cumulative affect at each of the neighbouring residences. The two major noise sources within the site are generally mechanical plant and loading dock activity.

Mechanical Plant

The main mechanical plant is predominantly the air-conditioning and refrigeration condensers, generally located on the roof of the supermarket. Details of all plant should be obtained from the proponent however; particularly at the development application stage this information is not always available. The size, number of fans, fan speed and make and model of condensers will have a bearing on the noise levels emitted.

Table 1 shows an example of a typical air-conditioning condenser and refrigeration condenser with the respective octave band sound power levels in decibels, re: 1 picowatt (10-12 Watts) and the overall 'A' frequency weighted sound power levels (LWA) in decibels, re: 1 picowatt.

There may often be more than one of each condenser or a number of different size condensers. In addition to the air-conditioning and refrigeration plant on the condenser deck there are likely to be supply and exhaust fans at varying locations across the supermarket roof. These may include, for example, fans for; kitchen, bakery, chicken oven, toilets, car park and smoke extraction.

A plant room is also likely to be located on the roof near to the condenser deck and contain, for example, supply air fans, compressors and a return air chamber. Further mechanical plant not located on the roof of the supermarket may include fans in the car park and a transformer often within a sub station.

From Noise and Sound Services database and previous noise measurements and experience, transformer noise levels are generally centred around 100 Hz. It is likely that the noise characteristics of transformers will be considered tonal in line with the INP. Cardboard compacting machines should also be considered, particularly if located externally.

Mechanical plant may be required for any specialty shops and the type and amount of plant will depend upon the proposed occupancy of the shops. Each may require air-conditioning either via a centralised system or individual units for each premise. If any shops are to be restaurants or cafes they may require refrigeration plant of their own in addition to kitchen and toilet exhaust fans.

Every item of mechanical plant for both the supermarket and any specialty shops must be assessed. Where details of individual plant are not available the proponent should be advised on the maximum sound power level (L_{WA}) that any plant must not exceed in order to meet the relevant noise goals. This advice must consider the cumulative affect of all plant combined, where there is potential for that to occur.

Depending on the operating hours of the development it is generally only the refrigeration plant that is required to run 24 hours per day, seven days per week. However, other plant may operate during night time hours (i.e. between 10.00 pm and 7.00 am Monday to Saturday and 10.00 pm to 8.00 am Sundays and Public Holidays). For example, a store that opens at 7.00 am may require the air-condition plant to switch on at 6.00 am in order to achieve the necessary ambient temperature inside the supermarket for the arrival of customers.

Delivery Vehicles

Noise levels emitted from delivery vehicles can vary considerably depending on the size of the truck, whether or not they are refrigerated and how they are unloaded whilst in the dock.

Reversing alarms should also be considered, particularly if deliveries are accepted during night time hours as these can cause sleep disturbance.

An example of the range of noise levels produced by delivery vehicles is shown in Table 2. These are from Noise and Sound Services database previous noise measurements and consist of a range of rigid refrigerated trucks being unloaded manually at loading docks. The reversing alarms were used during the operation and refrigerator motors were also running throughout.

Truck Type and Length	Noise Level dBA ($L_{Aeq, 15\ minute}$)	
	At Measurement Distance	Normalised to 20 metres
Rigid Refrigerated Truck about 13 metres	54 dBA @ 7 metres	45 dBA
Rigid Refrigerated Truck about 13 metres	59 dBA @ 6 metres	49 dBA
Rigid Refrigerated Truck about 19 metres	68 dBA @ 8 metres	60 dBA
Rigid Refrigerated Truck about 13 metres	73 dBA @ 3 metres	57 dBA
Old Isuzu Truck	64 dBA @ 5 metres	52 dBA
Milko Truck	57 dBA @ 3 metres	41 dBA
Rigid Refrigerated Truck about 19 metres	66 dBA @ 6 metres	56 dBA

Figure 2 Measurements of Trucks in Loading Docks

An assessment of truck noise levels whilst in the loading dock and traversing the development site should be compared with the INP criteria. Trucks approaching or leaving the site, once on the road way are subject to the Environmental Criteria for Road Traffic Noise.

Further Noise Sources

In addition to mechanical plant and on site delivery vehicles there is potential for further noise sources to be associated with the development, particularly the specialty shops. These will depend on the occupancy of the shops and may include amplified music noise and restaurant, café or bar patron noise.

If the occupancy of any proposed specialty shops is not known at the time of the assessment an additional assessment may be required following the development application stage.

On-Road Traffic Noise

The noise from road traffic vehicles entering and leaving a site depends mainly upon vehicle flow rate and the speed and distance to the receiver point.

The type and condition of vehicles and driver technique has a large influence on the noise levels at close distances where there are low flow rates. Road gradients and road surfaces can also influence the noise level.

If a traffic study has been undertaken the projected vehicle flow rates can be obtained from this document.

The proponent should also be able to provide a delivery schedule for heavy vehicle deliveries.

If this data is not available some assumptions will need to be made in order to determine a realistic worst-case scenario of vehicle movements.

This will depend on, for example, the number of car parking spaces, operating hours and size of the development.

The predictions of noise levels from road traffic using the proposed facilities can be calculated using standard formula as given in, for example, the Calculation of Road Traffic Noise from the UK Department of Transport and Welsh Office (1988).

With regard to delivery vehicles alone, the calculation procedure given in CoRTN is untested for small traffic flows. Therefore a calculation based on a sound exposure level (L_{AE}) of one truck can be used to predict an hourly noise level ($L_{Aeq, 1\ hour}$) from delivery vehicles.

For example, using a previously measured sound exposure level for one truck of 85 dBA at 15 metres, the

predicted hourly noise level is 55 dBA (from $L_{Aeq,\ 1\ hour} = L_{AE} - 10 \log_{10} (T) + 10 \log_{10} (N)$ where T is one hour in seconds and N is the number of trucks (i.e. 4 in this example)). This level can then be adjusted to suit the required distance (r2) from 55 – 10 $\log_{10}$ (r2/15) dBA.

On Site Vehicle Noise

Car parks may be located on or close to shared residential boundaries and noise levels arising from cars starting, doors opening and closing as well as cars accelerating can cause sleep disturbance depending on the operating hours of the development. Table 3 shows examples of previously measured noise levels (LA1, 1 minute) of these activities, normalised to 5 metres.

Source	Sound Pressure Level ($L_{A1,\ 1\ minute}$) at 5 m (dBA)
Car Starting	52
Car Door Closing	60
Car Accelerating	60

Figure 3: Sound Pressure Levels at 5 Metres for Car Movements.

NOISE MODELLING AND ASSESSMENT

The modelling of each noise source to all sensitive receiver locations can be done using computer modelling software (e.g. Soundplan or ENM) or by using the International Standard ISO 9613-2 (1996(E)) *'Acoustic – Attenuation of sound during propagation outdoors Part 2 General method of calculation'*. This Standard specifies methods for the description of noise outdoors in community environments. The method described in the Standard is general in the sense that it may be applied to a wide variety of noise sources, and covers the major mechanism of sound attenuation.

The equivalent continuous downwind sound pressure level (L_{Aeq}) at the main receiver points can be calculated for each point source using the equation below:-

$$L_{Aeq} = L_w + D_c - A$$

Where:

L_w is the sound power level of the noise source;

D_c is directivity correction; and

A is the attenuation that occurs during the propagation from source to receiver.

The attenuation term A in the equation above is given by:-

$$A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}.$$

Where:

A_{div} is the attenuation due to geometric divergence;

A_{atm} is the attenuation due to atmospheric ab-sorption;

A_{gr} is the attenuation due to the ground effects;

A_{bar} is the attenuation due to a barrier; and

A_{misc} is the attenuation due to miscellaneous other effects.

The last term (A_{misc}) generally refers to miscellaneous propagation through foliage, industrial sites and areas of houses. These are seldom applicable in supermarket noise assessments, particularly with neighbouring

residential properties.

Once each noise source has been modelled the overall predicted noise level at each receiver location can be determined from a summation of all relevant noise sources at those locations.

An assessment can then be made to determine compliance with the appropriate noise criteria and mitigation measures recommended where necessary.

MITIGATION MEASURES

In all instances mechanical plant should be located as far as reasonably practicable from neighbouring residences and quieter plant should be chosen where available.

Mitigation measures for mechanical plant may include constructing an acoustic screen around the condenser deck. The screen should be made from any impervious material such as sheet steel, fibre cement, dense PVC or timber and must not contain any acoustically untreated holes or gaps.

It is important that the screen meets the roof of the supermarket building in the direction of the residences. However, this may meet opposition from the refrigeration engineers as it can restrict the necessary air flow to the condensers.

At least one side of the deck should therefore be left open to allow air flow where practicable and consultation with the refrigeration engineers may be required. If a four sided screen is used it should be lined internally with an acoustic absorbent material to minimise the reverberant build up of sound.

If screening the deck is not sufficient, acoustic enclosures or fan attenuators may be required. Setting the refrigeration condensers to run at low speed during night time hours can reduce noise levels and consequently the impact on neighbouring residences. No mechanical plant should run at night time when it is not essential to do so.

At the design stage the plant room should be located between the condenser deck and the nearest affected residence to act as a noise barrier. The building elements of the plant room may need upgrading from those proposed to reduce noise levels. Where ventilation is required acoustic louvres or other attenuated air path may be necessary.

Acoustic screens can be erected around the loading dock to block line of sight to residences and these must be high enough to account for refrigeration motors, often a minimum of 3 metres from ground level.

Management plans should be put in place to ensure trucks do not queue up on the street waiting for access to the dock or remain waiting with engines running. However, it is not always practicable to expect refrigeration motors to be turned off, even whilst unloading.

All deliveries should be kept to day time hours including waste collection and truck sizes limited where necessary and practicable.

Car parks should be screened with acoustic fences between neighbouring properties. A management plan may be implemented to restrict the use of sensitive car parks after 10.00 pm and before 7.00 am so as to minimise the possibility of sleep disturbance.

Car park access and egress points should be designed to avoid neighbouring residences where practicable. Signage should be placed around the car park to remind customers to keep noise levels to a minimum when arriving or leaving during night time hours.

CONCLUSION

Noise assessments for supermarket developments must consider a range of individual noise sources and the combined affect on all receiver locations.

The main noise sources are mechanical plant, loading dock activity and on-road traffic, although various other noise producing aspects of a development may exist.

Noise goals should be set from the relevant NSW Government noise criteria and will depend on the noise sources associated with the particular development as well as the consent authority's requirements.

The noise goals can be met through a variety of mitigation measures including screening the condenser deck, the loading dock and implementing management plans with regard to delivery times and size and number of trucks.

Where specific details of mechanical plant are not known at the time of the assessment, maximum sound power levels (L_{WA}) not to be exceeded should be supplied. These must be checked with manufacturers prior to purchase and may often result in the need for additional assessments.

The expected on-road traffic using the proposed development can be calculated. The success of meeting the traffic noise goals will depend on the location of access and egress points as well as the number of vehicles.

REFERENCES

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