New Zealand Acoustics

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Features

Regulars

Cover Image: Padded room at Dominion Physical Laboratories, to test for noise.

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From the President and Editor

From the President

Dear Members,

Welcome to the first NZ Acoustics Journal of 2014 and, I'm afraid to say, the last for our Editor in Chief - Dr. John Cater.

John has been editor since the first issue of 2011, and under his guidance the Journal has strengthened its position as one of the 'most readable' acoustics journals. He has deftly trodden that fine line between academic and general interest content in the Journal, all while managing to raise two gorgeous wee girls at the same time.

John will be working and studying abroad for a significant portion of this year, and rather than have this impact on the standard of the Journal, he has offered to hand over the reins. On behalf of the Society, I'd like to thank him very much for his efforts over the past three and a half years, and I wish him well.

From the next issue we will have two Co-Editors in Chief at the helm – Lindsay Hannah and Dr. Wyatt Page.

Lindsay is a consultant with Malcolm Hunt Associates in Wellington. He has been an enthusiastic member of the ASNZ council in two separate stints since 2008 and has written many papers for the Journal over the years.

Dr. Page is an Associate Professor in Acoustics and Human Health at the Institute of Food, Nutrition and Human Health at Massey University. He has an engineering background and currently leads the "Noise and its Effects on People" research platform with Dr. Stuart McLaren.

I'm looking forward to working with both gentlemen over the coming months and am very interested to see the new direction they take our Journal!

Now, to a topic that is very dear to

Publication Dates and Deadlines

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my heart... and one that I'm sure is being discussed amongst acousticians throughout the world right now: Formula One.

No, wait... really. Whilst I might be a huge fan of the sport, I'm not quite so bold as to use up this valuable column space to simply spout on about my favourite lunchtime topic. There really IS an interesting acoustic aspect to this year's competition... and it poses some interesting questions about the global community's response to noise.

The formula changed this year from V8 engines to turbocharged V6 engines. The F1 community was all very excited about this prospect... that is, until they heard the engines.

After the first race at Melbourne last month, there was an outcry from fans, organisers and drivers alike saying that the cars aren't loud enough, and Formula One racing has been ruined. F1 supremo Bernie Ecclestone has labelled the new engines as 'totally absurd', saying that 'people want noise'. Reigning world champion Sebastien Vettel went so far as to say that they sound 'sh*t'. The organisers of the Melbourne Grand Prix are even considering suing F1 management over lack of noise, saying that they didn't get what they paid for and that new engines could be in breach of their contract with Formula One.

So what's going on here? Can people really be this angry over a lack of noise? It's an interesting question and, as an acoustician, one I'm not at all used to addressing. I've been to a Formula One race. The cars had the old V8 engines and if I hadn't had my earplugs in, I'm quite sure I would have completely used up my monthly (if not yearly) noise dose in one day. Those cars were loud. Too loud. Unnecessarily loud. But they were awesome! Although not because of how loud they were, it was the character of the sound that made it so. That high-pitched shriek of their approach, followed by the huge Doppler shift as they sped past.

The new sound is reportedly 11 decibels quieter than the old, but when you're talking about levels up in the mid-130s, they surely can't be called quiet! I think the key difference is that the sound is full octave lower than last year - simply because the new engines have two less cylinders and rev about 5,000 rpm lower. This probably also takes the sound away from the 1-2k hump in the A-weighting curve (which would have a further impact on the loudness... but again... they still ain't quiet). So I think it's an issue of frequency, not level... but nobody in F1 seems to have picked up on that yet. I'll be interested to see how it pans out, and if action is taken... what action will it be, and will it have the desired effect?

Back to the original thing that got me started on this though... Bernie Ecclestone said that 'people want noise'. Notwithstanding that this is an oxymoron (refer NZS 6802:2008), I think it's an interesting question to ask ourselves. What other sounds in our lives do we want to be at a high level? Fire alarms? Well sure, but that's a safety issue. Rock concerts? Maybe, but there again I think most would prefer good quality sound to out-and-out level. I'll leave you to ponder it. Stay tuned for details and a call for papers for our biennial conference, which will be held in late November this year, in Christchurch.

Until the next issue, enjoy Autumn, and remember to go and get your flu jab!

Yours faithfully,

James Whitlock

Editor's Ramble

Dear Readers,

As James notes above, this will be my last issue as editor (for now); a combination of travel and research commitments has meant that I can no longer devote the time that I would like to the Journal.

This issue is a little different to what I have usually presented, just two articles are included; one from Giles Parker (a regular contributor), which is a case study of the performance of noise barriers. The other paper is Part I of a larger work by a team from Massey, including your new editors. This review looks at the various environmental acoustic standards in NZ and examines their application and limitations.

My thanks to Stuart & Grant as well as everyone else that has contributed to the journal over the past 3 years,

John Cater ¶

Tinnitus Conference: A Short Report

Vern Goodwin

Adviser at Environmental Noise Analysis and Advice Service

Environmental acoustics practitioners are often required to consider how to evaluate the reasonableness of people exposed to environmental noise some of whom have bothersome tinnitus. Their response to environmental noise may not be normal and they deserve compassionate consideration. This short report describes features of a recent conference I attended - to improve insight into a related field of low frequency sensitivity and psychoacoustical disorders.

The Tinnitus Research Initiative (TRI) convened an informative 8th International Tinnitus Research Initiative Conference at the Viaduct Events Centre in Auckland on 10 to 13 March this year. The conference was preceded by a one day workshop attracting international and local delegates. Exhibitors at the conference included the National Foundation for the Deaf and various manufacturers of electronic aides for tinnitus treatments.

The host was the Centre for Brain Research at the University of Auckland which is a partnership between scientists, clinicians and the community. Grant Searchfield chaired the organising committee with the able assistance of staff from his Audiology Clinic within the Faculty of Medical and Health Sciences, School of Population Health and the support of sponsors including Ron Goodey from Deafness Research Foundation, and the NZ Tinnitus and Hyperacusis Network.

The theme of the conference was “over the horizon” reflecting the aspiration of the international research community and practitioners that a cure for tinnitus may be not far away. The range of delegates’ institutions and affiliations indicates the breadth of international research and practitioner experience and enquiry about the causes of tinnitus and its treatments. Invited speakers were leaders in their fields and shared their recent findings on new lines of research into causes of tinnitus and demonstrated the importance of the multi-disciplinary network that characterises TRI.

Numerous podium and poster presentations by Grant Searchfield’s team and colleagues at Otago University ably justified the high praise I frequently heard throughout the conference from imminent foreign delegates about New Zealand’s contribution to fundamental research on hearing disorders including tinnitus.

The Audiology section at Auckland University reported a major new survey establishing the prevalence of tinnitus is 6% for the total New Zealand population, a little higher for men (6.5%) than for women (5.5%). The incidence in NZ Europeans nearly double that in Maori and other races. More analysis of the data is expected to assist in planning development and planning of new treatment solutions and channels for further research.

Tinnitus (from the Latin tinnire, ‘to ring’) , describes the conscious perception of an auditory sensation but without any external auditory source. It is a multi-factorial symptom that may involve mechanisms in the peripheral hearing organ, the auditory brain and non-auditory portions of the brain. Tinnitus is not itself a disease rather it is a symptom and can be debilitating. It is a recognised clinical enigma. Risk factors include hearing loss, ototoxic medication, depression and head, neck and back injury.

Up to 25% of the people affected by tinnitus report distress caused by interference with their lives. This distress is known to influence development of tinnitus leading to psychological complications such as annoyance, concentration interference, depression, anxiety, sleep disturbances and intense worrying. No objective test is available for most tinnitus cases, medical history and effects on the patient being the main basis for diagnosis.

Functional magnetic resonance imaging, is a common method used to study the brain mechanisms involved in tinnitus. This has identified reduced functional connectivity between the brainstem and cortex in tinnitus patients, signifying abnormal auditory processing. Other research suggests a much larger role in the limbic system in tinnitus pathophysiology.

A clinical flowchart to guide treatment based on pathophysiological evidence is promoted by the Tinnitus Research Initiative: See http://www.tinnitusresearch.org/en/projects/flowchart_en.php)

The clinical start point is to ascertain whether the tinnitus is pulsative or non-pulsitative.

The Auckland University Hearing clinic takes a patient -centred approach based on a framework which considers the psychoacoustical and psychological characteristics of the individual’s tinnitus.

The limitations of existing tinnitus questionnaires have led to the development of a new questionnaire, the Tinnitus Functional Index (TFI), in the United States.

Research findings published by the Centre for Brain Research, The University of Auckland indicate that this new questionnaire is a reliable and valid measure of tinnitus severity in New Zealand and does not need modification for use here.

“To cure tinnitus we must: embrace new methodologies, challenge convention, and look over the horizon.”

(Grant D Searchfield, Chair of Organising Committee, 8th International Tinnitus Research Initiative Conference)

Performance of Noise Barriers for the Night Time Operation of a Rail-freight Terminal

Giles Parker

Managing Director, Sound Barrier Solutions Ltd, Market Harborough, United Kingdom

This paper was previously presented at the 21st Biennial ASNZ Conference, Wellington, NZ

Abstract

The operation of a Rail-freight Terminal can have many processes associated with the loading and unloading of containers that generate noise of an intermittent or impulsive nature. In particular the use of reach stackers can make it difficult to justify night-time operation when assessing the perceived L_{AMax} levels against the current WHO criterion. This paper examines modelling the real time performance of a noise barrier scheme around an urban rail freight terminal in the UK Midlands. It considers the typical noise signature of a train arriving unloading and departing. It al-so examines the processes involved in aggregate handling and the use of reach stackers and swing-through cranes for container transportation. It also covers the measurement validation of the model and the installed permanent monitoring system for the operating site. Using the model, the worst case combination of transient noise sources was deter-mined. The barrier design was then optimised and specified to meet World Health Organisation (WHO) Guidelines for Community Noise and BS 4142: The Rating of industrial noise in a mixed industrial area.

TELFORD RAILFREIGHT NOISE MODEL

A detailed noise model was constructed for the Rail-freight Terminal in Donnington near Telford, Shropshire in the UK. This study was carried out on behalf of Telford and Wrekin Council with regard to the Regulatory Framework, the Environmental Protection Act 1990, the Town & Country Planning Act 1990 and the Telford Local Plan 1995-2006.

The noise model was used to determine the acoustic viability of the fully operating site, by assessing the predicted noise impact of a typical arrival and departure of a freight laden train realistically combined with all the active processes involved in the unloading and processing of the freight containers and transported aggregates.

The first objective would be to construct a detailed three dimensional acoustic computer model of the site and surrounding location to demonstrate how noise would spread across the site itself to the surrounding neighbourhood. At the same time detailed noise measurements were taken of the existing site that could be incorporated into the noise model to help determine the current varying background noise levels for the most affected property facades.

Because of the nature of the noise, it would be necessary to model each specific noise source separately in terms of their magnitude, duration and location. By considering actual operational activities, these sources were then combined in the model for different worst case scenarios. “Snapshot” noise maps were then produced to quantify and illustrate the different stages of a typical rail-freight event.

Noise Mitigation

The model was then used to assess the impact of rail-freight noise on local residents with regard to the most relevant environmental noise guidance and standards given in the Protection Acts at the time and to deter-mine the best practical means of reducing the noise impact on site through the installation of an appropriate noise barrier scheme and through achievable on site operational controls that would suit all parties. All proposed measures would assume best practice. In other words, they would be realistic and proportionate to the noise impact of the site.

These mitigation measures were then incorporated into the noise model for each of the different “Snapshot” scenarios to show how they would provide sufficient protection to meet the noise requirements. It also would serve to demonstrate where, with best practice, these requirements would only be met subject to specific operational controls and limits being adhered to.

BACKGROUND TO THE SCHEME

Telford & Wrekin Council constructed the new railway terminal at Donnington in Telford, Shropshire. The proposed build process would include:

- The reinstatement of approximately 4 km of single line railway, along the former Wellington to Stafford route.
- The construction of a Railfreight Terminal adjacent to the MOD site at Donnington.
- The development of a 360,000 sq foot high bay distribution warehouse by a private sector developer
- The development of 2-3 smaller warehousing units of maximum floor area 90,000 sq ft by the Council’s Asset & Property Development Portfolio.

The Telford Railfreight Terminal (TRT) is located in the North of Telford next to existing manufacturing and warehousing facilities in Hadley Park, Hortonwood Industrial Estates and MOD Donnington.

The project had been promoted through a Transport & Works Act Order (T&WAO) which has the effect of creating a statutory railway. The application for the Order was made to the Department for Transport in July 2003 and was approved by the Secretary of State for Transport in April 2005. The T&WAO contains specific reference to noise levels and stipulates mitigation measures.

The design of the plant had undergone many changes and configurations. This noise model was constructed prior to the plant being built and was highly complex and cumulative in its nature being wholly representative of the final operational terminal design. All previous environmental impact reports and acoustic designs previously commissioned to assess noise within the TRT were therefore deemed to either be outdated because of changes in the terminal configuration and proposed operations or inadequate in that they only considered specific noise sources in isolation.

GUIDELINES AND STANDARDS CONSIDERED

According to the Environmental Planning Act 1990, the Town & Country Planning Act 1990 and the Telford Local Plan 1990, the noise model was used to assess noise levels against the most appropriate standards at the time. In this application these would be:

- World Health Organisation (WHO) Guidelines for Community Noise
- BS 4142: 1997: The Rating of industrial noise in a mixed industrial area
- Planning Policy Guidance 24 (PPG24) (Referenced in the Policy statement EH6 of the Telford Local Plan)

World Health Organisation

The World Health Organisation Guidelines for Community Noise provides guidance in appropriate noise levels for residential properties. Typically the WHO considers that general daytime outdoor noise levels of less than 55 dB L_{Aeq} (16hr) is desirable to prevent significant community annoyance. During the night the condition is more stringent requiring noise levels outside a bedroom window of no more than 45 dB L_{Aeq} (8hr). There is also a requirement that the Maximum noise level: L_{AMax}, (measured at the resident's window) should not exceed 60 dB at any time during the night to mimimise sleep disturbance.

The WHO guidelines only consider the impact of the maximum noise level L_{AMax} during the night-time. Whilst residents may complain about sudden impulsive noises during the day, the WHO guidelines provide no specific guidance for its assessment with regard to day-time L_{AMax} levels. Daytime Impactive operations in the Rail-freight terminal would therefore not be covered.

BS4142: 1997

BS4142: 1997 Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas, is a method of assessing the level of public nuisance due to industrial noise, in order to determine the likelihood or validity of a noise complaint. The specific noise level or L_{Aeq} measured noise at a residents home, generated by an industrial plant is compared to the background noise level in the area.

This study does not in fact apply BS4142 in its strictest sense. The rail-freight terminal does not fit the typical scope of the standard. More correctly, this study provides an assessment against ambient noise conditions in accordance with BS4142: 1997.

For night time measurements between the hours of 2300 and

0700, BS4142 requires L_{Aeq} levels to be averaged over 5 minute intervals. For intermittent noise sources, the average L_{Aeq} noise level should no exceed the background noise level by more than 5 decibels. For relatively continuous sources the exceedence rises to 10 dB. During the daytime, the assessed L_{Aeq} level is averaged over 1 hour intervals.

In the case of an arriving freight train, the general process is not really intermittent although some of the associated activities: shunts, clatters and bangs would be classified as intermittent.

PPG24

PPG 24 would normally be applied to assess the suitability of a site for residential development. Potential developments would be categorized for suitability or for potential mitigation based on their predicted noise levels. In this instance, the houses are already present and PPG 24 does not directly apply. In this scenario the key noise levels in PPG 24 match the requirements of the WHO guidelines in any case.

In 2012 PPG24 was deleted as part of UK National Planning Policy Framework (NPPF) however it remains a requirement under the policy statement EH6 of the Telford Local Plan.

BACKGROUND NOISE MEASUREMENTS

Noise Measurements were therefore taken over a 5 day period from 22nd to 27th November 2007 at the back of a property directly adjacent to the line of the new railway and close to the site boundary. Measurements were taken using 01-dB type SIP95 integrating real time noise analysers in weather proof protection casing.

Measurements were started on the Thursday afternoon 22nd November and continued over the weekend through to Tuesday afternoon 27th November. The aim was to obtain data that was representative of day time and night time for both weekday and weekend conditions.

The overall daytime and night time L_{Aeq} and L_{A90} values are given in Tables 1 and 2 for both weekday and weekend conditions.

From these it is immediately apparent that current levels show very little difference between weekday and weekend conditions. This is not so surprising considering the quantity of business activities in the vicinity operating 7 days a week. However the 24 hour profile for the weekday and weekend noise differs quite noticeably.

Table 1: Summary of L_{Aeq} Noise Measurements

L_{Aeq}	WEEKDAY dB(A)	WEEKEND dB(A)
DAY (0700-1900)	56	54
EVE (1900-2300)	54	51
NIT (2300-0700)	47	47
MIN (0700-2300)	52	-
MIN (2300-0700)	43	-

Background noise for residents prior to the rail-freight terminal being built was dominated by traffic on the adjacent A518 Hortonwood Bridge Road. The traffic noise ensured that background noise levels remain relatively high. Background noise measurements, together with the road traffic loadings were used to model both the daytime and night-time road traffic activity. This enabled a base line noise model to be produced of the current site with no rail-freight development in place.

Once the development is built the background noise level would potentially change due to presence of new site buildings and warehouses. With no site activity these would provide slight protection from the traffic noise on the Hortonwood Bridge Road. Once the proposed noise barrier system is built, this would have the effect of considerably reducing the background noise by masking the residents from the road. When no trains are running this improves the environment but it also has the adverse effect of making the trains more noticeable when they do pass.

METHODOLOGY

Computer Software

In order to assess the impact of the noise from the rail freight terminal being transmitted to adjacent properties, the three dimensional computational package Mithra was used. Mithra allows for precise acoustic modelling of particular noise sources: road, rail traffic or industrial sources of noise. This can be done either using specifically prescribed sources or by using generated point, line and surface sources that best rep-resent typical train arrival and unloading events.

It shows how the noise interacts with adjacent buildings, taking into account different ground conditions and topography. Mithra allows for sources to be modelled in terms of their magnitude, location, duration and frequency content. The large variation of options allows the sources to be represented as realistically as possible in the model.

With regard to noise barrier design, Mithra, uniquely compared to other leading noise modelling packages allows for performance variation in terms of both sound absorption and air-borne sound insulation. This enables barriers to be 'tuned' for optimum efficiency for noise mitigation giving Mithra an aspect of quality control not afforded by other packages.

Train Source Definitions

At Telford, a typical rail-freight train unloading event is defined by 10 separate movements associated with the arrival, manoeuvring, unloading and departure of the freight train.

Table 2: Summary of L_{A90} Noise Measurements

L_{Aeq}	WEEKDAY dB(A)	WEEKEND dB(A)
DAY (0700-1900)	53	53
EVE (1900-2300)	50	48
NIT (2300-0700)	42	42
MIN (24 hours)	39	39

Most of these sources were associated with the moving locomotive and their duration would be based on an assumed fixed locomotive speed of 5 miles per hour and a total train length of 500 metres. In contrast, the uncoupling, re-coupling events were assumed to occur over a short time duration based on measurements taken at a similar terminal site. The total duration from arrival to departure is modelled to last just over 1 hour in the following general pattern:

	Movement	Duration (s)
1	Locomotive travels through points along Line 1	665
2	Locomotive Un-couples	48
3	Locomotive travels along Line 2 to back of train	877
4	Locomotive Re-Couples	48
5	Locomotive pushes the train to end of Line 8	552
6	Train Un-Couples at Half-way	48
7	Locomotive backs up Half Train past points for 7 & 8	262
8	Locomotive pushes Half of train to end of Line 7	448
9	Locomotive Un-couples	48
10	Locomotive departs through points along Line 3	843
	Total Time	3839

Unloading Source Definitions

The second "set of sources" is associated with the container unloading operation. During the day-time, this would be carried out by a reach stacker, at night the operation would be carried out by a swing thru crane. In both cases the operation would be assumed to commence once the locomotive has departed. Both the crane and the reach stacker operate in a confined location. The reach stacker moves between the train where it picks up a container and then transfers it to a stack to unload and move on. The crane would transfer the container directly from the train to a waiting truck:

	Movement – Daytime – Reach Stacker
11	Reach stacker operations commence
12	Reach stacker picks up load (Bang at 6 m)
13	Reach stacker carries load
14	Reach stacker stack load (Bang at 6 m)
15	Reach stacker leaves load – and continues

	Movement – Nighttime – Swing Crane
11a	Swing thru Crane operations commence
12a	Crane Lifts container from Train to Truck
13a	Crane Feet Fold in (Clang!)
14a	Swing thru Crane moves to next container
15a	Crane Lifts container from Train to Truck

Other Sources

Other sources included in the noise model were:

- Container HGV Movements along site roads
- Bulk Traffic (for Aggregates and Concrete) – daytime only
- HGV Movements associated with Warehouse development
- Fork Lift Operations
- Aggregate Handling - daytime only
- Concrete Batching Plant – daytime only

For the model most of these sources are assumed to operate continuously whilst the freight train is moving through the terminal and whilst the reach stackers are operating. The exceptions would be the Aggregate Handling, the Concrete Batching plant and associated HGV movements that would only occur in the day.

The quantity of Vehicular movements on site was provided by Telford and Wrekin Council as was data for the Aggregate Handling and Concrete Batching Plant

NOISE ASSESSMENT AND BARRIER DESIGN

For both day-time and night-time conditions, in all 15 separate movement scenarios were modelled representing the time-slices of a complete train arrival, unloading, departure event. For each of these models noise levels were predicted for the 98 most exposed properties. The complete event was then analysed in detail to obtain worst case values that could be assessed against WHO and BS4142 for daytime and night-time conditions.

Different noise barrier designs and combinations were then inserted into the model and the same calculation was carried out to determine the level of noise mitigation afforded by the scheme.

Operational Controls

Where it was apparent that further noise mitigation may be required, operation control measures were proposed whose impact on noise could be quantified. These were proposed in discussion with the train operator and Telford and Wrekin Council.

DISCUSSION OF RESULTS

Dominant Sources

From the study, it was immediately apparent that in terms of the L_{Aeq}, not surprisingly, the train movement was the dominant source. In terms of sudden impulsive noise, the Reach Stacker dominated during the day due to the sudden "clang" of picking up and stacking a container. In contrast, the general HGV movements were of a lower order. This was also true at the access ramp to the roundabout where HGV traffic was servicing both the transport of Freight and Aggregate and the smaller warehouse development. At night-time, the crane operation was much quieter than the reach stacker and would only dominate when the feet clanged back into place.

WHO Assessment (no noise barriers)

Referring to the WHO guidelines, the agreed daytime noise limit for external (ground floor) living areas was 55 dB(A) L_{Aeq}(16hr). With no barriers in place, 89 % of the 98 properties assessed would exceed this level in the daytime however the assessment was carried out for the L_{Aeq} for the duration of the train event which was about 1 hour in duration rather than 16 hours. Since the L_{Aeq} is time averaged, this value should be adjusted to take into account the majority of the time when no activity would take place.

According to the WHO guidelines, the night-time noise limit at bedroom facades is 45 dB(A) L_{Aeq}(8hr). With no barriers in place, 100 % of the 98 properties assessed would exceed this level based on first floor façade noise predictions.

WHO Assessment (with noise barriers)

With the proposed barrier scheme installed, the day-time WHO noise limit of 55 dB(A) L_{Aeq}(16hr) for external (ground floor) living areas, would now be exceeded by 38% of the 98 properties assessed. Again, this was based on a 1 hour averaged L_{Aeq} rather than 16 hours. Since the L_{Aeq} is time averaged, this value should be adjusted to take into account the majority of the time when no activity would take place.

With the proposed barrier scheme installed, the night-time WHO noise limit of 45 dB(A) L_{Aeq}(8hr) at bed-room facades, would now be exceeded by 73% of the 98 properties assessed.

However, it was also noted that the predicted night-time background noise only falls below the 45 dB(A) level for 2 hours of the night. In other words, the fact that for most of the night that WHO limit would never be met was due to the background noise level.

Ambient Assessment (no noise barriers)

Interpreting BS4142, the freight train acts as a continuous dominant source. As such there is no need to apply the BS4142 5dB correction.

During the daytime, without barriers, the predicted worst L_{Aeq}(1hr) for all 98 properties was assessed and of these, 19% were found to exceed the predicted background noise level by 10dB or more. Complaints from these properties would be likely according to BS4142. A further 46 % were found to exceed the predicted background noise level by 5 dB or more. These would be only of marginal significance.

During the night-time, without barriers, the predicted worst L_{Aeq}(5min) for all 98 properties was assessed and of these, 55% were found to exceed the predicted background noise level by 10dB or more. Complaints from these properties would be likely according to BS4142.

Ambient Assessment (with noise barriers)

During the daytime, with barriers, the predicted worst L_{Aeq}(1hr) for all 98 properties was assessed and of these, no properties were found to exceed the predicted background noise level by 10dB or more. In fact all properties now exceeded the predicted background noise level by 5 dB or less. These would now all be only of marginal significance.

During the night-time, with barriers, the predicted worst L_{Aeq}(5min) for all 98 properties was assessed and of these, 26% were found to exceed the predicted background noise level by 10dB or more. Complaints from these properties would be likely according to BS4142. A further 53 % were found to exceed the predicted background noise level by 5 dB or more. These would be only of marginal significance.

WHO L_{AMAX} Assessment

According to the WHO guidelines, the night-time L_{AMax} noise limit for bedroom facades is 60 dB(A). With no barriers in place, 61 % of the 98 properties assessed would exceed this level in the night. This was due to the dominance of the train arrival on the proper-ties closest to the track and not due to the Swing thru crane.

With barriers in place, none of the 98 properties assessed would exceed the L_{AMax} limit of 60dB(A) in the night. The barriers would therefore be providing adequate protection against this high maximum level.

PROPOSED OPERATIONAL CONTROLS

With the barriers in place, the following operational controls were proposed to provide further mitigation:

Limiting Reach Stacker Activity to the Daytime

According to this study most of the primary noise sources are containable by barrier protection or operational control. However it was also confirmed that the limitation of reach stacker activity to daytime only was the correct one. Should reach stacker operations be allowed at night, the resultant L_{AMax} levels would almost certainly result in justifiable complaints.

Whilst it may be difficult to predict the arrival of a night train, this restriction essentially means that the containers themselves cannot be handled until 0700.

Semi-Permanent Container Barrier

At any time there would be about 400 containers on site. Typically according to the operator, a minimum of 10% would be stacked and stored. This gives the potential for a semi permanent barrier to be built to protect properties exposed to the operations of the reach stacker. 40 containers could create a barrier 240 metres long and 6 metre high.

Should there by any future allowance for reach stacker operations at night, this measure could be further enhanced by requiring the container barrier to be stacked and unstacked during the day, but left untouched during the night to ensure the barrier is not disturbed but offers the greatest protection.

A further measure could be to examine whether the reach stacker could be limited to only lifting containers off the train at night and placing them on the ground or straight onto a lorry. This would result in "clangs" occurring at a lower height which may receive greater protection behind the semi permanent wall. This is unlikely to remove the problem of the Reach Stacker at night but it may reduce the problem.

Aggregate Handling Confined to the Far West-ern End of the Track

Part of the barrier scheme would be to install a barrier section in front of the aggregate handling bay. The aggregate handling activity had been confined to the far western end of the unloading track section though this was primarily to restrict the spread of aggregate dust rather than merely being a measure to contain the noise.

Aggregate Handling and Concrete Batching Treated as Daytime Activities Only

It was also proposed that the Aggregate Handling and Concrete Batching be confined to daytime activity. This was already assumed in the model and analysis.

Restrict Train Arrivals during the Night

From an acoustic point of view, it would be beneficial to advise train operators for trains to arrive outside of the hours of 2.00 to 5.00 am. With regard to the ambient noise assessment this would reduce the number of properties that exceed the predicted background noise level by 10dB or more from 26% to only 6%. It was however noted that this could be too restrictive to be practical for the operator.

Furthermore, by restricted the operator to 1 train per night, this would ensure that the L_{Aeq} (8hr) WHO night time noise is "dampened" down by 4-6 dB.

IMPACT OF THE PROPOSED OPERATIONAL CONTROLS

WHO Assessment

These measures together with the proposed noise barrier system would result in reducing the number of properties that exceed the WHO daytime limit from 38% to 19%. Furthermore, all of the properties would then be within 1 dB of the background level so this should constitute a best practice solution.

Similarly, although 73% of properties would still be exceeding the night-time WHO limit, they would all be within 1 dB of the background level so again this should constitute a best practice solution.

Ambient Noise Assessment

The proposed noise barrier scheme is already predicted to provide sufficient reduction with regard to BS4142 daytime conditions.

For night time conditions measures would also result in reducing the number of properties that exceed the background noise level by 10dB from 26% to 6%. However it should be noted that these 26% properties are behind the new combined bund-barrier. The only reason that they are predicted to exceed the noise limit in the ambient assessment is that construction has the effect of significantly reducing the background noise from its original level. If compared with current back-ground levels, none of the properties would exceed background by 10dB or more.

WHO L_{AMAX} Assessment

By restricting reach stacker operations to the day-time and resorting to the use of the swing thru crane at night, the intrusive night-time WHO L_{AMax} limit would not be breached.

BARRIER DESIGN AND SPECIFICATION

Three separate noise barriers were proposed as part of the complete noise mitigation scheme, though one of the sections, in front of the warehouse was dependent on further site developments and to date has not been constructed.

The barrier scheme has been based on an acoustic performance specification rather than on any specific material construction.

Primary Barrier Bund Combination

The main barrier comprises a 580 m long, 2.0 m high Absorptive barrier on top of a 3 m high Gabion/Bund. For simplicity of build, the barrier would be situated 1.0m back from the face of the bund to ensure its foundations are not set into the gabion itself.

This 5 metre high barrier provided the main protection for the majority of the properties most exposed to the noise of the rail-freight terminal.

Secondary Aggregate Barrier

A second barrier section was built in front of the aggregate handling zone, which comprised a 240 m long, 3.0 m high basic reflective fence. This would primarily serve as a security barrier being too distant from the reach stacker operations to provide any meaningful protection.

Absorptive Barrier Specification

In the absence of any robust specification standards for noise barriers for rail, the absorptive barrier on top of the gabion/ bund was specified with reference to the Specifications standard for road traffic noise reducing devices: EN 14388:2005.

Referring to this standard and with regard to the acoustic performance, the barrier was specified for sound absorption in accordance with EN 1793-1 and for airborne sound insulation in accordance with EN 1793-2. Both of these test standards refer to and use the normative spectrum for road traffic noise given in EN 1793-3 so care was taken to ensure that the barrier performance in this study related to the noise spectra of the rail-freight terminal.

The absorptive barrier was certified as B3 in accordance with EN 1793 Part 2 and certified as A3 in accordance with EN 1793 Part 1

PERMANENT NOISE MONITORING SYSTEM

Installing a permanent noise monitoring system was a required planning condition for the rail-freight terminal. Two Bruel & Kjaer type 3639E Noise Monitoring Terminals (NMTs) were installed which could be operated centrally and remotely at a computer workstation via cable or GSM.

Each NMT consists of a weather-proof cabinet containing a noise-level analyser, a bracket for pole mounting, and an outdoor microphone. The system was self-calibrating and was able to process and collate noise data for long term storage.

Table 3: Minimum Acoustic Coefficients

1/3 Octave Frequency Band	Sound Absorption Coefficient	Sound Insulation Coefficient
100	0.2	15
125	0.4	17
160	0.6	19
200	0.8	20
250	0.8	22
315	0.8	24
400	0.8	26
500	0.8	38
630	0.8	32
800-5000	0.8	34

The NMTs were positioned at the boundary of the Telford Rail-freight Terminal, the first (BK-1) at the western end overlooking the track and installed above the gabion / noise barrier. The second (BK-2) was positioned at the far eastern end of the Terminal close to the boundary of the freight unloading bay.

VALIDATING THE MODEL AND THE NMTS

With the permanent noise monitoring system in place it was necessary to validate the noise levels recorded by the NMTs and at the same time validate the reliability and accuracy of the Mithra noise model on which the noise mitigation scheme had been founded.

Validation concentrated on measuring the noise levels of a stationary rail-freight locomotive engine using the installed B&K NMTs in permanent position. These were compared to the noise levels measured by independent noise meters simultaneously positioned in the vicinity of affected housing.

BK-1 and BK-2 were validated separately. In each case, the stationary locomotive source noise was monitored at a distance of 10 metres and measurements taken at the NMT and at an affected house.

This scenario would then be duplicated using the Mithra noise model and the resultant predicted noise levels compared to the actual measurement data as a means of further validation.

For each validation, the model was "tuned" to the source noise level of the locomotive and the levels at the NMT and affected house predicted and compared to the measurement.

In both cases the B&K NMTs measured levels within 1dB of those predicted by the model and within 2dB at the closest affected houses.

SETTING THRESHOLDS FOR THE NMTS

With the NMTs and model validated it was possible to produce transfer functions relating the noise levels measured by the Noise Monitoring Terminals and the noise levels modelled at the same positions.

Table 4: Validation of NMT – BK-1

Monitoring Position	Measured L_{Aeq} dB(A)	Modelled L_{Aeq} dB(A)
10m from Loco	77	77
BK-1	51	50
40 Preston Grove	51	53

Table 5: Validation of NMT – BK-2

Monitoring Position	Measured L_{Aeq} dB(A)	Modelled L_{Aeq} dB(A)
10m from Loco	75	77
BK-2	56	55
Wellington Road	49	47

The NMT's could therefore be incorporated into the noise model for the rail-freight unloading cycle. This could then be used to set threshold levels for the different required assessment criteria at the Noise Monitoring Terminal positions.

Example: Ambient Criterion Threshold

For example, for daytime conditions for the ambient assessment criterion to be exceeded the maximum L_{Aeq}(1hr) noise level during the train event would need to exceed the background noise by more than 10dB.

For daytime conditions, the modelled scenario shows a highest exceedence at 30 Stanmore Road at the western end of 4dB over background. This corresponds to a noise level at BK-1 of 67dB.

Should the level of the train noise rise by 7 dB, the noise level at 30 Stanmore Road would theoretically exceed the background by 11dB thus breaching the ambient criterion. This would correspond to a noise level at BK-1 of 74dB. Taking into account the result of the validation exercise, this gives a final threshold level for BK-1 of 73dB for daytime ambient noise.

REFERENCES

[1] BS4142: 1997 Method of rating industrial noise affecting mixed residential and industrial areas. BSI, 389 Chiswick High Road, London UK W4

[2] EN 14388(2005): Road traffic noise reducing de-vices – Specifications. CEN European Committee for Standardization, rue de Stassart, 36 B-1050 Brussels. ¶

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Tools of the Trade: A Review of NZ Acoustic Standards - 1977 to 2010

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An original contribution to New Zealand Acoustics

1. Introduction

This is the first of two technical papers which reviews the Standards New Zealand series for environmental acoustics, the 'NZS 680X series' between 1977 and 2010. The aim of the paper is to introduce the reader to environmental acoustics standards, discuss their overall purpose while setting out fundamental areas of service and restrictions.

2. Noise, Sound and Vibration

The terms 'noise' and 'sound' appear in the title of all environmental acoustics standards [the NZS 680X series]. The term 'noise' is considered by most to mean 'unwanted sound' and in the NZS 680X series, the term 'noise' is commonly defined as unwanted sound and for that reason has limits attached to it, for example noise limits prescribed in District Plans. The term 'sound' is mostly employed within the NZS 680X series to refer specifically to the sound source[s] being assessed.

Importantly, the Resource Management Act 1991 [RMA] defines noise as "includes vibration." This leaves noise along with other pollutants as something to be assessed as an environmental effect under the RMA. The RMA describes 'excessive noise' in Section 326 as "any noise that may unreasonably interfere with the peace, comfort, and convenience of any person [other than a person in or at the place from which the noise is being emitted], but does not include noise emitted by cars, vehicles, aircraft and trains." Section 16 of the RMA imposes duties on all persons using land or water for activities "to adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level." Section 17 of the RMA imposes duties to avoid, remedy, or mitigate any adverse effect whether or not the activity is in accordance with a rule in a plan.

3. Who is "Standards New Zealand"?

The first national standards organisation was created in New Zealand in 1932. "Standards New Zealand" is a user-funded, independent Crown entity, responsible for overseeing development and distribution of New Zealand Standards across a range of sectors, including environmental acoustics. Standards New Zealand is governed by the "Standards Council". Members of the Standards Council are appointed by the Minister of Commerce under the Standards Act 1988. Standards New Zealand facilitates the work of expert committees who prepare draft standards, and review public comments on drafts before voting on the final draft. When the committee reaches consensus on the final draft, it goes through an editing process before finally being approved for publication by the Standards Council.

4. What is a New Zealand Standard?

A 'New Zealand Standard' means a standard promulgated by the Council as a New Zealand Standard under the Standards Act. In essence, Standards are documents that provide requirements, specifications, and guidelines or benchmarks that, when applied correctly; promote consistency to ensure an agreed way of doing something, i.e. "standardisation". For example, standardised methods of measuring and assessing sound, if applied correctly, should produce consistent results. Standards New Zealand has a catalogue of 16 past and present NZS 680X series standards. Standards are generally developed by expert committees with consensus required before being formally approved by the Standards Council in accordance with the Standards Act. New Zealand Standards do not have any 'regulatory force' by themselves. Compliance with standards is voluntary unless cited as a means of compliance in a statutory document such as a regulation, a National Environmental Standard, a District Plan rule or, for example, as a condition of a Resource Consent.

5. Measurement and Assessment of General Environmental Sound

The science of acoustics describes sound by various functions including the level of sound, its frequency spectrum and duration. Many different sound descriptors [or metrics] have been defined and the traditional standard unit of a sound level descriptor is the decibel [dB]. For example, the time-average, A-frequency weighted sound level [$L_{Aeq}(t)$ dB] or the exceedance sound pressure level [L_{AN} dB]. Some of the most commonly used descriptors for environmental sound within the NZS 680X series of Standards are the L_{A90}, L_{A10}, $L_{Aeq}(t)$, L_{AFmax}, and L_{dn}. There are many other descriptors in use internationally for environmental sound assessments used for specialist assessment including but in no way limited to Pascal-squared seconds (Pa^2s), L_{Cpeak} or L_{Zpeak}, for example. The two core environmental standards for the measurement and assessment of environmental sound are NZS 6801 and NZS 6802. These two standards should be read in conjunction, as 6801 prescribes how sound is measured while 6802 prescribes the method for assessment of sound and guidelines for setting noise limits. The following sections discusses 6801 and 6802, 1977 to 2008 versions, with emphasis being provided on the most recent and technically advanced 2008 versions of these standards.

6. NZS 6801 and NZS 6802 - The First General Environmental Noise Standards

The first official environmental noise standards to be promulgated in New Zealand by the then Standards Association of New Zealand [SANZ], now Standards New Zealand, were 'NZS 6801:1977 Methods of Measuring Sound' and 'NZS 6802:1977 Assessment of Noise in the Environment'. These 1977 standards were declared on 16th December 1977 by the Standards Council to be 'standard specifications' pursuant to Section 23 of the Standards Act 1965. The two standards had been prepared by a special noise sub-committee of SANZ, following the recommendation 3[b] of the Board of Health Series No 21, Noise, HMSO Wellington 1974. Prior to the introduction of these standards, Department of Health guidelines published by National Audiology Centre were used nationwide.

The 1977 standards used the L_{95} noise descriptor, defined by NZS 6801 as the 'background noise level' as the primary descriptor for environmental noise. In that era it was "background plus 10 dB" that was used in most "District Schemes" as the sole descriptor for noise limits. The standard also defined 'nuisance' noise and introduced the L_{10} noise descriptor.

The 1977 standard also refers to 'single event noise', which although not referred to directly in the standard as the maximum A-frequency weighted sound pressure level, L_{Amax} noise descriptor, this is precisely what it was. The 1977 standards were prepared before integrating sound level meters were in common use. NZS6801 provides for measurement methods based on visual observation of analogue meter displays and manual [read-write] survey methods and statistical analyser results to determine "percentile levels." Visual or manual calculation was mostly conducted post measurement, as there were few statistical analysers available. This was quite different to modern assessment methods where sound level meters log the data and incorporate analysis and processing firmware providing the user with a host of instant noise descriptor information at their finger-tips.

6.1 NZS 6801 and NZS 6802: 1991 and 1999

NZS 6801:1977 and NZS 6802:1977 were superseded by 'NZS 6801:1991 Measurement of Environmental Noise' and 'NZS 6802:1991 Assessment of Environmental Noise'. In a decision of the Planning Tribunal AC52/85 Vision Wall Coverings Ltd. versus Papatoetoe City Council, the Court held the 1977 standard was "in many respects outdated and due for revision." By that era the science of environmental acoustics had rapidly advanced and international acoustic standards and British Standards had been revised. The project to revise the 1977 editions began in 1985 with a committee of the Acoustical Society of New Zealand. This committee became the Standards New Zealand Committee which prepared the standard eventually approved by the Standards Council in 1992.

As with the 1977 version of NZS 6802, the 1991 version retained the use of L_{95} defined by this standard, but to conform with international standards, changed the name to 'background sound level'. The standard also clarified that the descriptor for "intrusive noise" [referred to as 'nuisance noise' in NZS 6801:1977] was the L_{10} noise descriptor together with L_{max}. The 1991 standards defined L_{max} as the 'maximum A-weighted sound pressure level'. Further change in the noise descriptors was introduced in the 1999 revision eight years later when the L_{10} nuisance noise descriptor was superseded with the new L_{Aeq} noise descriptor for assessment of intrusive noise. 'NZS 6801:1999 Acoustics – Measurement of Sound' and 'NZS 6802:1999 Acoustics – Assessment of Environmental Sound' were published in 1999. The revision of the series in 1999 was designated as a New Zealand only project.

Although both the 1991 and 1999 versions were later identified as containing defects and deficiencies, it was not until December 2005 that a scoping workshop held by Standards New Zealand identified a number of areas requiring revision in both NZS 6801 and NZS 6802. The year following the workshop held by Standards New Zealand saw Standards New Zealand release a report entitled; "Report on the future options for New Zealand Standards – NZS 6801: Measurement of Environmental Sound and NZS 6802: Assessment of Environmental Sound". The key objective of the scoping project was to determine and agree options/scope for future solutions to environmental sound Standards in New Zealand. The report concluded Standards New Zealand position at this time was to recommend that Standards New Zealand only review and revise NZS 6801:1999 Measurement of Sound and NZS 6802:1999 Assessment of Environmental Sound which subsequently occurred.

There are many noteworthy issues about the 1999 standards editions which include NZS 6802:1999 adopting L_{Aeq} as the main descriptor for intrusive noise and clarifying the assessment methods by incorporating adjustments factors which had been omitted from the 1977 and 1991 editions. New meteorological effects provisions were incorporated and the modern 'Rating Level' assessment method adopted from ISO1996 was introduced.

The revision of most District Plans were substantially complete by time of the 1999 version was published and they had already incorporated the NZS 6802:1991 as the basis for assessment. Only the few "late" District Plan reviews were able to incorporate the 1999 edition. By the time of the 2008 edition the second generation plan reviews had commenced and these were mostly able to start incorporating the 2008 editions.

6.2 NZS 6801:2008 and NZS 6802:2008

In 2008 the most recent environmental noise standards for NZS 6801 and NZS 6802 were released, the scope of both standards remained the same, but noticeably the names were simplified being NZS 6801:2008 Acoustics – Measurement of Environmental Sound and NZS 6802:2008 Acoustics – Environmental Noise.

The majority of issues addressed within the updated standards are set out within the Forward of NZS 6801:2008 which states that the changes made in NZS 6801:2008 were "relatively minor corrections, clarifications and updates". Nevertheless in terms of NZS 6802:2008 the Foreword of this standard tells us that

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the 2008 version addresses "several significant changes" in the revision of NZS 6802:1999. The change or at least the overall appearance in the 2008 versions can be viewed as major; the 2008 standards are technically superior and include enhanced detail and guidance to assist the user. Like the 1999 version, they align closely to ISO 1996-2:2007 Acoustics - Description, measurement and assessment of environmental noise — Part 2: Determination of environmental noise levels.

What becomes obvious with the 2008 standards is the user must have a firm understanding of environmental acoustics. Such advances between standards is due to many issues including advances in the science of acoustics for both measurement and assessment, and related advances in 'tools', such as sound level meters and 'methods', such as computer modelling. It is considered appropriate by most acousticians that NZS 6801:2008 Acoustics Measurements of Environmental Sound and NZS 6802:2008 Acoustics Environmental Noise should be incorporated by reference into District Plans at the relevant point in time of that Plan's life-cycle as these versions are most up-to-date technically, and are considered current best practice. It is generally agreed among practitioners that the 1991 and 1999 versions of the standards are now out-of-date with known technical, legal defects and no longer reflect best practice in the field of environmental acoustics.

6.2.1 Terminology and Interpretation

The 2008 standards modify past terminology used in earlier standards and conform to international standards. Uncertainty about use of the historic term "ambient" was clarified in NZS6802:2008 by adopting from ISO 1996-2:2003 the terminology and definitions. It is noted that the term "ambient" has distinctively different meanings in Europe and the USA and as noted, it is replaced in New Zealand by "total sound" and "residual sound", as relevant. The term 'background sound level' remains in NZS 6802:2008 but the metric changed from L_{95} to $L_{90}(t)$. NZS 6802:2008 describes the background sound level as the level in decibels [dB] equalled or exceeded for 90% of the measurement interval and is the component of residual sound that subjectively is perceived as continuously present.

The term 'total sound' is introduced meaning the total encompassing sound from all sources, near and far including the 'specific sound', while the 'specific sound' is a component of the 'total sound' best defined as a being associated with a specific sound source. The 'residual sound' can be viewed as the sound remaining when the specific sounds under consideration are suppressed or are an insignificant part of the total sound. The concepts defined separately may be confusing, however applying them to the example of the noise of a heat pump which is being investigated, the sound the heat pump itself makes would be described as the specific sound, while residual sound could relate to local traffic on an adjacent busy road next to the site which the heat pump is located. The total sound would include both the heat pump and local traffic.

6.2.2 Assessment Methods, Measurements Interval and Rating Level

In the ISO standard ISO 1996-2:2007 'Acoustics – Description, assessment and measurement of environmental noise – Part 2: Determination of environmental noise levels', the "Rating Level" is a derived level used for comparison with a noise limit. The Rating Level is used to rank the potential subjective response to the sound environment.

Assessment under the 2008 standard of NZS 6802 is as in the 1999 version based on a "Rating Level" which is derived from assessment via two methods described in the standard as the "simple assessment method" or "detailed assessment method". The Rating Level is denoted within ISO 1996-2:2007 and NZS 6802 as 'L_R.'

The Rating Level process has three main steps. The first step in the process is to obtain the Rating Level from measured L_{eq} sound levels via the applicable 'simple' or 'detailed' method, outlined below. This provides an overall magnitude of the sound. The second step is to apply any applicable adjustments to the L_{eq}. NZS 6802:2008 contains adjustments to the L_{eq} for features which are likely to affect the subjective acceptability of the sound. The third and final step is to compare the Rating Level to the permitted noise limit.

NZS 6802:2008 sets out standardised adjustment provisions including [but not limited to] sound contamination, special audible characteristics [SACs] and duration. Where NZS 6802:1991 specified a measurement period of 'between 10 and 15 minutes and up to an hour in duration,' NZS 6802:2008 sets a standardised "reference time interval" of 15 minutes. Under NZS 6802:2008, the 'simple' method is to directly measure a representative L_{Aeq}(15 min) or equivalent value. For varying sounds a 'detailed' assessment method in Appendix B is described and examples are for the user are included in Appendix A. The difference between the two methods is that the detailed method allows for post-measurement calculations to arrive at a representative L_{Aeq}(15 min) value, while the simple method enables direct use of the measured levels.

NZS 6802:2008 recommends that in order to determine the Rating Level of a noise source, it is necessary to establish the level of the sound, the frequency of the sound, and occurrence of the sound, if it is intermittent. It also recommends the residual sound level be determined where relevant. Appendix A, Table A1 of NZS 6802:2008 provides suggested measurement time intervals and numbers of measurements relative to the nature of the sound for example steady, fluctuation and impulsive.

6.2.3 Averaging

Averaging is the process of finding the arithmetic mean of a data set, in the case of acoustics this is normally the "energy average". This averaging involves calculating the RMS [Root Mean Square] mean of data set and to do this the logarithmic effect of working in decibel units needs to be 'undone'. Thus the result is not the linear arithmetical "mean" of the decibel values as most people would know or would assume from everyday mathematical applications.

Prior to NZS 6802:2008, those in the acoustics profession in New Zealand had diverse opinions about averaging of sound levels, intermittency, duration and events, and the application of adjustments for averaging. NZS 6802:1991 allowed averaging if done as an energy average, and where the averaged L_{10} did not exceed the relevant limit, with all cases the limit must not be exceeded by more than 5 dB when averaged. The 1991 standard states if comparison is to be made with night time noise limits no averaging shall be allowed at any time. Prior to the 2008 revision of NZS 6802, acousticians were in some cases applying differing methodologies to averaging which was contrary to the purpose of the standard which in very general terms mean potentially allowing for two different assessments of as well as solutions to the same problem. The 2008 versions solved this issue by specifying averaging only over the "Prescribed time frame" which is a time period representing 'Daytime', or 'Evening' specified in any rule or national environmental standard. The averaging effect was limited by capping averaging at a maximum 5 dB with no averaging during night time hours.

6.2.4 Sound Level Descriptors

One of the main consequences of updating NZS 6801 and NZS 6802 was a change in measurement descriptors. Background sound level [previously L_{A95}] was changed to L_{A90} in the 1999 version. The change was an update consistent with international usage in BS4142:1997 ~ Method for rating industrial noise affecting mixed residential and industrial areas and ISO 1996-2:2007. The difference between the L_{A95} unit and L_{A90} is generally small [typically about 1 dB or less] depending upon the noise source being assessed.

The 1999 revision replaced the L_{10} descriptor with L_{Aeq}, technically referred to in the 1999 and 2008 versions as the 'time average sound level', being denoted as $L_{Aeq}(t)$). What is vital about the $L_{Aeq}(t)$ is the measurement or assessment period [t = time] is required by both the 1999 and 2008 versions to be stated. The key difference between the 1999 version and the 2008 version was the standardising of a reference time interval as 15 minutes. The BS 4142:1997 $L_{Aeq}(1h)$ daytime and $L_{Aeq}(5min)$ night-time criteria had been abandoned in favour of 15 minutes. The L_{10} descriptor was originally adopted as it was demonstrated to have a reasonably good correlation with the degree of annoyance experienced by a typical person and was easy to calculate. Furthermore L_{10} could be determined from analogue sound level meters by the visual mean maxima estimation method acceptable at the time.

The introduction of L_{Aeq} was considered to be on a 'firmer foundation' and appropriate as international research had shown that the L_{Aeq} descriptor has a greater degree of correlation to noise annoyance than L_{10}, and for this reason was widely accepted as being the preferred noise descriptor for use in environmental noise standards and noise limits. Furthermore the L_{Aeq} level, being unrelated to the statistical variation in sound levels, is more readily predicted, which is a considerable advantage over L_{10}. As noted above, by its very nature, L_{Aeq}, is related to a specific time interval and will only provide a valid description of a sound environment if the measurements cover the range and variability of that sound environment. The L_{Aeq} noise descriptor is used internationally and from an acoustician's point of view it can be readily used to combine, separate or average sound from various noise sources. The L_{Aeq} metric is an energy average and is affected by all sounds measured at all levels, in proportion to their sound pressure level, duration and spectrum. The difference between the L_{10} unit and L_{Aeq} will depend upon the sound under investigation, in particular its frequency spectrum and the variability or intermittency. It is generally accepted that the difference would typically be 2-3 dB for "common" sounds but may be much larger for some specific situations. In the case of simple constant sound sources with a fix spectrum, such as a fixed speed fan, all descriptors would be treated as the same, that is $L_{10} = L_{eq} = L_{90} = L_{max}$. For more complex variable sound sources such as wind farm sounds or the sounds of passing road traffic, the difference between L_{Aeq} and L_{90} for the same reference time interval is around 2.5 dB at receiver locations when all data with extraneous measurement noise is removed.

A difference of 2-3 dB may appear insignificant, however two sound sources of equal power [thus with the same sound level] only increases the received sound pressure level by 3 dB. For example two sources each with an output of 50 dB, when they are combined result in a level of 53 dB. While an increase in received sound of +3 dB is detectable, it is not usually a significant increase in an environmental noise context and is significantly less than a doubling of perceived loudness [which for simple sources typically occurs when a sound level is increased by 10 dB]. The single event L_{Amax} sound level descriptor remained in the 2008 standard, being denoted as L_{AFmax} in accordance

Table 1: Example of Applying SAC under NZS 6801:1991 and NZS 6802:2008

Permitted Noise Limit = 60 dB Measured Sound Pressure Level = 58 dB Measured sound is assessed as having special audible characteristics	
1991 Method	**2008 Method**
Assessment under 1991 +5 dB Adjustment to applicable Noise Limit	Assessment under 2008 Adjustment to Sound Level
Measured Sound level = 58 dB Noise limit = 60 dB - 5 dB = 55 dB [for SAC] Sound Level is 3 dB over Noise Limit	Sound Level = 58 + 5 dB adjustment [for SAC] = Rating Level 63 dB Noise limit = 60 dB Rating Level is 3 dB over Noise Limit

with ISO 1996:2007 usage. NZS 6802:2008 states that the L_{AFmax} is the maximum A-frequency weighted, F-time weighted sound pressure level in decibels. Typically obtained with an A-frequency weighting and Fast [exponential]-time weighting on a sound level meter [SLM]. However, as modern SLMs produce short-L_{Aeq} values [commonly set to a 1 second integration period [L_{Aeq}, 1s] per data point] there may be a difference between a L_{AFmax} value and L_{Amax} based on the maximum short-L_{Aeq} for the 15 minute measurement period. The L_{AFmax} criteria is set for night-time hours only to protect from disturbance to the onset of sleep and awakening thresholds for the average person. Note: L_{Amax} must not be confused with the descriptor L_{peak}.

6.2.5 Notation

Correct use of noise conventions is important so that persons using the current notation are clear on which particular noise descriptors is being used. For example whether the noise descriptor uses A, C or Z -frequency weighting. NZS 6801:2008 states that in accordance with international conventions, where a sound level is A-frequency-weighted this shall be denoted by an 'A' subscript in the descriptor, for example, L_{Aeq}(15 min). Previous conventions of adding an 'A' to the units [for example dBA] shall not be used according to 2008 series when reporting sound levels in accordance with the Standard. The "F" [is included to make it explicit that "F" time-weighting applies for example in L_{AFmax}. The expression dBA or dB(A) should not be used. NZS 6801:2008 states the sound levels shall be reported in the format 'value-unit- descriptor-sample time', for example, 65 dB L_{Aeq}(15 min).

6.2.6 Adjustments

Assessment under the 2008 standards is based on a "Rating Level" obtained from the measured sound levels via the simple or detailed method with adjustments applied as appropriate. The following discusses some [but not all] relevant adjustments under NZS 6802:2008.

6.2.6.1 Duration Adjustments

The standard states that for prescribed time frames other than at night, subjective response is related to both the level and the duration of a sound. A duration adjustment for intermittency may be applied [subtracting up to 5dB from the measured and adjusted sound level] to account for the "lesser annoyance" generally caused by an intermittent sound compared to the same sound if it were continuously present. No adjustments are allowed for night time. Essentially the more the sound source is present, the less the duration adjustment allowed. An example is a permitted adjustment of 5dB when the percentage duration of specific sound in the prescribed time frame is less than 30%.

6.2.6.2 Special Audible Characteristics [SAC]

Adjustment for Special Audible Characteristics [SACs] has been a feature of past standards and continues its important role in the 2008 standards. The standard states that the intrusiveness of a sound is not just a function of its sound pressure level but also affected by its character such as tonality or impulsiveness which is likely to cause adverse community response at lower sound levels. If justified, the representative sound level determined over the reference time interval shall be adjusted to take into account the character of the specific sound[s] under investigation.

NZS 6802:2008 requires that the adjustment for special audible characteristics, where warranted, is added to the adjusted measured sound level before determining the Rating Level, as opposed to the 1991 version where special audible characteristics if present required the adjustment [5dB] to be subtracted from the specified numerical noise limit. In any event, there is no difference in the product of the two methods in terms of the final outcomes - as shown in the following example where the permitted noise limit is 60 dB and the measured sound pressure level is 58 dB, the example shows that using either the 1991 or 2008 method the sound level is 3 dB over the permitted noise limit.

The change to adjust the Rating Level as opposed to the sound limit was made so that if multiple sound sources are present and only one source was assessed as having special audible characteristics this could be addressed, but keeping the same fixed limit the sources with special audible characteristic are penalised under the 2008 version, as under the 1991 version for example the limit was penalised if only one sound source triggered assessment of special audible character being present.

The 2008 version can allow an adjustment in the range 1.0 to 6.0 dB, in the case where the reference method is used to determine tonality. This is different to the zero or +5 dB adjustment possible under the 1991 version assessment method which applied a 5 dB penalty to the specified noise limit making it more stringent by 5 dB. Appendix B of NZS 6802:2008 [Table B2] specifies how SACs are to be assessed providing guidance on the simplified test for tonality. It should also be noted that the symbol "k_2" after heading B4.5 "Adjustment" is an error and should be drafted as "K_t" as found in ISO 1996-2:2007 Annex C.

6.2.6.3 Residual Sound Contamination Adjustment

When measuring a specific sound source the microphone will also sense the contribution from other sound sources and include their contribution as the total sound pressure level. NZS 6802:2008 recommends that where appropriate, measured sound levels shall be adjusted to take into account the contribution of residual sound inadvertently included within the reading. Adjustments up to 3 dB are permitted if the difference between the total measured sound and residual sound difference is at least 3.0 dB. The adjustment in this case allows for the adjustment value K_1 to be subtracted from the total measured level. The correct level of the sound under investigation may not be possible where this sound level is within 3 dB of the residual sound level. This adjustment had not been specifically provided for in the 1991 version and was introduced in the 1999 version. NZS 6802:2008 provides guidance of the permitted adjustments, if the difference between measured total sound [referred to in Table B1 as L_{Meas}] and residual sound [referred to in Table B1 as L_{Resid}] is <3.0 dB no valid assessment can be done.

6.2.6.4 Facade Adjustments

The standard states that an adjustment to measurements so as to approximate free-field conditions at the microphone shall be made if there are reflections from structures other than ground, as in the 1999 version the 2008 version provided for a single 3 dB façade correction to be applied. No similar provision for an adjustment was included in the 1991 version, but it was implied.

6.2.6.5 Comparison of Adjustments and Methods under NZS 6802

The table in Appendix A compares the various adjustments and methods in all versions of NZS 6802 and predecessor documents.

6.2.7 Guideline Limits for the Projection of Health and Amenity Value

The NZS 6802 series have since the 1977 versions always provided recommended criteria or noise limits for the protection of Health and Amenity. These recommended guideline limits are provided as guideline residential upper noise limit values using L_{AFmax} and L_{Aeq} in the latest 2008 version of NZS 6802. The standard states the guidelines are generally acceptable noise limits and communities can make more or less stringent limits to suit their particular circumstances. The standard states such limits when adhered to provide "reasonable" protection of health and amenity. The 2008 version of the standard introduced an evening time frame with limits between the day and night limits if Local Authorities wished to incorporate such in their rules. NZS 6802 sets out the recommended Guideline Residential Upper Noise Limits. A daytime level of 55 dB L_{Aeq}(15 min) is set while a night time level of 45 dB L_{Aeq}(15 min) and 75 dB L_{AFmax} is set for the protection of health and amenity

The limits recommended above from NZS 6802:2008 are consistent with the guideline values for community noise in specific environments published by the World Health Organization [WHO] in 1999 which states that during the daytime, few people are seriously annoyed by activities with levels below 55 dB L_{Aeq}(16h). The night-time limit recommended should not exceed 45 dB L_{Aeq}(8h) outside dwellings so that people can sleep with windows open for ventilation and achieve the desirable indoor 30 to 35 dB L_{Aeq}(8h) level as a design level to protect against sleep disturbance. The WHO recommends various guidelines for specific environments. In the case of bedrooms the critical effect is sleep disturbance, where guideline indoor limits are 30 dB L_{Aeq} (8 hr) for continuous noise and 45 dB L_{AFmax} for single sound events. The WHO does however acknowledge that lower levels may be annoying depending on the nature of the sound source.

To protect the majority of people from being 'moderately annoyed' during the daytime, the outdoor sound level should not exceed 50 dB L_{Aeq} (16 hrs). The night time sleep disturbance threshold set were re-examined by the WHO Regional Office for Europe in a document entitled 'Night Noise Guidelines for Europe' [NNGfE]. In this "Interim targets" were defined to encourage countries to gradually reduce the percentage of the population exposed to levels above specified targets expressed as L_{night}, outside, but these values are yearly averages and should not be directly compared with L_{Aeq}(8h) values. NNGfE guidelines are considered by WHO to be an extension of the WHO 2000 guidelines, but not yet formerly adopted as an international WHO guideline. WHO guidelines have always been used in New Zealand Standards as the basis for protection of health and amenity values for an 'average' person's sensitivity but currently New Zealand does not use the L_{night}, outside noise descriptor.

6.2.8 Objective versus Subjective Assessment

The World Health Organization [WHO] defines annoyance as 'a feeling of displeasure evoked by noise'. Annoyance can relate to both acoustic and non-acoustic factors, including social, psychological and economic issues. There are considerable differences in individual reactions to the same sound. Annoyance is generally a subjective assessment influenced by a number of 'social moderators' including the source and type of noise, and an individual's ability to control the source, affecting how an individual reacts to it.

The New Zealand Standards, including NZS 6802:2008, set objective recommended assessment limits to protect health and amenity. One key issue is the subjective response to a change in noise level is widely variable between the populace. It would be very difficult [if not impossible] and impractical to set noise limits based on subjective assessment alone due to the number of confounding non-acoustical variables such as annoyance evaluation factors.

A typical subjective 'annoyance evaluation factor' commonly mentioned is if a specific sound source under investigation can be heard, that is the sound is audible with the human ear at a receiver location. It is however important to note that even if the specific sound was audible above background sound level this does not automatically mean when evaluating this sound source that it is above permitted objective recommended assessment limits to protect health and amenity. It is therefore important to consider that audibility based on subjective assessment and compliance based on objective assessment are two different issues.

6.3 NZS 6801:2008 Overview - See Table 2.

6.4 NZS 6802:2008 Overview - See Table 3.

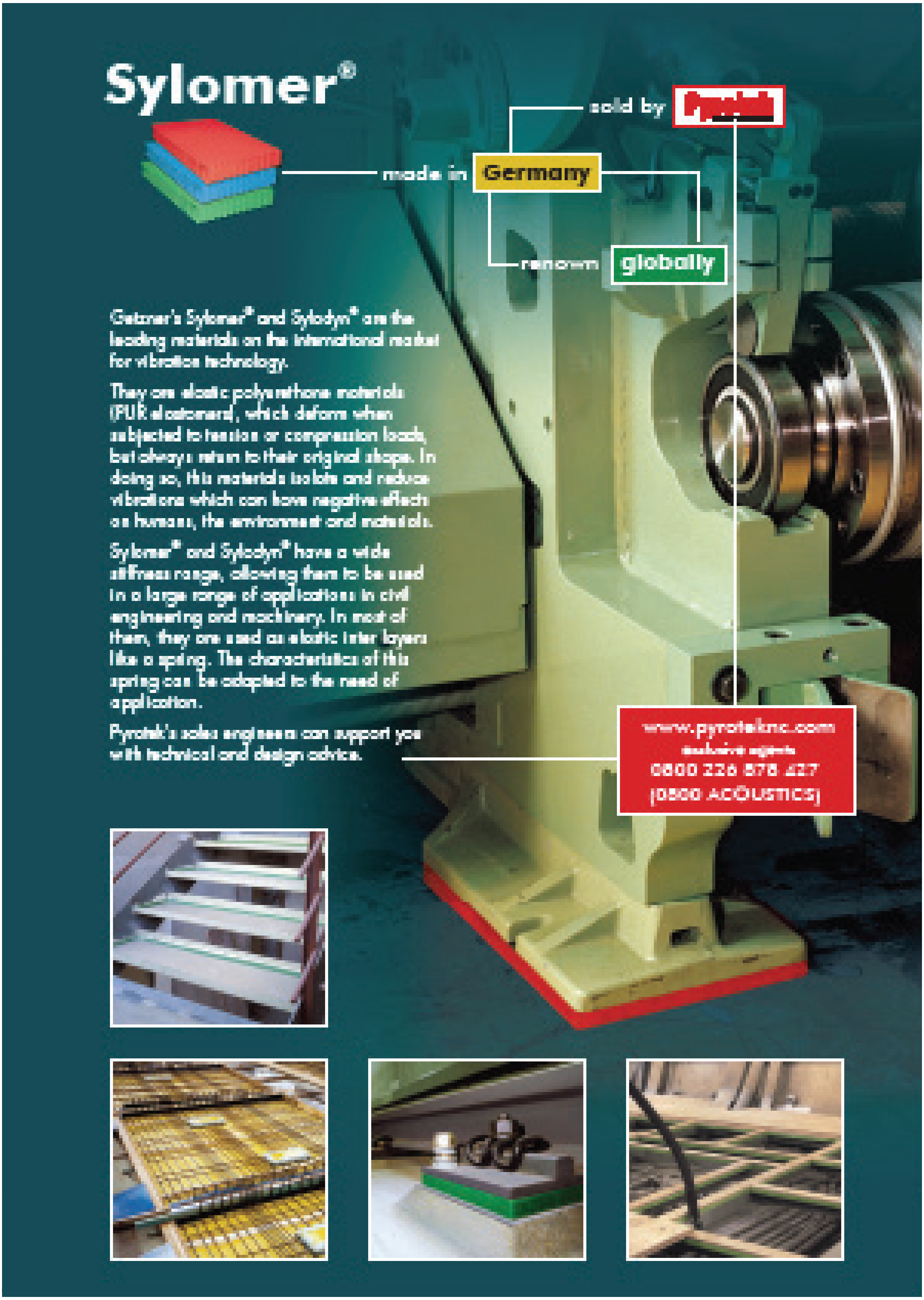
Table 2: Overview of NZS 6801:2008 Acoustics – Measurement of Environmental Sound

Full Name	NZS 6801:2008 Acoustics – Measurement of Environmental Sound
Abbreviation	NZS 6801:2008
Supersedes	NZS 6801:1977 NZS 6801:1991 NZS 6801:1999
Copyright	Copyright of the document is the property of the Standards Council
Purpose	This Standard sets out quantities to be used for the description of sound in community environments and describes procedures for the consistent measurement of these sound descriptors. The Standard may be cited in local authority rules, plans, and consent conditions or in National Environmental Standards to avoid the need for inclusion of technical information while ensuring national consistency in sound measurement methods
Key function[s]	Assessment Procedures Measurement Procedures √ Prediction Methods √ Guideline Noise Limits √ Management Methods and Procedures √ Compliance Methods and Procedures Land Use Planning Reporting Requirements √
Inclusions	NZS 6801 Foreword specifically states that the standard's methods and procedures for the measurement of sound are intended to be applicable from all sounds, individually or in combination.
Further Information **Related Documents**	-ANSIS12.181994. Procedures For Outdoor Measurement of Sound Pressure Level Describes procedures for the measurement of sound pressure levels -ISO 9613-1:1993 Acoustics -- Attenuation of sound during propagation outdoors -- Part 1: Calculation of the absorption of sound by the atmosphere -ISO 9613-2:1996. Acoustics -- Attenuation of sound during propagation outdoors -- Part 2: General method of calculation -ISO 1996-1:2003 Acoustics -- Description, measurement and assessment of environmental noise -- Part 1: Basic quantities and assessment procedures -ISO 1996-2:2007 Acoustics - Description, measurement and assessment of environmental noise -- Part 2: Determination of environmental noise levels -ISO 80000-8:2007 - Quantities and units - Part 8: Acoustics
Key Noise Descriptor	L_{A90} $L_{Aeq(t)}$, $L_{Aeq\ (15\ minute)}$, L_{AFmax}
Proficiency Level	Persons using the standard are assumed to have an understanding of the science of environmental acoustics and be proficient in and have experience in acoustic measurement.

Table 3: Overview of NZS 6802:2008 Acoustics – Environmental Noise

Full Name	NZS 6802:2008 Acoustics –Environmental Noise
Abbreviation	NZS 6802:2008
Supersedes	NZS 6802:1977 NZS 6802:1991 NZS 6802:1999
Copyright	Copyright of the document is the property of the Standards Council
Purpose	This Standard sets out procedures for the consistent assessment of noise for compliance with noise limits. The standard provides guidance for the setting of noise limits for consent conditions, rules or national environmental standards
Key functions	Assessment Procedures √ Measurement Procedures Prediction Methods Guideline Noise Limits √ Management Methods and Procedures Compliance Methods and Procedures √ Land Use Planning √ Reporting Requirements √
Inclusions	This Standard sets out procedures for the assessment of nose for compliance with noise limits and provides guide for setting noise limits. Sound from rail yards not attributable to vehicle on rails and sound from airport activities except from aircraft taxing and in-flight are within the scope of NZS 6802 Light aircraft flight and ground movements not at airports which are outside the scope of other standards are within the scope of NZS 6802 Where sound from transportation or construction is part of ongoing day to day sound emissions it shall be assessed using NZS 6802. Where the residual sound level is required for the purpose of this standard all sources of sound are included whether or not they are subject to assessment by another standard.
Restrictions	NZS 6802 does not apply to sound where the source is within the scope of and subject to the application of any other New Zealand Standard including -Road and rail transport -Flight operations of fixed or rotary wind aircraft associated with airports or helicopter landing areas -Construction noise -Port Noise -Vehicles on Public Roads -Wind Turbine Generators -Impulsive sounds [blasting and gun fire]
Further Information Related Documents	NZS 6801:2008 Acoustics – Measurement of Environmental Sound
Key Noise Descriptor	L_{A90} $L_{Aeq(t)}$, $L_{Aeq\ (15\ minute)}$, L_{AFmax}
Proficiency Level	Persons using the standard are assumed to have an understanding of the science of environmental acoustics and be proficient in interpreting acoustic measurement data as well as proficient in acoustic assessment and analysis.

Continued on Page 26...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7 NZS 6803 Measurement and Assessment of Construction Noise

'NZS 6803:1999 Acoustics – Construction Noise' is the current standard for construction noise assessment. The Standard was prepared by the 'Acoustics Construction Noise Committee' [EV/10/9] for the Standards Council established under the Standards Act 1988 as a "New Zealand" only project. The provisional version of NZS 6803 entitled 'NZS 6803P:1984 The Measurement and Assessment of Noise From Construction, Maintenance and Demolition Work' was first issued in 1982 but withdrawn due to errors and re-issued in 1984 as a provisional standard seeking comments from users of the new 1999 standard. Noise from construction projects generally cannot comply with the day-to-day permitted operational noise limits set out within District Plans or those recommended in standards such as NZS 6802. Although this may mean that the noise produced is undesirable by some parties it does not mean that the noise is unreasonable when all the relevant factors such as the limited duration, time of operation and mitigation measures, are taken into account.

This standard covers construction work of limited duration only. Projects such as demolition of a structure, alterations or additions to buildings, road reconstruction or re-alignment for example represent temporary noise sources and are assessed differently than noise from ongoing activities from a site, for example quarrying, landfill or the ongoing construction of pre-fabricated buildings or building components. The standard provides methods for the measurement, assessment, prediction and management of construction noise and should be read and used in conjunction with NZS 6801 and NZS 6802. While the versions of these standards referenced pre-date the 2008 versions, best practice should be followed to apply the latest versions unless there is a specific legal imperative requiring a specific edition be applied. NZS 6803 states that it should be used for the setting of noise limits to reduce the likelihood of annoyance, nuisance and adverse health effects to people in the vicinity of construction work. The standard recommended limits based on duration of works, time of day and if the activity occurs on a weekday or holiday. The standard provides two key tables; the first one is for noise sensitive residential areas and the second for industrial or commercial areas. The three categories are described for work duration as "short", "typical" and "long". This 1984 provisional standard was extensively reviewed in 1997-99 as NZS 6803:1999 and remains the current standard for the measurement and assessment of construction noise. Changes from the 1984 to 1999 version included the use of the L_{Aeq} noise descriptor for assessment of noise. Sound from construction work is usually highly variable. Therefore care must be taken to ensure that the measurements are representative of the sounds under investigation. The standard also states that measurement sample time should not exceed one hour and 15 minutes will often be adequate. Interestingly, unlike other standards [in particular the base standard 6801] or District Plans, the permitted noise limits NZS 6803:1999 requires noise assessment 1 metre from any exposed wall of a building used for a noise sensitive activity and not at the site boundary or notional boundary if the applicable assessment location. The construction standard is also unique in that the measured levels when compared against applicable limits in the standard are not adjusted for special audible characteristics as would occur under NZS 6802 all versions for example.

NZS 6803 is one of the larger standards, being over 70 pages; however the majority of these pages are Annexes, with Annexes B, C and D being reproduced from British Standard 'BS 5228-1:1991 Noise and vibration control on construction and open sites. Code of practice for basic information and procedures for noise and vibration control'. Both Part 1 and Part 2 of BS 5228 have now been superseded, the first updated version being 1997 and the latest versions being BS 5228-1:2009 and BS 5228-2:2009. The main change from the previous versions is Part 1 of the standard covers noise while Part 2 covers vibration. Updated databases for equipment noise values referred to in the NZS 6803 annexes are available on-line.

Section 1.4 of NZS 6803 specifically states that the standard

Table 4: Overview of NZS 6803:1999 Acoustics – Construction Noise

Full Name	NZS 6803:1999 Acoustics – Construction Noise
Abbreviation	NZS 6803:1999
Supersedes	NZS 6803:1984P
Copyright	Copyright of the document is the property of the Standards Council
Purpose	This Standard sets out procedures for the measurement and assessment of noise from existing and proposed construction work, including maintenance and demolition work. The standard recommends noise limits and provides guidance of prediction and management of construction noise. The standard is intended to assist Local Authorities, developers, architects, engineers, planners, designers, and contractors to control noise on and from construction, maintenance and demolition sites.
Key functions	Assessment Procedures √ Measurement Procedures √ Prediction Methods √ Guideline Noise Limits √ Management Methods and Procedures √ Compliance Methods and Procedures Land Use Planning Reporting Requirements √
Inclusions	Applies only to construction noise on temporary duration
Restrictions	NZS 6803 does not apply to -Vibration or blasting, noise induced hearing loss, or effects of noise upon wildlife, stock, or domestic animals. -NZS 6803 does not apply to 'emergency works' as defined in the Resource Management Act 1991.
Further Information Related Documents	-NZS 6801:2008 Acoustics – Measurement of Environmental Sound -AS2187.2-2006 Explosives - Storage and use -British Standard BS 5228-1:1991 Noise and vibration control on construction and open sites. Code of practice for basic information and procedures for noise and vibration control. -BS5228-1:2009 Construction Noise. Code of practice for noise and vibration control on construction and open sites. -BS5228-2:2009 Vibration. Code of practice for noise and vibration control on construction and open sites. -ISO 2631-2:2003 Mechanical vibration and shock - Evaluation of human exposure to whole body vibration — Part 2: Vibration in buildings [1 Hz to 80 Hz] -BS 6472:1992. 'Evaluation of Human Exposure to Vibration in Buildings [1Hz to 80Hz]
Key Noise Descriptor	$L_{A90,}$ $L_{Aeq(t)}$, L_{AFmax}
Proficiency Level	Proficiency of this standard depends upon which part of the standard is being applied. Generally the standard can be used without any immense knowledge or background science of acoustics in terms of the noise management side, however regarding assessment or measurement of construction noise the person using the standard are assumed to have an understanding of science of acoustics and related construction activities being assessed.

Table 5: Past and Present Environmental Acoustic Noise Standards NZS 680X Series.

NZS 6801:1977 Methods of Measuring Sound NZS 6802:1977 Assessment of Noise in the Environment	Superseded Superseded
NZS 6801:1991 Measurement of Environmental Noise NZS 6802:1991 Assessment of Environmental Noise	Superseded Superseded
NZS 6801:1999 Acoustics – Measurement of Sound NZS 6802:1999 Acoustics – Assessment of Environmental Sound	Superseded Superseded
NZS 6801:2008 Acoustics – Measurement of Environmental Sound NZS 6802:2008 Acoustics –Environmental Noise	Current Current
NZS 6803P:1984 The Measurement and Assessment of Noise From Construction, Maintenance and Demolition Work.	Superseded
NZS 6803:1999 Acoustics – Construction Noise	Current
NZS 6805:1992 Airport Noise Management and Land Use Planning	Current
NZS 6806:2010 Acoustics – Road Traffic Noise – New and Altered Roads	Current
NZS 6807:1994 Noise Management and Land Use Planning for Helicopter Landing Areas	Current
NZS 6808:1998 Acoustics – The Assessment and Measurement of Sound From Wind Turbine Generators.	Superseded
NZS 6808:2010 Acoustics –Wind Farm Noise	Current
NZS 6809:1999 Acoustics – Port Noise Management and Land Use Planning	Current

"does not cover vibration". Generally this is because although vibration is a common by–product of construction work, vibration itself is separate expert field for both assessment and measurement. The effects of vibration may relate to potential damage to buildings [structural damage] and human response [annoyance and subjective response]. NZS 6803 also does not specifically assess air-blast noise. Airblast noise is another type of potential effect from construction noise and can be described as the pressure wave that radiates out from the blasting area of an explosion hence 'noise' from explosives or 'blasting' is often described as "airblast" noise. Section 8.1.4 of NZS 6803 however states that noise from explosives is a special case and that the practice of good blasting should be adopted with the provisions of such documents as AS 2187.2-2006 Explosives - Storage and use, is referenced by NZS 6803:1999. AS 2187.2 provides a table with limits to avoid structural damage and to maintain human comfort. It is important to understand that 'modern blasting' is generally small scale controlled blasting which lasts a few seconds in duration and is assessed and conducted by suitable qualified and experienced engineers – noting that acoustical, geotechnical and blasting engineering are three distinct professional areas.

7.1 NZS 6803:1999 Overview - See Table 4.

8 NZS 6804:0000

There is no actual NZS 6804, this is the only standard designated between 01 and 09 that does not exist. It is noted that the NZS 6804 designation was left vacant for what was at the time going to be a planned New Zealand standard for Acoustics and electro-acoustics standards specifically sound level meters. NZS 6801:1977 related documents section tells us that this was going to be designated ' NZS 6804: Sound Level Meters'. However it is understood that a decision was made around 1984 not to produce this New Zealand standard.

9 List of NZS 680X: Past and Present

See Table 5.

10 List of Supplementary New Zealand Standards

The following list of standards are not NZS 680X series standards but are examples of those referenced within the series [the list is not exhaustive]

- AS/NZS2107:2000 Acoustics Recommended Design Sound Levels and Reverberation Times For Building Interiors.
- AS/NZS 2460:2002 Acoustics Measurement of the reverberation time of rooms
- ISO 1996-2:2007 Acoustics - Description, measurement and assessment of environmental noise — Part 2: Determination of environmental noise levels
- ISO 9613-1:1996 Acoustics - Attenuation of sound

during propagation outdoors - Part 1: General method of calculation of the absorption of sound by the Atmosphere

- ISO 9613-2:1996 Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation
- ANSI S12.18-1994 Procedures For Outdoor Measurement of Sound Pressure Level Describes procedures for the measurement of sound pressure levels.

Note IEC standards, such as those related to instrumentation, have been omitted from this list – A list can be found in NZS 6801:2008.

11 Qualifications of Review

This paper review is intended as a guide only, it is not intended to be surrogate for any person using a NZS 680X standard or expert advice from a professional acoustician or acoustic engineer. The reader and users should further understand that the information within this review does not attempt to cover all areas and applications of the NZS 680X standards and therefore there will be omissions. While all care has been taken in the preparation of this work and the information which is included is believed to be correct at the time of preparation, users of this paper should apply discretion and rely on their own judgements regarding the use of the above information. It may be necessary to obtain independent professional advice from a suitably qualified and experienced acoustician or acoustic engineer. It is not considered appropriate for the user to simply rely on the contents of this note without reading the contents of NZS 680X standards themselves.

12 Copyright and Further Information

This paper review includes information reproduced from the relevant New Zealand Standards NZS 680X series as referenced. The review has been undertaken with the authorization and review of Standards New Zealand. Information pertaining to standards and all related information remains at all times the property of the Standards Council and anyone wishing to reproduce, copy or use this information must ensure they comply at all times with the legal copyright of Standards New Zealand for each standard. Standards encourage suggestions for improvement of Standards and comments can be directed to Standards Private Bag 2439, Wellington 6140. Suggestions should be sent to the Chief Executive Officer, Standards New Zealand. Standards can be purchased through the on-line Standards New Zealand web shop via http://www.standards.co.nz. No parts of this review may be used, reproduced or stored for any purpose including consulting or commercial purposes without the written permission of both the authors and Standards New Zealand.

Appendix A - Differences in methods of applying adjustments to NZS 6802 Editions 1972-2013

The methods for making adjustments for special audible characteristics, duration and intermittency, background contamination, reflections and facade adjustments or corrections are different in most editions of NZS 6802. The table below summarises the differences. Note the differences in terminology, metrics and the different methods of application to measured or derived values. ¶

Table 6: Adjustment Methods - Environmental Acoustic Noise Standards NZS 680X Series.

<table>
<tr><th colspan="2">Which version?</th><th colspan="6">Methods of adjustment</th></tr>
<tr><th>Edition</th><th>Defined terms</th><th>Applies to</th><th>Intermittency / duration
daytime only
dB</th><th>Background contamination
[residual sound]
Method</th><th>Special audible characteristics
dB</th><th>Reflections method</th><th>Microphone sound field
method</th></tr>
<tr><td>MOH guide
Pre-1977</td><td rowspan="2">Corrected noise level</td><td rowspan="2">Measured level
L_{10} dBA</td><td>tabulated
0 to -30</td><td rowspan="2">Not stated</td><td rowspan="4">0 or - 5</td><td colspan="2" rowspan="2">Not stated</td></tr>
<tr><td>1977</td><td>tabulated
0 to -20</td></tr>
<tr><td>1991</td><td>Adjusted sound level</td><td>Noise limit
$L_{10}(t)$ dBA</td><td>0 or -5</td><td>Referred to but method undefined</td><td colspan="2">Referred to but method undefined</td></tr>
<tr><td>1999</td><td rowspan="2">Rating Level</td><td>noise limit
$L_{Aeq}(t)$</td><td>Not applicable</td><td rowspan="2">Calculated method or nomogram</td><td colspan="2">Not included in Rating Level calculation</td></tr>
<tr><td>2008</td><td>Measured level
$L_{Aeq}(t)$</td><td>Tabulated</td><td>0 or - 5
[0 to - 6 for reference method]</td><td colspan="2">Included in Rating Level calculation</td></tr>
</table>

January 2014

The purpose of the ICA is to promote international development and collaboration in all fields of acoustics including research, development, education, and standardisation.

http://www.icacommission.org/

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To all Member Societies and International Affiliates

Please receive best wishes for your organization for the New Year of 2014.

The highlight for the ICA in the year of 2013 was the 21st ICA congress in Montreal, Canada. This meeting was jointly organized by the Canadian Acoustical Association and the Acoustical Society of America and there was a record attendance during the 5 day congress with 2300 registrants and over 1600 technical papers presented and 49 Exposition booths. Sincere thanks are due to the excellent planning and organization by the local team around Mike Stinson, Gilles Daigle and Luc Mongeau.

The General Assembly for the ICA was held during this conference. The proposed changes in governance were all accepted and the new board elected under the new rules. The benefit of the new governance was immediately obvious from the number of nominees for the positions on the board. Following the election the Board now comprises Júlio A. Cordioli (Brazil), Dorte Hammershøi (Denmark), Bertrand Dubus (France), Roberto Pompoli (Italy), Kohei Yamamoto (Japan), Jeong-Guon Ih (Korea), Grazyna Grelowska (Poland), Monika Rychtarikova (Slovakia), Yiu Lam (UK) and Mark Hamilton (USA). The executive are Marion Burgess as President, Michael Vorlander as Past President, Jing Tian as Vice President, Mike Stinson as Secretary General and Antonio Perez-Lopez as Treasurer. Those board members retiring at the time of the General Assembly included some who had served many terms in various positions and were all warmly thanked for their contributions to the board and the ICA.

The ICA is continuing to grow with the new members, Israel and Nigeria welcomed at the General Assembly. This took our membership to 47 member organizations and 8 International Affiliates.

Increasing the awareness around the world of the science and technology of sound is an important task for the ICA. The ICA is an Affiliate Member of the global organization for science, the International Council for Science, ICSU as well as Associate Member of International Union for Pure and Applied Physics (IUPAP) and the International Union of Theoretical and Applied Mechanics (IUTAM).

To further increase awareness internationally the ICA is actively working towards an International Year of Sound in 2019. We are pleased to report that Manell Zakharia has accepted to lead a task group to work on achieving this aim. To have an "International Year" status is a very great challenge and the ICA will be seeking the support from all the member societies and international affiliates as the project continues.

A task group, under the leadership of Vice President Jing Tian, has been set up to investigate the fee structure and the communication with members. At the 2013 board meeting there was agreement that information on each of the member societies would be a valuable addition to the ICA web page. The board also agreed to cover the costs of scanning all the old ICA proceedings and make these freely available from the website. As the ICA congress covers all areas of acoustics this will be a valuable record showing the development of acoustics over the decades. We are grateful for the assistance from Jing Tian for organizing this scanning. As soon as this has been completed and the access arrangements finalized we will advise of the link and make it freely available from the ICA webpage.

The ICA encourages acoustic endeavors by providing financial support for international symposia. In 2014 the support will be provided to:

- 6th Congress of the Alps Adria Acoustics Association, Graz, Austria
- XXV Encontrol da Sociedade Brasileira de Acustica (SOBRAC), Campinas, Brazil
- Intl. Symposium on Musical Acoustics 2014, Le Mans, France
- 11th Intl. Congress on Noise as a Public Health Problem (ICBEN 2014), Nara, Japan
- 2nd Intl. Conference of the Acoustical Society of Nigeria (ASON 2014), Nsukka, Nigeria
- XXXI Symposium on Hydroacoustics, Swinoujscie, Poland
- European Symposium on Smart Cities and Environmental Acoustics, Murcia, Spain

And in conjunction with the Acoustical Society of America will be supporting

- 12th School on Acousto-Optics and Applications, Druskininkai, Lithuania

In order to increase the awareness of the ICA, all members are encouraged to identify their involvement with the ICA by including the ICA logo on their webpage and on the documentation for meetings and conferences. This logo is available from: http://www.icacommission.org/archive/. A poster that can be used for promotional purposes is also available at this site.

Please stay in contact with the ICA Board, particularly with the Secretary General, Mike Stinson, with the Treasurer, Antonio Perez-Lopez, with Vice-President Jing Tian, and with myself. We would be happy to receive your comments and suggestions. And finally, let me wish a Happy and Prosperous New Year 2014 for your organisation.

Marion Burgess

President ICA 2013-2016


CELEBRATING
100 YEARS
IN THE MAKING
WALLS
LED LIGHTING
SOLAR
FORMAN
BUILDING SYSTEMS

Pickering Medal Winner

Sir Harold Marshall

Sir Harold Marshall has been awarded the 2013 Pickering Medal by the Royal Society of New Zealand, in recognition of his innovative acoustic design.

Sir Harold, who is a former Professor of Architecture and also headed the Acoustics Research Centre at the University of Auckland, is the co-founder of Marshall Day Acoustics.

For over thirty years Sir Harold has explored asymmetry in acoustic design, with his methods now acknowledged as the preferred genre for concert halls. Recognised as one of the most talented acoustic designers of the 20th and 21st centuries, Sir Harold's work includes the Christchurch Town Hall, the Guangzhou

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Opera House and more recently the Philharmonie de Paris. The Guangzhou Opera House received an RIBA International Award for architectural excellence, with the citation stating 'for all the auditorium's asymmetry, the acoustics are perfect'.

"Sir Harold Marshall has made an outstanding contribution to acoustics research, teaching and practice in Australasia and beyond, having taught and inspired generations of architecture students at the University of Auckland." says Professor Diane Brand, Dean of the National Institute of Creative Arts and Industries.

The Pickering Medal is awarded annually. Named after William Pickering, a New Zealand born, world-acclaimed rocket scientist, the medal is bestowed on a person who, while in New Zealand, has through design, development or invention, produced innovative work of importance both nationally and internationally, or which have led to significant commercial success.

Sir Harold has received a multitude of accolades. In 2008 he was made a Distinguished Companion of the New Zealand Order of Merit for services to acoustical science and in 2009 he accepted the title Knight Companion of the Order, KNZM.

AS/NZ 2107 Review Project

Standards Australia have announced a project to revise to AS/NZS 2107 "Acoustics - Recommended design sound levels and reverberation times for building interiors". The project will involve input from New Zealand, with 3 members of the Acoustical Society of New Zealand on the review committee. If you are interested in providing comments or input on this project, contact Dr George Dodd in the first instance g.dodd@auckland.ac.nz.

Last Word

Acoustics pioneer Amar Bose, founder and chairman of the audio technology company Bose Corp., known for its small tabletop radios and its noise-canceling headphones, has died at age 83. Bose started a research program in physical acoustics and psychoacoustics at MIT, leading to patents in nonlinear systems. ¶

2014

6 - 10 July, 21st International Congress on Sound and Vibration (ICSV21), Beijing, China
http://www.icsv21.org/

07 -12 September, Krakow, Poland Forum Acusticum 2014
http://www.fa2014.pl/

08 -10 September, Fort Lauderdale, USA
Noise-Con 2014
http://www.inceusa.org/nc14/

29 September - 1 October, Berlin, Germany
16th International Conference on Low Frequency Noise and Vibration and its Control
http://www.lowfrequency2014.org

06 - 10 October, Prague, Czech Republic 11th European Conference on Non Destructive Testing
http://www.ecndt2014.com/

27 - 31 October, 168th Meeting of the Acoustical Society of America, Indianapolis, USA
http://www.acousticalsociety.org

16 - 19 November, Melbourne, Australia
Internoise 2014
http://www.internoise2014.org

2015

18 - 22 May, Pittsburgh, USA
169th Meeting of the Acoustical Society of America
http://www.acousticalsociety.org

12 - 16 July, Brescia, Italy
22nd International Congress on Sound and Vibration (ICSV 22)
http://www.iiav.org

31 May - 3 June, Maastricht, Netherlands
Euronoise 2015
https://www.euracoustics.org/events/events-2015

9 - 12 August, San Francisco, USA
44th International Congress and Exposition on Noise Control Engineering (INTER-NOISE 2015)
http://internoise2015.com/

Auckland

215, Dominion Rd	(1)	★★★★½
Andrea (form. Positano), Mission Bay	(1)	★★★
Aubergine's, Albany	(1)	★★★★½
Backyard, Northcote	(1)	★★
Bask, Browns Bay	(1)	★★★
Bay (The), Waiake, North Shore	(1)	★★★★★
Bolero, Albany	(1)	★★★★
Bosco Verde, Epsom	(1)	★★★★½
Bouchon, Kingsland	(1)	★★
Bowman, Mt Eden	(1)	★★★★½
Bracs, Albany	(1)	★★★★
Brazil, Karangahape Rd	(1)	★★★
Buoy, Mission Bay	(2)	★★★★½
Byzantium, Ponsonby	(1)	★★★
Café Jazz, Remuera	(1)	★★★★½
Carriages Café, Kumeu	(1)	★★★★
Charlees, Howick	(1)	★★★★★
Cibo	(1)	★★★★★
Circus Circus, Mt Eden	(1)	★★
Cube, Devenport	(1)	★★
Del Fontaine, Mission Bay	(1)	★★★★★
Deli (The), Remuera	(1)	★★★★
Delicious, Grey Lynn	(1)	★★★★★
De Post, Mt Eden	(1)	★★
Dizengoff, Ponsonby Rd	(1)	★★
Drake, Freemans Bay (Function Room)	(1)	★★
Eiffel on Eden, Mt Eden	(1)	★★
Eve's Cafe, Westfield Albany	(1)	★★★½
Formosa Country Club Restaurant	(1)	★★★★★
Garrison Public House, Sylvia Park	(1)	★★★★½
Gee Gee's	(1)	★★★
Gero's, Mt Eden	(9)	★★★
Gina's Pizza & Pasta Bar	(1)	★★★½
Gouemon, Half Moon Bay	(1)	★★
Hardware Café, Titirangi	(1)	★★★★★
Hollywood Café, Westfield St Lukes	(1)	★★½
IL Piccolo	(1)	★★★★
Ima, Fort Street	(1)	★★★★
Jervois Steak House	(1)	★★★
Kashmir	(1)	★★★★
Khun Pun, Albany	(2)	★★★★★
Kings Garden Ctre Café, Western Springs	(1)	★★
La Tropezienne, Browns Bay	(1)	★★
Malaysia Satay Restaurant, Nth Shore	(1)	★★★★★
Mecca, Newmarket	(1)	★★★★★
Mexicali Fresh, Quay St	(1)	★★
Mezze Bar, Little High Street	(16)	★★★★
Monsoon Poon	(1)	★★★★★
Mozaike Café, Albany	(1)	★★
Narrow Table (The), Mairangi Bay	(1)	★★★★½
One Red Dog, Ponsonby	(1)	★★★
One Tree Grill	(1)	★★★
Orbit, Skytower	(2)	★★★★
Patriot, Devonport	(1)	★★★½
Pavia, Pakuranga	(1)	★★★★★
Prego, Ponsonby Rd	(2)	★★
Remuera Rm, Ellerslie Racecourse	(1)	★★★★★
Rhythm, Mairangi Bay	(1)	★★
Rice Queen, Newmarket	(12)	★★★★
Sails, Westhaven Marina	(2)	★★★★★
Scirocco, Browns Bay	(1)	★★★
Seagers, Oxford	(1)	★★★★
Shahi, Remuera	(1)	★★★½
Shamrock Cottage, Howick	(1)	★★
Sidart, Ponsonby	(1)	★★★★½
Sitting Duck, Westhaven	(1)	★★★½
Sorrento	(1)	★★½
Stephan's, Manukau	(1)	★★★★★
Tempters Café, Papakura	(1)	★★★★★
Thai Chef, Albany	(1)	★★★★★
Thai Chilli	(1)	★★★★★
Thai Corner, Rothesay Bay	(1)	★★★★★
Tony's, High St	(1)	★★★
Traffic Bar & Kitchen	(1)	★★
Umbria Café, Newmarket	(1)	★★★★½
Valentines, Wairau Rd	(1)	★★★★★
Vivace, High Street	(2)	★★½
Wagamama, Newmarket	(1)	★★★★½
Watermark, Devonport	(1)	★★
Woolshed, Clevedon	(1)	★★½
Zarbos, Newmarket	(1)	★★
Zavito, Mairangi Bay	(1)	★★ ★

Arthur's Pass

Arthur's Pass Cafe & Store	(1)	★★★½
Ned's Cafe, Springfield	(1)	★★★★

Ashburton

Ashburton Club & MSA	(1)	★★★★½
Robbies	(1)	★★★
RSA	(1)	★★★★

Readers are encouraged to rate eating establishments which they visit by completing a simple form available on-line from www.acoustics.ac.nz, or contact the Editor.
Repeat ratings on listed venues are encouraged.

★ Lip-reading would be an advantage. ★★ Take earplugs at the very least. ★★★ Not too bad, particularly mid-week.
★★★★A nice quiet evening. ★★★★★The place to be and be heard. (n) indicates the number of ratings.

Tuscany Café & Bar	(1)	★★★

Bay of Plenty

Alimento, Tauranga	(1)	★½
Imbibe, Mt Maunganui	(1)	★½
Versailles Café, Tauranga	(2)	★★

Blenheim

Raupo Cafe	(1)	★★

Bulls

Mothered Goose Cafe, Deli, Vino	(1)	★★

Cambridge

GPO	(1)	★★★★★

Christchurch

3 Cows, Kaiapoi	(1)	★★★★
Abes Bagel Shop, Mandeville St	(1)	★★★★
Alchemy Café, Art Gallery	(1)	★★★★★
Anna's Café, Tower Junction	(1)	★★★★
Arashi	(1)	★★
Azure	(2)	★★★
Becks Southern Ale House	(11)	★★★★½
Bridge (The), Prebbleton	(1)	★★★★★
Buddha Stix, Riccarton	(1)	★★★★
Bully Haye's, Akaroa	(1)	★★
Café Valentino (St Asaph St)	(1)	★★★
Cashmere Club	(1)	★★★★★
Chinwag Eathai, High St	(8)	★★
Christchurch Casino	(1)	★★
Christchurch Museum Café	(1)	★★★★
Cobb & Co, Bush Inn	(1)	★★★
Coffee Shop, Montreal Street	(1)	★★
Cookai	(3)	★★½
Cortado, Colombo Street	(4)	★★★★
Costas Taverna, Victoria Street	(1)	★½
Coyote's	(6)	★★★
Curator's House	(25)	★★★½
Decadence Café, Victoria St	(1)	★★★★★
Drexels Breakfast Restaurant, Riccarton	(1)	★★★★
Elevate, Cashmere	(6)	★★★
Fava, St Martins	(1)	★★
Foo San, Upper Riccarton	(1)	★★★½
Fox & Ferrett, Riccarton	(1)	★★★★★
Freemans, Lyttleton	(9)	★★★½
Gloria Jean's, Rotheram St	(1)	★★★★
Golden Chimes	(1)	★★★★★
Governors Bay Hotel	(1)	★★★★
Green Turtle	(1)	★★★★
Harpers Café, Bealey Ave	(1)	★★★★★
Hari Krishna Café	(1)	★★★
Holy Smoke, Ferry Rd	(1)	★★
Indian Fendalton	(2)	★★
Joyful Chinese Rest., Colombo St	(1)	★★★★★
Kanniga's Thai	(1)	★★★
La Porchetta, Riccarton	(4)	★★½
Lone Star, Riccarton Road	(6)	★★★
Lyttleton Coffee Co, Lyttleton	(1)	★★★★
Manee Thai	(6)	★★½
Merrin Street (Monteiths)	(2)	★★½
Mexican Café	(6)	★★★
Myhanh, Church Corner	(4)	★★★½
Number 4, Merivale	(2)	★★★★
Oasis	(1)	★★★★½
Old Vicarage	(2)	★★★½
Phu Thai, Manchester Street	(1)	★★★
Portofino	(3)	★★★★★
Pukeko Junction, Leithfield	(1)	★★★★
Red, Beckenham Service Centre	(1)	★★★★
Red Elephant	(1)	★★★★
Retour	(1)	★★★
Riccarton Buffet	(2)	★★★★½
Robbies, Church Corner	(2)	★★★★½
Route 32, Cust	(1)	★★★★
Salt on the Pier, New Brighton	(6)	★★★½
Sand Bar (The), Ferrymead	(2)	★★★½
Speights Ale House, Ferrymead	(3)	★★★★★
Speights Ale House, Tower Junction	(1)	★★★★
Tokyo Samurai	(1)	★★★★★
Tutto Bene, Merivale	(2)	★★
Twisted Hop (The), Woolston	(3)	★★★★½
Untouched World Cafe	(1)	★★★★★
Venuti	(3)	★★★★★
Visions Restaurant, CPIT	(1)	★★
Waitikiri Golf Club	(1)	★★
Waratah Café, Tai Tapu	(1)	★★★

Clyde

Old Post Office Cafe	(1)	★★★★★

Dunedin

A Cow Called Berta	(1)	★★★½
Albatross Centre Cafe	(1)	★★★★★
Bennu	(1)	★★★★
Bx Bistro	(1)	★★★★
Chrome	(1)	★★★★½
Conservatory, Corstophine House	(1)	★★★★★
Fitzroy Pub on the Park	(1)	★★★★★
High Tide	(2)	★★

Nova	(1)	★★★★★
St Clair Saltwater Pool Cafe	(1)	★★★★½
Swell	(1)	★★
University of Otago Staff Club	(1)	★★

Feilding

Essence Cafe & Bar0	(1)	★★★★

Gore

Old Post	(1)	★★★
The Moth, Mandeville	(1)	★★★★★

Greymouth

Cafe 124	(1)	★★★

Hamilton

Embargo	(1)	★★★★★
Gengys	(1)	★★
Victoria Chinese Restaurant	(1)	★★★★★

Hanmer Springs

Coriander's	(2)	★★★★½
Laurels (The)	(2)	★★★★★
Saints	(1)	★★★★½

Hastings

Café Zigliotto	(1)	★★★

Havelock North

Rose & Shamrock	(1)	★★★½

Levin

Traffic Bar & Bistro	(1)	★★

Masterton

Java	(1)	★★

Matamata

Horse & Jockey	(1)	★★★★★

Methven

Ski Time	(2)	★★★

Napier

Boardwalk Beach Bar	(2)	★★★★★
Brecker's	(1)	★★★★★
Café Affair	(1)	★★
Cobb & Co	(1)	★½
Duke of Gloucester	(1)	★★★★½
East Pier	(1)	★★
Estuary Restaurant	(1)	★★★★★
Founder's Cafe	(1)	★★★★★
Napier RSA	(1)	★★★★★
Sappho & Heath	(1)	★★

Nelson/Marlborough

Allan Scott Winery	(1)	★★★★★
Amansi @ Le Brun	(1)	★★★★★
Baby G's, Nelson	(1)	★★★★★
Boatshed Cafe (The)	(1)	★★★★
Boutereys, Richmond	(1)	★★★★
Café Affair, Nelson	(1)	★★
Café on Oxford, Richmond	(1)	★★★
Café Le Cup, Blenheim	(1)	★★★
Crusoe's, Stoke	(1)	★★★
Cruizies, Blenheim	(2)	★★★★½
Grape Escape, Richmond	(1)	★★★★★
Jester House, Tasman	(1)	★★★★★
L'Affaire Cafe, Nelson	(1)	★★
Liquid NZ, Nelson	(1)	★½
Lonestar, Nelson	(1)	★★★★
Marlborough Club, Blenheim	(1)	★★
Morrison St Café, Nelson	(1)	★★½
Oasis, Nelson	(1)	★★★★★
Rutherford Café & Bar, Nelson	(1)	★★★★★
Suter Cafe, Nelson	(1)	★★
Verdict, Nelson	(1)	★★
Waterfront Cafe & Bar, Nelson	(1)	★★★
Wholemeal Trading Co, Takaka	(1)	★★★★★

New Plymouth

Breakers Café & Bar	(1)	★★★
Centre City Food Court	(1)	★★★★
Elixer	(1)	★★★★
Empire Tea Rooms	(1)	★★★★½
Govett Brewster Cafe	(1)	★★
Marbles, Devon Hotel	(1)	★★★
Pankawalla	(1)	★★★★★
Simplicity	(1)	★★★
Stumble Inn, Merrilands	(1)	★★★
Yellow Café, Centre City	(1)	★★★
Zanziba Café & Bar	(1)	★★★

Oamaru

Riverstone Kitchen	(1)	★★★★★
Star & Garter	(1)	★★★
Woolstore Café	(1)	★★★★

Palmerston North

Café Brie	(1)	★★★
Café Esplanade	(2)	★★★★
Chinatown	(1)	★★★★
Coffee on the Terrace	(2)	★★★
Elm	(1)	★★★★½
Fishermans Table	(1)	★★★★★

Gallery	(3)	★★★★
Rendezvous	(1)	★★½
Roma Italian Restaurant	(1)	★★★
Rose & Crown	(1)	★★
Tastee	(1)	★★★
Thai House Express	(1)	★★★★★
Victoria Café	(1)	★★★★

Queenstown

Bunker	(1)	★★★★
The Cow	(1)	★★★
Sombreros	(1)	★
Tatler	(1)	★★★★
Winnies	(1)	★★★★★

Rotorua

Cableway Rest. at Skyline Skyrides	(1)	★★★★★
Lewishams	(1)	★★★
Woolly Bugger, Ngongotaha	(1)	★★★
Valentines	(1)	★★★★★
You and Me	(1)	★★★★★
Zanelli's	(1)	★★

Southland

Lumberjack Café, Owaka	(1)	★★★★★
Pavilion, Colac Bay	(1)	★★
Village Green, Invercargill	(1)	★★★★★

Taihape

Brown Sugar Café	(1)	★★★★½

Taupo

Burbury's Café	(1)	★★★
Thames		
Thames Bakery	(1)	★★★
Waiheke Island		
Cortado Espresso Bar	(1)	★★★★
Cats Tango, Onetangi Beach	(1)	★★★★

Timaru

Fusion	(1)	★★★★★

Wanganui

3 Amigos	(1)	★★★½
Bollywood Star	(1)	★★★½
Cosmopolitan Club	(1)	★★★★
Liffiton Castle	(1)	★★½
RSA	(1)	★★★½
Stellar	(1)	★★★★½
Wanganui East Club	(1)	★★★★

Wellington

162 Café, Karori	(1)	★★★★★
180o, Paraparaumu Beach	(1)	★★
88, Tory Street	(35)	★★
Anise, Cuba Street	(1)	★★
Aranya's House	(1)	★★★★★
Arbitrageur	(2)	★★★
Arizona	(1)	★★
Astoria	(2)	★★★
Backbencher, Molesworth Street	(1)	★★★
Bordeaux Bakery, Thorndon Quay	(1)	★★
Brewbar (function room)	(49)	★★★
Brown Sugar, Otaki Railway Station	(1)	★★★
Buzz, Lower Hutt	(1)	★★½
Brewery Bar & Restaurant	(5)	★★★★
Carvery, Upper Hutt	(1)	★★★★★
Chow	(1)	★½
Cookies, Paraparumu Beach	(1)	★★★½
Cosa Nostra Italian Trattoria, Thorndon	(1)	★★★★
Gotham	(6)	★★★½
Great India, Manners Street	(2)	★★★★★
Habebie	(1)	★★
Harrisons Garden Centre, Peka Peka	(1)	★★★★
Hazel	(1)	★★
Katipo	(1)	★★★★★
Kilim, Petone	(4)	★★★★½
Kiss & Bake Up, Waikanae	(1)	★★★
La Casa Pasta	(1)	★★★★½
Lattitude 41	(3)	★★★★
Legato	(1)	★★
Le Metropolitain	(1)	★★★★★
Loaded Hog	(5)	★★★★½
Manhatten, Oriental Bay	(1)	★★★★
Maria Pia's	(1)	★★★
Matterhorn	(1)	★★★
Mungavin Blues, Porirua	(1)	★★★★★
Olive Cafe	(1)	★★★★★
Olive Grove, Waikanae	(1)	★★★½
Original Thai, Island Bay	(1)	★★★★
Palace Café, Petone	(1)	★★½
Parade Café	(1)	★★
Pasha Café	(1)	★★★★
Penthouse Cinema Café	(2)	★★★½
Pod	(1)	★★½
Rose & Crown	(1)	★★★★★
Shed 5	(1)	★★
Siem Reap	(1)	★★
Speak Easy, Petone	(1)	★★
Speights Ale House	(1)	★★
Sports Bar Café	(1)	★★★★
Stanley Road	(1)	★★★
Stephan's Country Rest., Te Horo	(1)	★★★★★
Wakefields (West Plaza Hotel)	(1)	★★★
Windmill Café & Bar, Brooklyn	(1)	★★
Yangtze Chinese	(1)	★★★★½
Zealandia Café, Karori Sanctuary	(1)	★★★½