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The Importance of Sound in the Marine Enviironment

A Review of New Zealand Acoustic Standards: Part II

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Features

Regulars

Cover Image: Acoustic Isolators [AI]. AI is the scient of using sound to determine distance and diretion. Civilian use include locating wildlife. Military use includes locating aircraft.

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From the President and Editor

From the President

Dear Members,

It's time for the second NZ Acoustics Journal of the year, and the debut for our two new Co-Editors-In-Chief: Lindsay Hannah and Wyatt Page. I'm excited to see how it turns out (I have to write this column before I've seen the issue!), but I know that both gentlemen have been hard at work sourcing new articles and re-jigging a few things. I'd also like to acknowledge the continued efforts of Stuart Camp and Grant Emms, who have been working behind the scenes supporting our last few editors.

When writing this column every couple of months, I do try to make an effort to talk about acoustic issues... and I'm the first to admit that the links I draw can be tenuous at best (having in the past managed to shoehorn in content ranging from my Grandma's 100th birthday to Formula One), but this time I have a real humdinger for you, one which I hope will get you environmental noise boffins thinking.

A fortnight ago, I was treated to a seminar by Fiona Crichton, a PhD student at University of Auckland's Department of Psychological Medicine. Fiona is looking at the link between expectation and symptoms relating to infrasound from wind farms.

We all know that the general public's reaction to noise can be hugely varied, and there are some well publicised case studies where environmental noise has caused alarming effects on local community. Wind farms in particular have gained an international reputation as being hotbeds for such debates, even

to the high court level where experts duke it out, slinging competing theories about with careless abandon.

We have seen a similar phenomenon in Auckland over the last year or so, with residents of central suburbs waging war

Publication Dates and Deadlines

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The Deadline for material for inclusion in the journal is 1st of each publication month, although long articles should ideally be received at least 4 weeks prior to this.

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on Auckland Airport over aircraft noise.

These sorts of public outcries are exactly what prompted Fiona's research – with all the science and anti-science relating to wind farm acoustics effectively resulting in a stalemate, she changed tack by looking directly at the health effects themselves rather than noise levels. In a nutshell, her experiments involve a room with an infrasound signal playing (or not playing) in it and a group of subjects who are either told that infrasound is bad for you, or it's not. She then looks at whether the subjects report any health symptoms that they attribute to the infrasound... but of course they don't know whether or not they were actually exposed to any.

The results show that subjects who are told "infrasound is bad for you" report more symptoms, but symptom reporting is not influenced by whether there is actually any infrasound. This suggests that public outcries against wind farms aren't actually due to noise effects, but about the perception of noise effects.

The big question then is this: Can the noise still be blamed for the health effects? There may not be a direct link between the two, but one does still lead to the other (albeit via a labyrinth of human emotion and preconception).

To my mind, the issue can't be argued using acoustic principles as evidence, because we're actually in the realm of psychology. In which case, Fiona's research may be one of the few lights at the end of the tunnel, and I for one am looking forward to the results of her continuing research. I've invited her to publish a paper in our journal, and to present at our conference in November. Maybe if I think positively enough about it, it'll happen.

Speaking of which, here's a quick plug for the conference: 24-25 November 2014 at the Novotel in Christchurch. The theme is "Acoustics in a Rebuilding City". Abstracts may well have closed by the time you read this, but I trust we'll have a good number of interesting papers to look forward to!

Best of luck for the winter, and I hope to see you in Christchurch come November!

Yours faithfully,

James Whitlock

Editor's Column

Dear Readers and Members,

Welcome, it is our great pleasure to become the new co-editors of Acoustics New Zealand and produce our first editon of hopefully many more to come under our watch. We wish to thank our preddecessor Dr John Cater for all his support and encouragement with producing this issue. We also thank the current Assistance Editors, Stuart Camp and Grant Emms, who are instrumental in assisting with producing Acoustics New Zealand.

This issue contains the second part of our paper looking at the New Zealand Acoustics Standards that specialise in enviromental noise. It looks at NZS6805 through to NZS6809. This paper is timely as also in this issue is a review prepared by Mr Vern Goodwin of Environmental Noise Analysis and Advice Services which provides comment on a recent New Zealand Government decision pretaining to the future of the Standards New Zealand.

The paper from Dr Matthew Pine reviews the importance of sound in the marine environment. We encourage readers to take the time to read Dr Pine's paper as it provides good insight into underwater bioacoustics and its impact on marine life.

We have introduced a new section which looks at recent legal decision including decisions from New Zealand Environment Court [foremerly the Planning Tribunal] and relevant judgments of the New Zealand District Court, High Court, Court of Appeal and Supreme Court, plus relevant decisions of the Privy Council relating to the areas of acoustics. This section will be prepared each issue specifically for Acoustics New Zealand by the Principal Editor at RMA.net, a specialist online source for legal decisions affect New Zealands Acoustic Environment.

Our final word in this edition is we encourage all our readers to consider contributing original material to the journal. It could be anything from a review of a recent acoustics book, software/App they tried, through to an originally prepared paper.

Lindsay and Wyatt ¶

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Proposed Changes to Standards System for New Zealand

Vern Goodwin

Environmental Noise Analysis and Advice Service [ENAAS]

Most members will be aware the Government commissioned a review undertaken by the Ministry of Business, Innovation and Employment (MBIE). In October 2013 the Government announced it had made key decisions on the future of the Standards Council and Standards New Zealand

The decisions included that:

- *A new standards model will replace the Standards Council and Standards New Zealand;*
- *Standards and standards development committee membership approval will be undertaken by an independent statutory board;*
- *Standards development will be undertaken by an independent statutory officer function within MBIE using independent committees; and*
- *Independent committees will continue to comprise industry and technical experts, consumer representatives, and regulators.*

An oversight group made up of senior staff from MBIE and Standards New Zealand, was established to oversee the transition of the national standards body function into MBIE. Briefings were conducted with invited representatives of organisations which had made submissions. The opportunity was taken to mention while attending one of these sessions to mention ASNZ's then current initiatives to rationalise its representation on various joint AS/SNZ committees.

Items of interest discussed included:

- MBIE would continue funding SNZ representation on key ISO TC43 SC 1 and SC 2 working groups. This was important as ISO acoustics related standards were cited in the building code.
- The Council Chairman was keen to recognise the role of professional societies in supporting national/ joint AS/SNZ and international ISO and IEC standards review and development and said this work was highly valued and should continue. "Business as usual" was the byword.
- I raised the need for review of the SNZ decision in 2012 to change the status of NZ participation in certain key IEC TC29 working groups and committees from "P" participating Member to "O" observing member status and in some cases withdrawing all NZ participation.
- The need for advisory groups was recognised by MBIE.
- Continued joint AS/SNZ committee activity would continue as at present

The changes proposed would of course depend on legislation to be introduced.

May 2014 Update

A proposed Standards and Conformance Bill will disestablish the Standards Council and establish the new model. The Bill is expected to be introduced into Parliament this year, but is unlikely to be passed before Parliament rises at the end of July prior to the general election in September. The time-line for implementation of the new standards structure is presently expected to be mid-late 2015. Standards New Zealand publishes regular bulletins about the transition on its web site.

One of the transition outcomes already is that SNZ has now established an International Review Group of mostly ASNZ members to support work on ISO TC 43 / SC 2 Building acoustics. In addition ASNZ has now arranged for wider representation on key joint AS/NZ committees coving the topics of terminology and vibration as well as health effects, architectural and environmental acoustics.

Vern Goodwin

Marine Bioacoustics: The Importance of Sound in the Marine Environment

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Abstract

Our understanding of underwater bioacoustics has increased markedly over the last half-century and evidence for the impacts of sound on marine life is overwhelming. Since the 1960's, background sound levels below 100 Hz has increased by approximately 15 dB in the deep sea. Moreover, anthropogenic sound is estimated to double in intensity every decade in coastal waters in some regions of the world. Currently, regulatory bodies in New Zealand require emitted sound levels from any marine development project be assessed in order to predict the degree of impact on marine life. This process is critical for sustainability and conservation, and there is an urgent need to better understand the impacts of anthropogenic sound on fish and crustaceans. Here, the variety of underwater sounds of biological origin around New Zealand and the potential impacts of anthropogenic sound on fishes and crustaceans is discussed.

Simple Physics: Underwater Sound Propagation

Sound is transmitted through water as longitudinal waves, also called compression waves. These waves consist of alternating pressure deviations from the equilibrium state, which cause localised regions of compression and rarefaction, and corresponding oscillation of the water molecules [1,2]. The frequency of sound relates to the number of repeating compressions, or waves, per second which in term determines the wavelength of the sound; the longer the wavelength, the lower the frequency (f) (i.e., $f = \lambda/c$, where λ is the wavelength and c is the speed of sound in water (1500 m s^{-1})). Attenuation is the loss of sound energy, or sound intensity, as it passes through a medium. In seawater lower sound frequencies have lower attenuation over a given distance compared to higher frequencies. For example, a 500 Hz sound wave only loses 1 dB of intensity over a distance of 100 km of transmission in seawater, which is much less than frequencies above 500 Hz [3,4,5]. The audibility of sound at a given distance from the source is a factor of not only the level of the sound, but also the transmission properties of the local environment which are determined by scattering (reflections) and attenuation (absorption) [6]. The propagation of sound in shallow water is different than in deep water because it has greater interaction with the sea surface and seafloor. Therefore, the depth of water column, sea state and seafloor composition can greatly influence the propagation of sound in the sea, especially in shallow coastal waters.

Under the waves is a noisy environment

A wide range of sounds characterise underwater environments that are generated by biological (biotic) and physical (abiotic) sources [7,8]. A large majority of abiotic sounds underwater are due to the effect of wind interacting with the sea surface and waves, producing sound with dominant frequencies in the 10 – 1000 Hz range [8,9]. Biotic sounds are mainly attributed to soniferous animals engaged in reproductive and social behaviours, territorial defences and echolocation as well as incidental sound resulting from feeding activity and movement [8,9,10]. These sounds are produced over a wide range of frequencies from below 20 Hz in fin and blue whales [11,12] to 200 kHz in dolphins and shrimps [13,14].

Temporal and spatial variation in the underwater sound environment

Several studies have shown patterns of periodic increases in the intensity of underwater biotic sound from coastal reefs which are referred to as dawn and evening choruses [9,15,16]. During any chorus, the overall power level for the frequency band 0.7 – 2 kHz can increase by as much as 20dB re 1 μPa^2 Hz^{-1} which is due to the increased crepuscular activity of many reef inhabitants [9]. Furthermore, there can be variation within individual choruses which coincide with the lunar cycle [9]. For example, snapping shrimp showed significant lunar, diurnal and seasonal periodicity in their sound production, which accounted for the increases in the sound levels recorded in different habitats in the evening [8].

Nearshore environments may also be characterised by different underwater sounds. Marked differences have been found between the sounds emitted from three localised coastal habitats; a macroalgal-dominated reef, a

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sea urchin-dominated reef, and a sandy beach [8]. Overall, the urchin-dominated reef produced significantly more intense sound in biologically relevant frequencies (800 – 2500 Hz) compared to the macroalgal-dominated and sandy beach habitats [8]. There were also many differences in the sound among the habitats with the time of day the recordings were taken, showing that not only temporal compositions vary, but also the spectral composition between habitats.

The role of acoustics in the lives of crustaceans and fishes

Sound underwater has lower attenuation than in air meaning sound travels further underwater [17]. Light as an orientation cue for fish and crab larvae is only effective while it is detectable and it is therefore greatly limited due to its high attenuation in coastal waters. Chemical cues in aquatic environments are also limited by their detection distance. Therefore, underwater sound is considered as the principal cue for long-distance orientation from the open ocean to a desired settlement coastal habitat for fish and crab larvae [18,19]. Thus, it is not surprising crustaceans and fishes have evolved hearing mechanisms that allow for the detection and cognition of underwater sound.

Our understanding of the detection of acoustic stimuli by pre-settlement crustacean and fish larvae has slowly improved over the last 20 years. The planktonic larvae of fish and brachyuran crustaceans must find a suitable reef habitat if they are to settle and grow [8,9,18,20,21,22,23]. There is increasing evidence that underwater sound cues are used by the larvae of fishes and crustaceans to orient themselves towards reef habitats and settle once they arrive at the source [8,16,18,20,21,22,23,24,25]. Underwater sound is thought to act as an important cue for settlement-stage larvae because it can travel long distances with minimal attenuation, whilst also conveying information regarding the quality of and direction to habitats [18,20,21,26,27].

Jeffs et al. (2003) [27] demonstrated first hand that larval crustaceans may orient toward underwater reef sounds by using light traps coupled with an artificial source of natural ambient sound. The results showed significantly greater numbers of larvae in light traps coupled with sound compared to silent traps, although this effect was only observed during particular moon phases and no effect was seen near full or new moons when tidal currents would be strongest. Other scientists have also reported strong evidence for the attraction of larvae to reef sound in five common New Zealand coastal crab species (Plagusia chabrus, Notomithrax ursus, Cyclograpsus lavauxi, Hemigrapsus edwardsii and Pagurus spp.) (Radford et al. 2007).

Underwater sound has also been found to act as a settlement cue in both temperate (Hemigrapsus sexdentatus, Cyclograpsus lavauxi, Macrophthalmus hirtipes) and tropical (Grapsidae spp.) crab species [23]. Larvae subjected to reef sound showed a significantly shorter time to metamorphosis than individuals in the silent treatment, across all species. These results provide the first experimental evidence that underwater sound can advance the physiological development of larval decapod crustaceans.

Simpson et al. (2005) [20] demonstrated that larval fish orient toward underwater reef sounds by building 24 reef patches from dead coral on sand flats and at each patch they deployed underwater loudspeakers which broadcasted reef sound, predominantly consisting of snapping shrimp and fish calls. The results showed greater fish diversity and abundance on reef patches which broadcast reef sounds, compared to those which did not. Also, Tolimieri et al. (2000) [28] reported a median of 350 individual fish larvae entering light traps with sound (sound traps), compared to only 24 entering light traps without sound (silent traps). By using binary choice chambers with recorded reef sounds being played on one end, Tolimieri et al. (2004) [29] found that significantly more triplefin and damselfish larvae were orienting towards the sound during the night – coinciding with similar findings from Leis et al. (1996) [30] and Stobutzki and Bellwood (1998) [31].

Despite the vast amount of literature describing the possibility of sound as an orientation and settlement cue, very few studies have attempted to identify the specific sound frequencies to which fish and crustaceans are responding. Simpson et al. (2005) [20] found that higher frequency sounds (where 80% of the spectral energy was greater than 570 Hz – predominantly shrimp) attracted more fish taxa generally, compared to low frequencies (80% of spectral energy less than 570 Hz – predominantly produced by fish). What they also found was that pomacentrid (damselfish) larvae or juveniles were preferentially attracted to the higher frequency sounds, while apogonids (cardinalfish) were equally attracted to both high and low frequency acoustic signals. Thus, there is evidence that some fishes are discriminating between sound frequencies and are attracted to specific sounds (see also [8]). There is also evidence that some decapod crustaceans may be discriminating between sound frequencies with the mediation of settlement and metamorphosis to reef sound, rather than sound emanating from an estuary [32].

Anthropogenic sound: from discovery to understanding

Anthropogenic sound is any sound generated by human activity [33]. Anthropogenic sounds which are of specific concern are those which are within the audible frequencies of the receiver and are loud enough to overpower ambient sound levels [17]. In general terms, masking can be defined "when a noise interferes with or obscures a signal" [34]. Masking of natural ambient sounds is considered to occur when the anthropogenic sound is louder than biologically important sounds and thus impairs the receiver's ability to detect and assess the source in space and time [17].

Underwater anthropogenic sound sources

Research investigating underwater anthropogenic sound has been increasing since the end of the First World War [35]. Anthropogenic sound is estimated to double in intensity every decade in coastal waters in some regions of the world with intense shipping activity [36,37]. The sources of anthropogenic sounds are wide-ranging and include ships, boats, seismic exploration devices (e.g. air guns), construction activities (e.g., pile driving) and sonar [38,39]. Shipping and boat sound is a major anthropogenic sound source and can increase ambient levels within harbours and open oceans considerably [40]. Motorized shipping has increased ambient sound levels at frequencies below 100 Hz in the deep sea by approximately 15 dB since the 1960's [41,42,43]. Most shipping sound is low frequency (< 300 Hz [36]) and sound from a modern cargo ship travelling at 16 knots can emit frequencies at intensities over 150 dB re 1 µPa at 1 m at 10 Hz, over 160 dB re 1 µPa at 1 m at 100 Hz and 180 dB re 1 µPa at 1 m at 200 – 500 Hz [44].

Industrial construction activity is a major source of underwater anthropogenic sound. Such activity includes pile-driving, dredging, drilling, installing offshore wind farms and blasts from air guns and explosives [17,45,46] and can produce sound levels greater than 200 dB re 1 µPa @ 1 m [47,48]. Pile-driving is increasingly common in coastal waters and can produce frequencies between 20 Hz to more than 20 kHz, with most energy reported between 100 Hz and 200 Hz [17,49]. Marine dredging is used to deepen channels and harbours to mine seabed resources and it produces sound levels above 160 dB re 1 µPa @ 1m with much energy between 50 and 500 Hz [38,50,51]. Drill ships and semi-submersible drill rigs can produce sound levels of 191 dB re 1 µPa @ 1 m at broadband frequencies (10 Hz – 10 kHz) [38,52]. Explosions are often used during construction to remove subsurface structures and even in dredging when boulders are too large to be moved in one piece [17]. Explosions produce the highest sound level (274 dB re 1 µPa @ 1 m [38]) from a point source in the sea with the ability to travel great distances [6,17].

As the demand for energy rises each year, offshore wind farms and tidal turbines are becoming more common, with most of them being built in shallow waters (<20 m) [49]. Underwater sound emanating from wind farms has two main sources; air flow through the wind blades and machinery sound [53], producing underwater sounds below 1 kHz [54,55,56] at 154 dB re 1 µPa @ 1 m at a wind speed of 13 m s^{-1} [56]. Wind speeds, wind turbine size and the number of turbines affect underwater source levels and the distance at which fishes and marine mammals can hear them. Tidal turbines have been estimated to produce a source level of 175 dB re 1 µPa @ 1 m for frequencies between 200 and 8000 Hz [57]. Initial installation and

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turbine operation are the main sources of sound in tidal turbines.

Petroleum exploration is a source of high intensity sounds which can impact marine life. Such exploration can involve the repetitive use of high energy sound sources, such as airguns, which produce short, sharp low-frequency sounds [58] and source levels more than 230 dB re 1 µPa @ 1 m [59]. Military sonar and seismic surveys have also shown to impact marine mammals [60,61].

Potential sound impacts on marine organisms

Over the last 20 years, there has been an increasing concern for the impact these sounds have on marine mammals, fishes and invertebrates. Currently, however, there is not enough data to predict how anthropogenic sound will alter ecosystems [45]. Thomsen (2009) [17] describes several studies which have shown possible detrimental impacts from anthropogenic sound on marine organisms. Such impacts include disrupted communication among cetaceans and porpoises, as well as decreased abundance of cetaceans in areas of marine construction (such as wind farms, turbines, oil rigs, pile-driving and dredging) [17,44,48].

In fishes, hearing loss and increased mortality has also been linked to high sound levels [46], such as with the shiner surfperch [17]. Loud anthropogenic sounds induced stress responses and hearing loss in the goldfish *Carassius auratus* [62,63], while air-guns were found to severely (and evidence suggesting permanently) damage the hearing structures of fish [58]. High intensity sounds have been found to affect behavioural responses and act as a distraction to important acoustic signals, such as that given from a predator. For example, boat sound had a significant effect on the behaviour of the Caribbean hermit crab with simulated predators getting closer during sound playback experiments [64]. Similarly, three-spined sticklebacks (*Gasterosteus aculeatus*) showed poorer foraging performance (measured by decreased discrimination between food and non-food items and food handling errors) in treatments exposed to white sound (bandwidth 100 – 1000 Hz) compared to the silent control [65]. Sound transmitted from boats has been found to mask communication signals between vocal fishes, such as *Chromis chromis, Sciaena umbra* and *Gobius cruentatus* [66] and the Lusitanian toadfish, *Halobatrachus didactylus* [67], and disrupt the schooling behaviour of the blue fin tuna, *Thunnus thynnus* [68]. Ship sound has also been found to increase the secretion of the stress hormone cortisol in freshwater fishes [69] and seismic pulses were found to cause body malformations in scallop larvae [70]

The impacts of offshore wind farms are more localised than other anthropogenic sound sources, with wind farm construction being of greatest concern [49,71]. Actual recordings of offshore wind farms are rare, and little is known about their impacts on marine life. Sounds produced during the operation of a wind turbine were found to have little or no physiological impacts on fishes, harbour seals and porpoises [53,56]. Even within 10 m of an operating wind turbine, the received levels were much lower than those required to cause temporary and permanent hearing damage to fishes [56], and have been described as incapable of masking communication between harbour seals and porpoises [53]. However, some caution should be taken about interpreting potential impacts of wind farms on marine mammals and fishes as there are huge uncertainties surrounding the data on sound impacts [56] and thus, our understanding about offshore wind farms is poor.

Over the last 20 years there has been growing concern regarding the possible impacts of anthropogenic sound in the ocean. There is considerable evidence to suggest that anthropogenic underwater sound may impact many species and their behaviours (as in the Caribbean hermit crab and vocal fishes), yet currently, there is insufficient data available to support, or negate, the growing concerns that anthropogenic sound may change whole ecosystems. We need much more species- and habitat-specific data before conclusions can be drawn about how these sounds affect an ecosystem [45].

References

1. Urick RJ (1983) Prinicples of Underwater Sound. United States of America: McGraw-Hill, Inc.
2. Moyle PB, Cech, J.J. (2004) Fishes: an introduction to ichthyology. San Francisco: Pearson Benjamin Cummings.
3. Ainslie MA, De Jong, C.A.F., Dol, H.S., Blacquiere, G., Marasini, C. (2009) Assessment of Natural and Anthropogenic Sound Sources and Acoustic Propagation in the North Sea. The Hague. TNO-DV 2009 C085 TNO-DV 2009 C085.
4. Francois RE, Garrison GR (1982) Sound absorption based on ocean measurements - 2. Boric acid constribution and equation for total absorption. J Acoust Soc Am 72: 1879-1890.
5. Francois RE, Garrison GR (1982) Sound absorption based on ocean measurements - 1. Pure water and magenesium sulfate contributions. J Acoust Soc Am 72: 896-907.
6. Richardson WJ, Thomson, D.H. (1995) Marine Mammals and Noise. Ontario, Canada: Gulf Professional Publishing.
7. Cato DH, McCauley, R.D. (2002) Australian research in ambient sea noise. Acoust Aust 30: 13-20.
8. Radford CA, Stanley JA, Tindle CT, Montgomery JC, Jeffs AG (2010) Localised coastal habitats have distinct underwater sound signatures. Mar Ecol Prog Ser 401: 21-29.
9. Radford CA, Jeffs AG, Tindle CT, Montgomery JC (2008a) Temporal patterns in ambient noise of biological origin from a shallow water temperate reef. Oecologia 156: 921-929.
10. Cato DH (1992) The biological contribution to the ambient noise in waters near Australia. Acoust Aust 20: 76-80.
11. Schevill WE, Watkins, W.A., Backus, R.H. 1964. The 20-cycle signals and Balaenoptera (fin whales). . Pages 147-152 in Tavolga

WN, editor. Marine Bio-acoustics. Pergamon Press, New York.

12. Cummings WC, Thompson, P.O. (1971) Underwater sounds from the blue whale, Balaenoptera musculus. J Acoust Soc Am 50: 1193-1198.
13. Au WWL, Floyd, R.W., Haun, J.E. (1978) Propagation of Atlantic bottlenose dolphin echolocation signals. J Acoust Soc Am 64: 411-422.
14. Cato DH, Bell, M.J. (1992) Ultrasonic ambient noise in Australian shallow waters at frequencies up to 200 kHz. Melbourne: DSTO.
15. Kaiser MJ, Attrill, M.J., Jennings, S., Thomas, D.N., Barnes, D.K.A., Brierley, A.S., Polunin, N.V.C., Raffaelli, D.G., Williams, P.J., Le, B. (2005) Marine Ecology: Processes, Systems and Impacts. . New York: Oxford University Press.
16. Radford C, Jeffs, A., Tindle, C., Montgomery, J.C. (2008b) Resonating sea urchin skeletons create coastal choruses. Mar Ecol Prog Ser 362: 37-43.
17. Thomsen F (2009) Marine Construction and Industrial Activities. In: Commission O, editor. Overview of the impacts of anthropogenic underwater sound in the marine environment.
18. Radford CA, Jeffs AG, Montgomery JC (2007) Directional swimming behavior by five species of crab postlarvae in response to reef sound. Bull Mar Sci 80: 369-378.
19. Stanley JA (2011) Ambient Underwater Sound: Measuring the importance of spatial variability and its effect on late-stage larval crabs. Auckland: University of Auckland.
20. Simpson SD, Meekan M, Montgomery J, McCauley R, Jeffs A (2005) Homeward sound. Science 308: 221.
21. Simpson SD, Radford AN, Tickle EJ, Meekan MG, Jeffs AG (2011) Adaptive avoidance of reef noise. PLoS ONE 6: e16625.
22. Mann DA, Casper BM, Boyle KS, Tricas TC (2007) On the attraction of larval fishes to reef sounds. Mar Ecol Prog Ser 338: 307-310.
23. Stanley JA, Radford CA, Jeffs AG (2010) Induction of settlement in crab megalopae by ambient underwater reef sound. Behav Ecol 21: 113-120.
24. Leis JM, Carson-Ewart, B.M., Hay, A.C., Cato, D.M. (2003) Coral-reefs enable nocturnal navigation by some reef-fish larvae in some places and at some times. . J Fish Biol 63: 724-737.
25. Montgomery JC, Jeffs A, Simpson SD, Meekan M, Tindle C (2006) Sound as an orientation cue for the pelagic larvae of reef fishes and decapod crustaceans. Adv Mar Biol 51: 143-196.
26. Roger PH, Cox H. 1988. Underwater sound as a biological stimulus. Pages 131-149. in Atema J, Fay, R.R., Popper, A.N., Tavolga, W.N., editor. Sensory Biology of Aquatic Animals. Springer-Verlag, New York, NY.
27. Jeffs A, Tolimieri N, Montgomery JC (2003) Crabs on cue for the coast: The use of underwater sound for orientation by pelagic crab stages. Mar Freshw Res 54: 841-845.
28. Tolimieri N, Jeffs A, Montgomery JC (2000) Ambient sound as a cue for navigation by the pelagic larvae of reel fishes. Mar Ecol Prog Ser 207: 219-224.
29. Tolimieri N, Haine, O., Jeffs, A., McCauley, R., Montgomery, J. (2004) Directional orientation of pomacentrid larvae to ambient reef sound. . Coral Reefs 23: 184-191.
30. Leis JM, Sweatman, H.P.A., Reader, S.E. (1996) What the pelagic stages of coral reef fishes are doing out in blue water: daytime field observations of larval behavioural capabilities. . Mar Freshw Res 47: 401-411.
31. Stobutzki IC, Bellwood, D.R. (1998) Nocturnal orientation to reefs by late pelagic stage coral reef fishes. . Coral Reefs 17: 103-110.
32. Stanley JA, Radford CA, Jeffs AG (2011) Behavioural response thresholds in New Zealand crab megalopae to ambient underwater sound. PLoS ONE 6: e28572.
33. Slabbekoorn H, Bouton N, van Opzeeland I, Coers A, ten Cate C, et al. (2010) A noisy spring: The impact of globally rising underwater sound levels on fish. Trends Ecol Evol 25: 419-427.
34. Erbe C (2008) Critical ratios of beluga whales (Delphinapterus leucas) and masked signal duration. J Acoust Soc Am 124: 2216-2223.
35. Ross D (1976) Mechanics of Underwater Noise. . New York, NY: Pergamon Press.
36. Wright AJ (2008). International Workshop on Shipping Noise and Marine Mammals. Hamburg, Germany.
37. Frisk GV (2012) Noiseonomics: The relationship between ambient noise levels in the sea and global economic trends. Scientific Reports 2.
38. Greene CRJ, Moore, S.E. 1995. Man-made noise. Pages 101-158 in Richardson WJ, Greene, C.R.J., Malme, C.I., Thomson, D.H., editor. Marine Mammals and Noise. Academic Press, San Deigo.
39. Popper AN, Halvorsen, M. B. Effects of human-generated sound on fish: Experimental studies; 2009. pp. 67-71.
40. Popper AN, Hastings MC (2009) The effects of anthropogenic sources of sound on fishes. J Fish Biol 75: 455-489.
41. Ross D (1993) On ocean underwater ambient noise. Acoustics Bulletin 1-8.
42. Mazzuca LL (2001) Potential effects of low-frequency sound (LFS) from commerical vehicles on large whales. Seattle: University of Washington.
43. Andrew RK, Howe BM, Mercer JA, Dzieciuch MA (2002) Ocean ambient sound: Comparing the 1960s with the 1990s for a receiver off the California coast. Acoustic Research Letters Online 3: 65-70.
44. Erbe C (2012) Modeling cumulative sound exposure over large areas, multiple sources, and long durations. Adv Exp Med Biol 730: 477-479.
45. Popper AN, Hastings MC (2009a) The effects of human-generated sound on fish. Integrative Zoology 4: 43-52.
46. Popper AN, Hastings MC (2009b) The effects of anthropogenic sources of sound on fishes. J Fish Biol 75: 455-489.
47. Erbe C, King AR (2009) Modeling cumulative sound exposure around marine seismic surveys. J Acoust Soc Am 125: 2443-2451.
48. Erbe C, MacGillivray A, Williams R (2012) Mapping cumulative noise from shipping to inform marine spatial planning. J Acoust Soc Am 132: EL423-EL428.
49. Madsen PT, Wahlberg M, Tougaard J, Lucke K, Tyack P (2006) Wind turbine underwater noise and marine mammals: Implications of current knowledge and data needs. Mar Ecol Prog Ser 309: 279-295.
50. Robinson SP, Theobald, P.D., Hayman, G., Wang, L.S., Lepper, P.A., Humphrey, V., Mumford, S. (2011) Measurement of underwater noise arising from marine aggregate dredging operations.
51. Reine KJ, Clarke, D.G., Dickerson, C. (2012) Characterization of underwater sounds produced by a backhoe dredge excavating rock and gravel.
52. Nedwell J, Howell, D. (2004) A review of offshore windfarm related underwater noise sources. No. 544 R 0308 No. 544 R 0308.
53. Tougaard J, Henriksen OD, Miller LA (2009) Underwater noise from three types of offshore wind turbines: Estimation of impact zones for harbor porpoises and harbor seals. J Acoust Soc Am 125: 3766-3773.
54. Fristedt T, Moren, P., Soderberg, P. (2003) Acoustic and Electro-

magnetic noise induced by wind mills – implications for underwater surveillance systems. Pilot study. Swedish Defence Research Agency. Report No. FOI-R-233-SE Report No. FOI-R-233-SE.

55. Lindell H (2003) Utgrunden off-shore wind farm – measurements of underwater noise. . Ingemansson Technology Report No. 11-00329-03012700. Ingemansson Technology Report No. 11-00329-03012700.
56. Wahlberg M, Westerberg H (2005) Hearing in fish and their reactions to sounds from offshore wind farms. Mar Ecol Prog Ser 288: 295-309.
57. Parvin SJ, Workman R, Bourke P, Nedwell JR (2005) Assessment of tidal current turbine noise at the Lynmouth site and predicted impact of underwater noise at Strangford Lough. Subacoustictech Ltd. Report No. 628 R 0102. 628 R 0102 628 R 0102.
58. McCauley RD, Fewtrell J, Popper AN (2003) High intensity anthropogenic sound damages fish ears. J Acoust Soc Am 113: 638-642.
59. Pearson WH, Skalski, J.R., Sulkin, S.D., Malme, C.I. (1994) Effects of seismic energy releases on the survival and development of zoeal larvae of Dungeness crab (Cancer magister). . Mar Environ Res 38: 93-113.
60. Parsons ECM, Dolman SJ, Wright AJ, Rose NA, Burns WCG (2008) Navy sonar and cetaceans: Just how much does the gun need to smoke before we act? Mar Pollut Bull 56: 1248-1257.
61. Gordon J, Gillespie, D., Potter, J., Frantzis, A., Simmonds, M.P., Swift, R., Thompson, D. (2003) A review of the effects of seismic surveys on marine mammals. . Mar Technol Soc J 37: 16-34.
62. Smith ME, Kane AS, Popper AN (2004a) Noise-induced stress response and hearing loss in goldfish (Carassius auratus). J Exp Biol 207: 427-435.
63. Smith ME, Kane AS, Popper AN (2004b) Acoustical stress and hearing sensitivity in fishes: Does the linear threshold shift hypothesis hold water? J Exp Biol 207: 3591-3602.
64. Chan AAYH, Giraldo-Perez P, Smith S, Blumstein DT (2010) Anthropogenic noise affects risk assessment and attention: The distracted prey hypothesis. Biol Lett 6: 458-461.
65. Purser J, Radford, A.N. (2011) Acoustic noise induces attention shifts and reduces foraging performance in three-spined sticklebacks (Gasterosteus aculeatus). PloS ONE 6: e17478.
66. Codarin A, Wysocki LE, Ladich F, Picciulin M (2009) Effects of ambient and boat noise on hearing and communication in three fish species living in a marine protected area (Miramare, Italy). Mar Pollut Bull 58: 1880-1887.
67. Vasconcelos RO, Amorim MCP, Ladich F (2007) Effects of ship noise on the detectability of communication signals in the Lusitanian toadfish. J Exp Biol 210: 2104-2112.
68. Sarà G, Dean JM, D'Amato D, Buscaino G, Oliveri A, et al. (2007) Effect of boat noise on the behaviour of bluefin tuna Thunnus thynnus in the Mediterranean Sea. Mar Ecol Prog Ser 331: 243-253.
69. Wysocki LE, Dittami JP, Ladich F (2006) Ship noise and cortisol secretion in European freshwater fishes. Biol Conserv 128: 501-508.
70. De Soto NA, Delorme N, Atkins J, Howard S, Williams J, et al. (2013) Anthropogenic noise causes body malformations and delays development in marine larvae. Scientific Reports 3.
71. Peterson JK, Malm, T. (2006) Offshore windmill farms: threats to or possibilities for the marine environment. Ambio 35: 75-80.

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A new feature of this issue and future issues of this journal is the inclusion of a summary of recent legal decisions kindly provided to Acoustic New Zealand from the Chief Editor, Dr Sarah Brand, from rma.net®.

The rma.net® service was established in 1998 to provide environmental law information in a purely electronic form with its focus on providing an on-line library of legal decisions relating to New Zealand's environment. The legal decisions include decisions from the New Zealand Environment Court [formerly Planning Tribunal] and relevant judgments of the New Zealand District Court, High Court, Court of Appeal and Supreme Court, plus relevant decisions of the Privy Council.

In each future issue we will include a selection of decisions relevant to acoustics, vibration and related environmental topics.

Full decisions and further information on these and any other decisions can be found at www.rma.

The following provides a brief summary listing of recent Court decisions in which acoustic issues have been of considerable note.

All of the listed decisions can be found on the RMA.net website at www.rma.net

In the Enviromental Court

SKYDIVE QUEENSTOWN LIMITED – Appellant

[2014] NZEnvC 108, 58p, [208] paras, 16 May 2014

Summary of Facts

A Direct Referral application by Skydive Queenstown Limited for a replacement resource consent to operate increased flight numbers from an airstrip at Remarkables Station, Queenstown. The central issue concerned the noise effects of the application on the neighbouring residents and recreationalists engaged in outdoor activities. The Court noted the airport was "unique" and the operation intensive, which caused more disturbance than a more conventional airport due to restricted flight paths.

The Court's view was that it was actually the number of plane movements that was the most crucial factor on effects, not the volume of noise or the total sound bucket. The application would roughly double the present activity;

the Court felt this would cause a serious reduction in the recreational amenities of Skydive's immediate neighbours compared to existing operations.

Court held
Application was refused.

NEW ZEALAND WINEGROWERS, HORTICULTURE NEW ZEALAND – Appellant

MARLBOROUGH DISTRICT COUNCIL - Respondent

[2014] NZEnvC 85, 14p, [44] paras, 16 April 2014

Summary of Facts
An appeal by NZ Winegrowers and Horticulture NZ to proposed Plan Changes 23 and 58 to the Marlborough Sounds Resource Management Plan (MSRMP) and the Wairau / Awatere Resource Management Plan (WARMP) in relation to the use of wind machines for grape protection against frost. In an interim decision [2013] NZEnvC 7, the Court directed the Council to amend the WARMP by substituting the rules it set out in relation to noise insulation in rural residential properties, maximum frost fan wind speed and the frost fan rule in the Rural 3 (Wairau Plains) Zone. The most recent decision focused on three main issues; the inconsistency between the NZ Standard and accounting for special audible characteristics in the frost fan rule; the requirement or not for a note concerning existing use rights, and whether the Awatere catchment be treated differently?

Court held
The Court noted that it was required only to ensure that the NZ Standard could be applied as clearly as possible and suggested a provisional determination as parties had not been heard on it and the applicability of the rule within the Rural 4 Zone of the Awatere River catchment.

Court directed a note on existing frost fans was not required.

CONCERNED RESIDENTS GROUP INC – Appellant

MANUKAU TRAIL RIDERS INC – Appellant / Applicant

AUCKLAND COUNCIL - Respondent

[2014] NZEnvC 71, 10p, [40] paras, 28 March 2014

Summary of Facts
The Concerned Residents Group (CRG) appealed a new consent granted by the Council to Manukau Trail Riders Incorporated (MTR) which had operated a motorcross track at Ardmore Quarry Road, Papakura for over 30 years. Issues included whether a penalty for special audible characteristics (SAC) ought to be imposed in relation to noise levels; which existing dwellings ought to be included for noise testing purposes; and start times on Sunday mornings.

The Court found in this case that SAC adjustment should not apply and that the condition should specifically state that. All parties agreed that for purposes of assessing noise at the closest notional boundary, the relevant property was the existing dwelling at 50 Petersons Road and not the New Zealand Defence Force dwellings. The Court agreed with the Council that on Sunday mornings up to three bikes could use the track from 9.15 to 10.00am for the purpose of track assessment only.

Court held
Consent granted, conditions to be finalised.

Costs reserved, although the Court considered costs should lie where they fall.

COLONIAL VINEYARD LIMITED – Applicant/ Appellant

MARLBOROUGH DISTRICT COUNCIL - Respondent

[2014] NZEnvC 55, 54p, [193] paras, 14 March 2014

Summary of Facts
Colonial Vineyards Limited (CVL) appealed a decision by the Council to decline its application for a private Plan Change (PC59) for their 21 hectare vineyard land on New Renwick Road, Blenheim, from Rural to Residential. The land to the east and north of the site was already zoned residential, with land to the south in pasture and light industrial/commercial development. Over 600m to the south was the Omaka Airfield, with the 55 dB(A) Ldn noise contour from the airfield crossing land several hundred metres to the south of the site. The aviation industry was concerned that such a residential development would limit the future development of Omaka airfield and the nearby Aviation Heritage Centre and believed residents would have concerns over aircraft noise.

The Court noted that in relation to the airport zones no air noise contours or outer control boundaries had yet been introduced for the Omaka airfield in the Regional and District Plans. Discussion was had on the position of the 55 dB(A) Ldn noise contour position which varied considerably and the Court considered the proper approach to the noise standard was to use it as a guide, bearing in mind that the standard involved value judgment as to a range of matters.

Overall the Court felt it was more plausible from the evidence that growth of the Omaka Airfield would be minimal and that the heritage values could be protected into the future without causing reverse sensitivity effects if the site was rezoned.

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Specialist Tools of the Trade: A Review of NZ Acoustic Standards - 1992 to 2010

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An original contribution to New Zealand Acoustics

Introduction

This paper looks at the 'speciality' Standards New Zealand series for environmental acoustics, the 'NZS 680X series' between 1992 and 2010. The aim of the paper is to introduce the reader to specialist environmental acoustics standards, discuss their overall purpose while setting out fundamental areas of service and restrictions.

The scope of NZS 6802:1977 was from the outset restricted and excluded transportation, construction and impulse noise. Other guidelines for these types of noise existed and there were ideas about producing a range of standards covering, noise labelling, traffic and helicopter noise. Over the last 20 years several specialty standards have been published, relating mainly to transportation noise with one standard relating to wind turbine energy. These have all had regard to the control of noise being subject to the Resource Management Act.

The first standard relating to transportation noise was 'NZS 6805:1992 Airport Noise Management and Land Use Planning'. Two years later 'NZS 6807:1994 Noise Management and Land Use Planning for Helicopter Landing Areas' was published dealing specifically with the special needs of helicopter landing areas. Four years later came the world's first specialist standard for wind farm developments, 'NZS 6808:1998 Acoustics – The Assessment and Measurement of Sound From Wind Turbine Generators'. A year later 'NZS 6809:1999 Acoustics – Port Noise Management and Land Use Planning' was published. After an unsuccessful attempt in 2000, a new road traffic noise standard project led to 'NZS 6806:2010 Acoustics – Road Traffic Noise – New and Altered Roads' which along with the updated version of 6808 [NZS 6808:2010 Acoustics –Wind Farm Noise] are the most recent two environmental noise standards in New Zealand to be published.

NZS 6805: 1992 Airport Noise and Management and Land Use Planning

There are over 50 airports and aerodromes in New Zealand, half a dozen of these are listed as International Airports and some 18 are considered mainly commercial airports. Airport noise has been an issue in New Zealand for over 50 years with early cases before the Town and Country Planning Appeal Boards [predecessor to the Planning Tribunal and later Environment Court] as far back as 1959. Generally airports hubs are located close to cities and their large populations with airports being surrounded by various land based activities including noise sensitive sites. There must therefore be a balance struck between the operation of the airport as an important transportation hub and the people that live around them.

NZS 6805 is used as a basis for both managing maximum [long term] noise from airports, while also providing guidance on land use planning controls to deal with effects of aircraft noise on noise sensitive activities establishing within noise affected areas surrounding airports. It is understood that after a rising number of complaints about noise associated with airports in the 1980s, the Department of Health began initiatives which led to a Standards New Zealand project and NZS 6805 was prepared by a committee of nominees of various industry sector organisations under the supervision of the Mechanical, Electrical and General Division Committee [50/-] for the Standards Council.

NZS 6805 defines an airport or aerodrome as an area of land or water intended or designed to be used whether wholly or partly for the landing, departure and surface movement of aircraft and includes buildings and areas used in connection with the airport. The words "airport" and "aerodrome" are synonymous under the standard.

Although individual aircraft have generally become quieter over the last 20 years due to modern engine technologies, air traffic growth continues to grow. The total amount of aircraft noise depends upon various factors including but not limited to the aircraft size, aircraft type [prop or jet] and number of flights per day as well as other factors such as departure and arrival routing. The standard included a "noise boundary concept" as a tool for managing airport noise restricting proximity of noise sensitive activities and protection of people in high exposure locations.

The foreword of the standard states that the standard is concerned with land use planning and management of aircraft noise in the vicinity of airports or aerodromes and is intended to be used for all airports or aerodromes

under 'Civil Aviation Regulations which have since been repealed. This standard compared to others is brief in length, but very technical in content and requires proficiently and understanding of not only acoustics, but aircraft noise and civil aviation planning as a whole.

The standard is divided into three key areas being: Part 1 - Airport noise management using the air noise boundary concept; Part 2 - Measurement and description of aircraft noise exposure and Part 3 - Investigation for aircraft noise monitoring. The discussion below will focus primarily on Part 1, however the following brief commentary is provided on Parts 2 and 3.

Part 2 of NZS 6805 defines the measurement and description of aircraft noise exposure, the key here is that this part of the standard provides the conditions required for the siting of a noise measurement terminal and does not provide procedures for measurement and description of noise emissions from an aircraft, as base data predicting noise exposure contours around an airport.

The standard recommended '*ISO 3891:1978 Acoustics - Procedure for describing aircraft noise heard on the ground*' be used for such procedures, but this standard was under revision at the time and the project was never completed and the standard was eventually withdrawn in 2012. Between 1993 and about 2005 NZS 6805 was applied to all the heavy commercial airports through the process of separate District Plan reviews. There is a large degree of consistency in the conditions for Designations covering airports, rules in Plans and the numerous resource consents ancillary to the routine growth of airports. The standard was subjected to significant judicial scrutiny through the plan making and appeal processes.

NZS 6805 does state that if an airport is operational at night [some airports are subject to night time curfews on flights] then night time operations should be considered. The standard also recognises individual aircraft noise events at night could potentially cause sleep disturbance effects if not adequately managed. Although the standard does recommend a day/night L_{dn} limit the standard does not however include a limit on individual events. Some District Plans have adopted a night time sleep disturbance 95 dB L_{AE} contour. As with the L_{dn} contours, this generally means that the airport operator must manage single aircraft movements that do not exceed 95 dB.

Part 3 is a 'carry on' from Part 2, that is once the siting of a noise measurement terminal is set, Part 3 provides details on specifying the actual monitoring system and the provisions for the system, both Parts 1 and 2 are especially technical and cross into other expert areas such as instrumentation related to aircraft noise measurement which in itself is the expertise of electrical engineering, telecommunications, aviation, aircraft flight and noise analysis.

Part 1 is the main focus of this review and sets out airport noise management using the 'Airnoise Boundary' concept. In order to plan the use of the areas around airports, the establishment of a buffer zone [a large distance] between the noise source [e.g. aircraft] and noise sensitive sites, such as residential dwellings or other noise sensitive locations, would be the most obvious solution. However because land near airports is generally already fully developed and rezoning this land in District Plans to exclude certain development is not always possible, such buffer zones are generally unrealistic and unachievable in many cases. Therefore it is the case that for most existing airports, noise sensitive locations have to be catered for, bringing a balance between the airport and surrounding environments. This is where Part 1 of NZS 6805 comes into play.

Overall the standard is designed to provide guidance for making rules in District Plans and Designations and managing airport noise. Non-flight related noise is outside the scope of the standard, being subject to NZS 6802. NZS 6805:1992 promotes land use planning which uses the Air Noise Boundary to set long term limits on total noise emitted by aircraft activities at airports. It is recommended in this Standard that the controls are implemented via District Plan policies and rules. Planning instruments are envisaged that provide for efficient aviation activity at the airport and the need to protect community health and welfare, consistent with the RMA. The formal determination of airport planning involves the public process set out in the First Schedule of the RMA.

NZS 6805:1992 utilises a system in which a limit is set for the average daily amount of aircraft noise exposure that is permitted in the vicinity of an airport, and only inside a fixed working area defined by the "Airnoise Boundary" is the noise exposure allowed to be greater than this. In this working area there are supposed to be rules for compatible land use, and periodic aircraft noise monitoring at the Airnoise Boundary to ensure that the noise exposure is kept within the prescribed limits. The standard states that in the planning steps the sound exposure predictions for the setting of contours should be based on an average day flight operations during the busiest three month [90 days] of the year. The standard states that the contour predictions should be based on minimum 10 year period [or long term projection] using the FAA [Federal Aviation Administration] Integrated Noise Model [or similar] and must take into account a number of things, including but not limited to, aircraft types [current and future], flight frequencies and seasonal effects among many other things.

The standard guidance is for land use planning measures to define areas of land in District Planning Maps which

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show areas which require special control provisions and these areas are different from noise controls applicable in other parts of the District Plan. It is understood that this Standard was the first national standard to introduce a linear [not in dB] noise descriptor as the key descriptor for specifying noise control criteria. The night-weighted "Sound Exposure" descriptor [E_n] is measured in pascal-squared-seconds or *pasques* with approximate values provided for comparison purposes only, using the traditional L_{dn} descriptor. The two control boundaries recommended in NZS 6805 are the 10 Pa^2s E_n [about L_{dn} 55 dB] contour [outer control boundary] and the 100 Pa^2s E_n [about L_{dn} 65 dB] contour [inner "Airnoise Boundary"].

Certain land use planning rules have been developed in relation to these contours. The standard states that after considering the matters in the standard pertaining to incorporating the boundaries, the local authority should incorporate into its District Plan a map showing the projected exposure contours showing the Air Noise Boundary and Outer Control Boundary.

The recommendations of NZS 6805:1992 also include land use planning measures in areas around the airport affected by aircraft noise. NZS 6805:1992 recommends that noise sensitive uses [such as residential uses, schools and healthcare facilities] not be permitted in a District Plan on sites located within the 100 Pa^2s E_n contour area but maybe permitted in a District Plan within the 10-100 Pa^2s E_n [about 55 to 65 L_{dn}] area [Outer Control Boundary] so long as suitable methods such as acoustic insulation is incorporated within new buildings housing noise sensitive activities such as sleeping areas. The standard recommends for sound exposure > 1000 Pa^2s E_n [about L_{dn} 70] that consideration should be given to purchasing existing homes, or relocating residents, and rezoning the area to non-residential use only.

In regards to sound exposure > 1000 Pa^2s E_n [above > L_{dn} 75 dB] the standards recommends that there is a high possibility of adverse health effects - Land shall not be used for residential or other noise sensitive uses. There are no aircraft noise recommendations applying to areas receiving less than 10 Pa^2s E_n [about L_{dn} 55 dB].

The Airnoise Boundary is a critical contour as it defines the total measured exposure to noise emitted by aircraft using the airport. According to NZS 6805:1992, the objective of the Airnoise Boundary is *"avoiding, remedying or mitigating any adverse effects on the environment, including effects on community health and amenity values whilst recognising the need to operate an airport efficiently"*. Controls associated with the Air Noise Boundary are therefore intended to manage the effects of aircraft noise associated with the movement of aircraft to and from the airport while providing for the safe and efficient operation of the airport.

In regards to the management area, the standard states that the airport operator shall manage its operations so that the three [3] month [90 days] average 24 hour night weighted sound exposure does not exceed the limit or are outside the air noise boundary, this is where Parts 2 and 3 of the standard apply as the airport operator must therefore be able to site and specify the required air noise monitoring system on the air noise boundary.

The standard also includes information on airport noise management. The standard states that only Civil Aviation Organisation noise abatement procedures may be considered when using the Standard. One such example applies at the Wellington International Airport where New Zealand Civil Aviation Rule Part 93 Subpart C specifies the noise abatement requirements for Wellington Airport. Appendix B of that document shows a map for Wellington Airport identifying the noise abatement area. CAA rules state that no aircraft shall be flown over this noise abatement area at an altitude lower than that required by Civil Aviation Rule Part 91 [generally 1000 ft AGL for flight over a populous area] or 1500 ft, whichever is the higher.

Application of the standard throughout New Zealand has been relatively consistent through adherence to the advice in the standard, but rules about acoustic isolation vary. Ultimately it is anticipated the former Building Industry Authority and Environmental Sound Project's outcome now under the building division of Building Group Ministry of Business Innovation and Employment and expressed through amendments to the Building Act and Building Code and its related documents, will standardise all acoustic isolation measures and related ventilation provisions. The same will probably apply to equivalent provisions in, Helicopter, Road-traffic and port noise standards.

NZS 6805:1992 Overview Table Overview

Overview of NZS 6805:1992 Airport Noise Management and Land Use Planning. See page 28.

NZS 6806:2010 Traffic Noise from New or Altered Roads

Prior to NZS 6806:2010, the de facto document entitled "*Transit New Zealand's draft guidelines for the management of road traffic noise – state highway improvements 1994* " was generally used to assess road traffic noise. These Transit guidelines served in practice as a de facto national standard for management of road traffic noise because there were no other guidelines or standards at that time. The Transit Guidelines were incorporated into a new *Transit New Zealand Planning Policy Manual* dated December 1999.

NZS 6806:2010 is a multifaceted document over 120 pages long and representative of a modern technical environmental acoustic standard. Persons using the

standard are assumed to have a good understanding of the science of acoustics as well as a good understanding of RMA and other legal and policy context in terms of New Zealand Transport Strategy and land use planning. Importantly, its application is restricted to the assessments required to obtain planning approvals under the RMA for new or altered roads and does not deal with noise emitted by the existing roading network [which is responsible for most if not all noise effects caused by vehicles operating on public roads].

One of the interesting things about this standard is that it represents only one element in a programme developed by New Zealand Transport Agency [NZTA] for assessing noise and vibration from new or altered roads. For example the Agency has a standalone document entitled "*Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects*". There is also a web site developed by NZTA intended to provide a range of information and tools to help ensure that traffic noise is managed in an effective and efficient manner, and to assist with the adoption of the new road-traffic noise standard NZS 6806. That approach is fairly unique to this standard in the NZS 680X series.

NZS 6806 aims to "control" traffic noise from new and altered roads to reasonable limits by providing noise criteria to address the adverse effects of this noise on people. NZS 6806:2010 provides consistent procedures and requirements to measure, predict, assess, and mitigate road traffic noise establishing reasonable criteria for road traffic noise, taking into account health issues associated with noise, the effects of noise on people and communities, and the potential benefits of new and altered roads to people and communities.

The Standard does not address noise from existing roads except in relation to situations where new or altered roading projects interact with existing roads. Noise criteria are set based on the adoption of the "Best Practicable Option" which integrates the approach of the RMA with the cost benefit approach used by roading authorities such as NZTA to justify spending on noise mitigation measures. While this represents a flexible approach, it means that a set of noise mitigation measures achieving appropriate noise limits in one roading project may be found to be unsustainable when applied to another project that has a different layout and regime of affected sites. The basis of the cost-benefit procedures are set out in Appendix D of NZS 6806, which provides a basis for calculating the costs and benefits of mitigation for various engineering designs for projects across New Zealand.

One of the perceived "weaknesses" by some parties of the past guidelines such as the draft Transit Guidelines was "rigid technical compliance noise limits" hence mitigation and related design solutions were not always what could be described as good economic value, that is the cost benefit in some instances resulted in construction of substantial barriers for the sake of say 1 dB attenuation, which has no definable benefit. Past guidelines also were perceived as failing in some cases in terms of planning and urban design outcomes. For this reason NZS 6806 does not set what one might refer to as "rigid technical compliance noise limits", instead NZS 6806 provide "Categories" referred to as A, B and C of noise criteria.

As part of the detailed assessment process, NZS 6806:2008 requires ambient sound levels in the existing environment to be measured at representative noise sensitive sites. The aim is to quantify, in acoustical terms, the existing noise environment at a location of interest, however such data has no bearing on what will ultimately be determined as the "best practicable option" for noise mitigation associated with any particular roading project. The basis of

the noise criteria set out in NZS 6806:2010 is the concept that the best practicable option [BPO], as contained in the RMA, should be used to mitigate road traffic noise effects. The BPO concept is used within the NZS 6806:2010 to identify the most efficient noise mitigation option.

Noise mitigation options are assessed under the standard and if practicable, the "Category A" criterion [Primary Free Field External Noise Criterion] should be achieved. Category A sets a design noise level of 64 dB $L_{Aeq\ (24\ hours)}$ for an altered road and new road with traffic volume < 75,000 AADT [Annual Average Daily Traffic] at Design Year'. A "Category A" design noise level of 57 dB $L_{Aeq\ (24\ hours)}$ is set for new roads with volume of 2000 to 75,000 AADT at Design Year.

The standard states that if it is not practicable to meet the "Category A" criterion, then mitigation should be assessed against "Category B", however, if mitigation is still not practicable to comply with Categories A or B then the standard states that mitigation should be implemented to ensure the internal criterion in "Category C" is achieved. Separate criteria apply to "new roads" as opposed to "altered roads". Noise Criteria from NZS 6806:2010 requires assessment for the design year which is a point in time no less than 10 years but not more than 20 years after the opening of the new road, or alteration of an alter road is expected.

The standard requires assessment at "protected premises and facilities" [PPFs] which represent noise sensitive locations where road-traffic noise is assessed and for which noise mitigation measures may be required. NZS 6806 does not apply to PPFs in urban areas that are located more than 100 m from the edge of the closest traffic lane for the new or altered road, or PPFs in rural areas located more than 200 m from the edge of the closest traffic lane.

As a limited example NZS 6806 lists Maraes, overnight medical care, teaching [and sleeping] in educational facilities, playgrounds that are part of educational facilities that are within 20 m of buildings used for teaching purposes as PPF's. Residential activities are also listed in the definition of PPFs such buildings used for residential activities including [but not limited to] boarding establishments, homes for elderly persons; teaching spaces and so on. The standard also lists a number of situations which PPF's do NOT include, such as residential activities which have predominately other uses such as industrial premises, garage or ancillary buildings or premises not yet built other than those which have a Building Consent.

As recommended within NZS 6806:2010, PPF assessment locations are grouped geographically into "clusters" where the PPF assessment locations are located within 100 metres of each other. The reason is to ensure only the most cost-effective mitigation options are considered. The relevance here is for example an isolated dwelling [not forming clusters] roadside barriers may be considered ineffective as structural mitigation assessed as per NZS 6806:2010. This is because the barriers or screens may for example fail to provide the required 5 dB of attenuation. The control of noise from individual vehicle movements is beyond the control of the standard but prescribed in the Land Transport Rules.

The standard also advises that noise assessment should be undertaken by suitably qualified and experienced persons. This is the standard's way of advising persons wishing to use the standard and apply it that the standard and its application is very technical in content and persons using the standard are assumed to have a thorough understanding of the science of acoustics, including measurement, assessment, monitoring and analysis of traffic and related topics covered under the standard.

NZS 6806:2010 Overview Table

Overview of NZS 6806:2010 Acoustics – Road Traffic Noise – New and Altered Roads. See page 29.

NZS 6807:1994 Noise Management and Land Use Planning for Helicopter Landing Areas

'*NZS 6807:1994 Noise Management and Land Use Planning for Helicopter Landing Areas*' was produced to provide guidelines for controlling helicopter landing area noise in the context of the then newly enacted Resource Management Act and after a series of contested cases. The purpose is to assess noise from helicopter landing areas and the foreword specifically states that the assessment of noise from airports for fixed wing aircraft is included in NZS 6805. This is because of the distinctive character of helicopter noise and the nature of helicopter operations chiefly being able to depart or arrive on a vertical slope, enabling helicopters to be much closer in proximity to noise sensitive sites.

It is critical that users also understand that NZS 6805 is inappropriate for assessment of helicopter landing areas, similarly so is NZS 6802. Ancillary activities such as maintenance operations are outside the scope of NZS 6807 and NZS 6802 should be used in this instance. NZS 6807:1994 supersedes earlier Department of Health Publication titled *Acoustic Guidelines for New Heliports*. The standard provides guidance on control of noise from helicopter landing areas by way of Resource Consent or rules in District Plans under the RMA.

The daily sound exposure from flight operations for any landing site depends upon the sound contributed by each helicopter landing and take-off, the number of these movements per day, and time of day that movements occur. Noise from any movements taking place between 10.00pm and 7.00 am the next day are automatically penalised in the L_{dn} calculation so that one movement taking place during this noise-sensitive period is equivalent to the

sound energy produced by 10 of these movements taking place during daytime. This is consistent with international practice where L_{dn} has been used to describe aircraft noise for more than 30 years.

The standard is not intended to apply to infrequently used helicopter landing areas or to emergency operations such as search and rescue including training. This provision is intended to recognise the vital role for society's benefit of helicopters as emergency vehicles. However this exemption is not intended to apply to bases solely for emergency purposes. In mixed usage bases, noise during emergency flight operations has been regarded by the Courts as being excluded from sound exposure calculation and assessment.

The standard is however intended to apply to helicopter landing areas used for ten or more flight movement in any month or where flight movements are likely to result in a maximum sound level [L_{AFmax}] exceeding 70 dB at night time or 90 dB during day time in a residential zone or within the notional boundary of any rural dwelling. The L_{AFmax} noise descriptor provides for night time sleep protection for these low usage landing areas.

The approach of NZS 6807:1994 is to assess helicopter noise on a 24 hour basis [using L_{dn}] with a separate consideration of the maximum levels due to any night time operations [using L_{AFmax}]. The standard allows for a relaxation of the limits by 5 dB where background sound levels [L_{95} under this standard] exceed threshold levels set in the standard, hence if this criteria is met a limit of 50 dB L_{dn} would be permitted to be relaxed by +5dB and becomes 55 dB $L_{dn.}$

Civil Aviation Authority [CAA] law requires that unless landing or taking-off, aircraft must operate not lower than 500ft [approximately 150 m] above ground level in an open area and 1000 ft [approximately 300 m] above built up areas [other than during take offs and landings]. At these altitudes noise effects of the helicopter associated with the site would not be more noticeable than noise from any other aircraft that would be overflying. Section 90[5] of the RMA exempts aircraft during over flight from noise control, but provides for control of "noise emission controls for airports" enabling Local Authorities to set rules for this purpose. This enables control of noise of aircraft flight operations for the purposes of managing the effects of aircraft noise in the vicinity of landing areas. However the RMA does empower Councils to control noise from overflying aircraft when aircraft are en route to a destination and <u>not</u> in the vicinity of the landing area as this aircraft noise is under jurisdiction of Civil Aviation Law Section 29A of the Civil Aviation Act 1990 which empowers Civil Aviation Authority [CAA] to control noise from overflying aircraft.

The Environment Court case Dome Valley District Residents' Society Incorporated and Skywork Helicopters Limited versus Rodney District Council, Decision A099/2007 Dated 14th December 2007 considered this when determining whether the adverse effects of over-flying by helicopters could be taken into account on a resource consent application for a helicopter landing area. At Paragraph 69 the Court said: "So, reading Section 104[1] in its context, we infer that the scope of effects of allowing a helicopter base activity to which consent authorities are to have regard includes the noise of helicopters in the course of landing at the base, on the ground, and in the course of departing from the base; but is not intended to extend to effects generated by helicopters [or other aircraft] while airborne or in flight. That is our understanding of how Section 104[1] applies to Skywork's Application." The decision was upheld in the High Court, once in relation to an appeal against the Environment Court decision and again when leave was refused to Appeal the High Court decision to the Court of Appeal. (Dome Valley District Residents Society Inc. versus Rodney District Council [2008] 3 NZLR 821; [2008] 14 ELRNZ 237; [2008] NZRMA 534 [HC] and, Dome Valley District Residents Society Inc. versus Rodney District Council 8/12/08, Priestley J, HC Auckland CIV-2008-404-587).

New Zealand law has been structured so that the Civil Aviation Authority has full responsibility for dealing with managing noise from aircraft in flight (e.g. take-off and landing noise abatement procedures) including helicopter landing areas. Importantly for both NZS 6807 and NZS 6805, this is in the definitions. One key definition is a "movement" which is defined under the standard as a <u>single</u> flight operation that is either an arrival or departure but not both, hence with the helicopter landing this is a single movement, with the helicopter departing this is a separate movement. Therefore an arrival and departure is two movements under the standard and this is sometimes confused by users of the Standard.

The standard provides for the measurement of helicopter noise. The standard states that measurements for verification with recommended limits shall be with ventilating window or doors open, this means that if an affected building for example commercial property, does not have forced or mechanical ventilation then assessment under this standard is with doors and windows open, however assessment may be with doors and windows closed if there is sufficient mechanical ventilation for the habitable spaces within that commercial building. Interestingly the standard states that for long-term monitoring systems, Parts 2 and 3 of NZS 6805 shall apply. Best practice will require application of the latest versions of relevant IEC standards, and NZS 6802:2008 to non-flight operations except where a rules citing the standard must be interpreted to require the standards and versions valid at 17 November 1994 when NZS 6807 was

published as a New Zealand Standard.

NZS 6807 also uses sound exposure concepts similar to NZS 6805 Airnoise Boundary. It utilises a "helinoise boundary" and that a projection to determine sound exposure contours should be at least a 10 year projection [or long term projection] period, and as with NZS 6805, the FAA Helicopter Noise Model [HNM - or similar] is recommended and modelling must take account of a number of things including but not limited to aircraft types [current and future], flight frequencies and seasons effects. The HNM has however been superseded by incorporation into INM for about a decade.

NZS 6805 is very similar to NZS 6807 in terms of establishing the 'helinoise boundary' however NZS 6807 states that the projected helinoise boundary in the case of residential areas shall enclose 50 dBA L_{dn}. As expected the standard states that only noise from helicopter operations shall be considered when determining the helinoise boundary. Generally the helinoise boundary defines an area of land subject to noise from helicopters in *excess* to the relevant limits in the standard. The standard recommends that new residential uses, schools and hospitals shall be prohibited inside the helinoise boundary unless a District Plan permits their uses in such areas subject to requirements for acoustic insulation to provide suitable noise environments inside. The standard does state that in some circumstances areas or land may be subject to land use planning under NZS 6805 for airport noise planning and therefore to ensure consistently between NZS 6805 and NZS 6807 the position of the Outer Control Boundary set according to NZS 6805 should take into account the position of the helinoise boundary. It is noted that the helinoise boundary would generally be set at 50 dBA L_{dn} while under NZS 6805 the Outer Control Boundary is set at 55 dBA L_{dn} hence the helinoise boundary is 5 dB more rigorous.

Application of the standard throughout New Zealand has been relatively consistent through adherence to the advice in the standard, but there are few heliports not within airport control so land use planning measures defining helinoise boundaries have been uncommon. Ultimately it is anticipated the Environmental Sound Project's outcome expressed through amendments to the Building Act and Building Code and its related documents will standardise all acoustic isolation measures and related ventilation provisions. The same will probably apply to equivalent provisions in Airport, Helicopter and Road traffic noise standards.

The standard includes an Appendix dealing with Noise Management. This includes recommendations in accordance with international practice to plan and conduct flight operations in accordance with Helicopter Association Internationals "fly neighbourly" programme and its various guidelines. Since 2008 the programme has changed to an on-line accreditation scheme based on pilots completing an on-line training/re-training course periodically. Compliance with the "Fly Neighbourly Guide" was a condition of consent frequently imposed on resource consents for helicopter land areas. In New Zealand the Aviation Industry Association [AIA] has adapted this HAI programme for New Zealand conditions and in 2011 instituted a similar certification scheme to HAI called "Aircare" and a "Noise Abatement Code of Practice." While the status of such codes is voluntary, Civil Aviation recognises the AIA scheme and observance of the code of practice should generally satisfy the BPO obligation under section 16 of the RMA.

NZS 6807:1994 Overview Table
Overview of NZS 6807:1994 Noise Management & Land Use Planning for Helicopter Landing Areas. See page 30.

NZS 6808:2010 Acoustics – Wind Farm Noise

There are currently in excess of 15 wind farms with just under 500 wind turbine generators in New Zealand which are producing a total energy capacity of just below 700 MW. In addition, there are plans proposed for over 15 more wind farms developments to be built.

The current New Zealand wind turbine acoustic standard is '*NZS 6808:2010 Acoustics – Wind Farm Noise*'. NZS 6808:2010 was prepared under the supervision of the P6808 Committee the Standards Council after its predecessor NZS 6808:1998 having first been considered for review in 2004 was subject of another review in 2007 with Standards holding a scoping workshop in the latter part of 2007. A technical committee was formed in 2008 to conduct a full technical review and the result was the release of the latest standard in 2010. Wind farm development in New Zealand can be controversial at times with numerous Resource Consent Applications that have been granted being appealed in the Environment Court. In some cases Environment Court decisions have be appealed on 'points of law' in the High Court.

NZS 6808 was developed specifically for the measurement and assessment of sound from wind turbine generators and wind farms in New Zealand conditions. NZS 6808 provides details on prediction, measurement and assessment with the stated purpose being to aid both wind farm development and Local Authority planning procedures by providing a suitable method for the measurement and assessment of sound from wind turbine generators. NZS 6808 provides specific guidance on limits of acceptability for sound received at residential and noise sensitive locations emitted from both wind farms and single wind turbine generators. NZS 6808:2010 like NZS 6806 both being contemporary standards, are very comprehensive and descriptive, generally this is for

avoidance of doubt or misinterpretation which is absolute key for any standard.

The original 1998 version of the standard '*NZS 6808:1998 Acoustics – The Assessment and Measurement of Sound From Wind Turbine Generators*' was partly based on work done in the United Kingdom by the Working Group on Noise from Wind Turbines, documented in the report entitled '*The assessment and rating of noise from wind farms*", ETSU-R-97, 1996'. There were however various differences between the New Zealand Standard and ETSU documents such as ETSU document had day and night limits while NZS 6808:1998 took the variable approach of background sound level +5 dB. The 1998 version of this standard was written prior to significant wind farm development in New Zealand. The basic methodology proved robust, but experience and research over the following decade since its introduction, brought to light numerous refinements and enhancements which are addressed in the revised 2010 version of the Standard.

The terminology and format of the NZS 6808:2010 have been updated in line with international standards and 2008 editions of NZS 6801 and NZS 6802 which includes adopting L_{A90} in place of L_{A95} as a measure of sound levels – technically referenced to in the NZS 6808:2010 as $L_{A90(10\ min)}$ for background and wind farm sound levels.

Although other standards reference NZS 6801 for the measurement of noise, it is important to note that it is not appropriate to apply all parts of NZS 6801 for the measurement of wind farm noise. NZS 6801 refers to a "meteorological window"' under which normal noise measurements should be conducted, however this is not suitable for measuring sound from wind turbine generator[s] because wind turbines operate in wind speeds typically from 5 m/s to 25 m/s with sound pressure levels changing as a function of wind speed.

NZS 6808 requires background sound levels be measured [as L_{A90}] at relevant receiving locations with noise level data being measured concurrently with wind speed and directions. Once background sound levels are measured at relevant receiving locations, a direct correlation of wind speed versus background sound level is made for each receiving location by using a regression curve which describes this relationship [taking account of day and night and different wind directions if required. This data is then used to derive the recommended 'design limits' such as 40 dB or 5 dB above the measured background sound level [the greater of the two]. Once the known limits are set, they can then be compared to the predicted wind turbine [predicted as L_{Aeq}] or wind farm sound pressure level at the relevant receiving site from the wind turbine[s] to allow for a statement regarding compliance with the recommended limits to be made. NZS 6808 states that there is no need to consider noise sensitive locations outside the predicted 35 dB $L_{A90\ (10\ min)}$ wind farm sound level contour.

The 2010 version of the standard also includes a new provision for a higher degree of protection of acoustic amenity in a particular area. The new limits are referred to as the 'High Amenity Area' noise limits. NZS 6808:1998 did not assess or comment on cumulative wind farm noise effects from one or more wind farms or a single wind farm installation completed over several stages, this is addressed in NZS 6808:2010 with the standard stating that all cumulative wind farm sound affecting any noise sensitive site shall be assessed.

Like NZS 6806's PPF's, NZS 6808:2010 provides details on 'noise sensitive locations', that is a detailed list of sensitive locations similar to NZS 6806 'PPF's". In regards to NZS 6808, the location of a noise sensitive activity associated with a habitable space or education space in a building not on the wind farm site are listed under NZS 6808 including [but not limited to] any part of land zoned predominantly for residential use in a District Plan.

In some instances holiday cabins and camping grounds might be considered as noise sensitive locations. Matters to be considered include whether it is an established activity with existing rights. The standard also states that residential buildings designed for permanent habitation on land zoned for predominantly rural or rural-residential use are not classified as commercial or industrial for the purposes of this Standard. The standard acknowledges that wind farm sound may be audible at times at noise sensitive locations; however the Standard does not set limits that provide absolute protection for residents from *audible* wind farm sound.

NZS 6808:2010 Overview Table
Overview of NZS 6808:2010 Acoustics – Wind Farm Noise. See page 31.

NZS 6809:1999 Acoustics – Port Noise Management and Land Use Planning

Noise created by the movement of commodities in and around major Seaports [ports] areas may occur at all times of the day and night. There are over 20 working ports in New Zealand a number of which provide container services, terminals for crude oil or a mixture of various services including seasonal cruise ship services with passenger terminus. There are in excess of ten major city based ports, most of which offer services for container, cruise ships and various logistic services such as logs and other commodities processing. Regardless of the type of port most ports are for the obvious reasons strategically located providing hubs linking road, rail and shipping on the fringe of busy cities surrounded by noise sensitive

...Continued on Page 26

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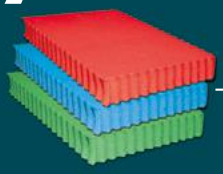

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sites hence a balance between the operation of the port and the people that live around them is key to successful operation of the port and its operations.

'*NZS 6809:1999 Acoustics – Port Noise Management and Land Use Planning*', when introduced was a new approach to the management of port noise. NZS 6809 recommends that both District Plan measures and non-statutory measures be used to manage noise associated with ports. The foreword to NZS 6809:1999 states that whilst the standard recognises the need for the ports to be operated in an effective manner and provides guidance and controls to ensure that the communities living near ports will be able to co-exist with them and their activities. The foreword goes on to state that where it is appropriate that controls be placed on the noise generated by the ports' operations, noise limits will be developed and monitored by the relevant Local Authorities.Prior to the RMA, Ports were essentially their own planning authorities but when the RMA was enacted, ports lost their maritime planning powers to Regional Councils and were not scheduled as network utility operators.

Controlling port noise to what one would describe as typical District Plan type limits of say for example 55 dB L_{A10} daytime, 45 dB L_{A10} night time can prove difficult at times for large ports. This is due to issues such as the historical close relationship between ports and surrounding noise sensitive sites such as adjacent residential areas and the fact some of the noise comes from activities in the Coastal Marine Area under Regional Council Jurisdiction rather than on land under Local Authority jurisdiction. Furthermore the guidelines of such general environmental standards as NZS 6802 are viewed as inadequate for the dual purpose of assessment of specialised noise sources including seaports, airports or heliport noise while also addressing longterm land use compatibility. NZS 6809 was released with the intention to integrate NZS 6809 into District Plans as a means of both limiting noise emissions to reasonable levels, and as noted above, as a guide on land use planning in the vicinity of ports.

New Zealand Standard NZS 6809 is therefore intended to be used by Local Authorities for the use of existing ports, new port or ports which require change. The provisions of NZS 6809 enable long term compatibility between port operations and noise sensitive activities. NZS 6809 relates to the total port operation, that is, the noise within both the *Coastal Marine Area* [CMA] and on the landward side of the *Coastal Marine Area Boundary*. This is because the efficient transport of commodities by sea necessitates the ability to receive, load and dispatch vessels at all hours hence the standard relates to the concept of 'total operation', that is, the noise within *both* the CMA and on the landward side of the CMA boundary.

NZS 6809 is similar in concept for land use planning as NZS 6807 and NZS 6808, that is where noise control boundaries are predicted and established for long term noise management. As with other standards, NZS 6809 sets proposed boundary limits for noise generated by port activities. In NZS 6809 these boundaries are known as the Inner [Port Noise Boundary] and Outer Control Boundaries. Within an area defined by the "Inner Control Boundary" the Standard proposes that District Plan rules be put in place for compatible land use. The Inner Control Boundary or Port Noise Boundary is a line on planning maps limiting noise emissions to 65 L_{dn} dB(A). New noise sensitive uses are not recommended inside the 65 L_{dn} dB(A) limit.

A further second boundary, named the Outer Control Boundary, is used to guide land use planning to avoid or

mitigate noise effects. The Outer Control Boundary is used to identify the area between 55-65 L_{dn} dB(A) The Standard recommends that any new residential use [or other noise sensitive activity] must be designed to take the higher noise levels into account. Where the level is below 55 L_{dn} dB(A) specific noise controls are not generally regarded as being necessary as the impact on residential activities is considered to be within a reasonable criteria. The concept of the control boundaries is to establish a reasonable projection of future [e.g. 10 years or long term projections] noise levels from the total port operation, taking into account all practicable steps that may be implemented to minimise the noise output. The daily average noise level is adopted, the L_{dn} level which incorporates a 10 dB night time "penalty" for night time sounds. Depending upon if the port is new or existing the noise boundary lines are set based on noise projections from current port activities or future projected activities.

The L_{dn} level provides a measure of sound exposure averaged over a period of time to allow for the typical variations in noise generated by port activities and to take special account of night-time noise. NZS 6809 refers to energy averaging the L_{dn} value over five [5] consecutive days i.e. 5-day rolling average 24 hour night-weighted sound exposure level, expressed in L_{dn}. This method of quantifying port noise has a number of characteristics [including but not limited to] a rolling 5-day average which takes into account variations in noise levels associated with ship visits, the cumulative contributions of all port noise throughout the 24 hour period and potential increased effects associated with night time noise events [10.00pm to 7.00am] noting that a 10 dB penalty for night time noise events is inherent in the L_{dn} unit.

This method of quantifying noise exposure therefore takes into account both acoustical matters [in particular the temporal and spectral characteristics of sound]; variations in port activity; and the potential cumulative noise effects. Average sound exposure is used as it is the on-going amount of noise received that is important for determining the impact on people. However, the Standard does recommend short term noise limits [65 dB L_{Aeq} measured over 15 minutes and 85 dB L_{AFmax}] apply during night time as a means of providing basic protection of amenity and to avoid sleep disruption and as a means of dealing with short term and immediate night-time noise impacts. The short-term noise limits are intended as the main method by which compliance can be determined. The standard requires the short term L_{Aeq} compliance limit be adjusted for additional annoyance due to sounds containing "special audible characteristics" and possible contamination by background sounds. The methods are described in a way that enables users of the Standard to undertake a simple and straightforward compliance assessment using the short term noise limits. The standard has a provision of maximum 1 hour L_{eq} levels which is effective in reducing the averaging effect of L_{dn} [24 hr] type of controls on short duration high level events. In addition to the L_{dn} value at night time [10:00pm - 7:00am] the L_{AFmax} should not exceed specified criteria at the noise zone boundaries. This control is consistent with the controls for night time L_{AFmax} values recommended in NZS 6802 for the protection of sleep.

Application of the standard throughout New Zealand has been relatively consistent through adherence to the advice in the standard, but rules about acoustic isolation vary. Ultimately it is anticipated the Environmental Sound Project's outcome expressed through amendments to the Building Act and Building Code and its related documents will standardise all acoustic isolation measures and related ventilation provisions. The same will probably apply to equivalent provisions in Airport, Helicopter and Road traffic noise standards.

The "Port Noise Affected Area" represents an area within which some noise from port activities can be expected and provides both an advisory function [to people who may wish to move into the area in the future] and a protective function for new noise-sensitive uses establishing in the area. The Standard recommends controls on any new noise sensitive activities which are defined in the Standard as residential activities in residential zones, schools, rest homes and hospitals [but excludes trade training or other industry related educational facility within a port operational area]. The Standard recommends controls based around acoustic insulation and the ability to decline applications to establish noise sensitive activities in areas affected by port noise.

NZS 6809:1999 Overview Table

Overview of NZS 6809:1999 Acoustics – Port Noise Management and Land Use Planning. Refer to page 31.

Review Status and Copyright

This 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.

Full Name	NZS 6805:1992 Airport Noise Management and Land Use Planning
Abbreviation	NZS 6805:1992
Copyright	Copyright of the document is the property of the Standards Council
Purpose	This Standard is for the control of airport noise. The standard establishes maximum acceptable levels of aircraft noise exposure around airport and aerodromes for the protection of community health and amenity, whilst recognising the requirement for the airport to operate effectively. The standard is for use by local or regional government to control airport noise. Establishes maximum acceptable levels on noise for the protection of community health
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	Only noise resulting from aircraft operations shall be considered when determining sound exposure contours and the air noise boundary
Restrictions	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 should be assessed using NZS 6802
Further Information **Related Documents**	NZS 6801:2008 Acoustics – Measurement of Environmental Sound NZS 6802:2008 Acoustics –Environmental Noise
Key Noise Descriptor	Sound Exposure Level, A-weighed L_{AE} [SEL] Sound Exposure [Pascal-squared seconds or "Pasques" [Pa^2_s]] Night Weighted Sound Exposure [Pa^2s] Single Event Sound Exposure [Pa^2s] Maximum Sound Level [L_{AFMax}] Equivalent continuous sound level [L_{eq}] Day Night Level [L_{dn}]
Proficiency Level	Persons using the standard are assumed to have an understanding of the science of acoustics, including measurement, assessment, monitoring and analysis. A level of understanding regarding civil aviation and airport planning is also required.

<table>
<tr><td>Full Name</td><td>NZS 6806:2010 Acoustics – Road Traffic Noise – New and Altered Roads</td></tr>
<tr><td>Abbreviation</td><td>NZS 6806:2010</td></tr>
<tr><td>Copyright</td><td>Copyright of the document is the property of the Standards Council</td></tr>
<tr><td>Purpose</td><td>This standard recommends noise criteria to be applied to road traffic noise from new or altered road received at protected premises and facilities. Sets out procedures and requirements for the prediction, measurement, and assessment of road traffic noise for new and substantially altered state highways and local roads. The Standard is intended to be used primarily by Local Authorities and road controlling authorities and seeks to promote quicker and consistent decision-making nationally regarding the management of road traffic noise. It also provides best practice guidance and advice on methods for mitigating reverse sensitivity situations and the environmental effects of noise exposure on nearby noise-sensitive activities. For the purpose of this Standard, where any project includes a mixture of new and upgraded existing roads the roading authority shall determine the relevant criteria to be applied to each section of the road for traffic noise mitigation.</td></tr>
<tr><td>Key functions</td><td><table>
<tr><td>Assessment Procedures</td><td>√</td></tr>
<tr><td>Measurement Procedures</td><td>√</td></tr>
<tr><td>Prediction Methods</td><td>√</td></tr>
<tr><td>Guideline Noise Limits</td><td>√</td></tr>
<tr><td>Management Methods and Procedures</td><td>√</td></tr>
<tr><td>Compliance Methods and Procedures</td><td>√</td></tr>
<tr><td>Land Use Planning</td><td>√</td></tr>
<tr><td>Reporting Requirements</td><td>√</td></tr>
</table></td></tr>
<tr><td>Inclusions</td><td>New and altered roads of scale and state highways</td></tr>
<tr><td>Restrictions</td><td>The standard is generally not recommended to apply to low volume roads.
The standard [Section 1.3] lists 15 detailed restrictions, the following is a sample of several [not all] restrictions
-Existing roads
-New and altered roads predicted to carry less than 2000 AADT;
-PPFs located in urban areas and located >100m from the edge of the road
-PPF's located in rural areas and located >200m from the edge of the road
-The control of noise generated by an individual vehicle;
-Noise from the construction or maintenance of roads [refer to NZS 6803];
-Vehicle induced ground borne vibration;
-Vehicle noise from land that is not road [refer to NZS 6802];
-The development of noise sensitive activities which will or may give rise to reverse sensitivity effects; and
-Private ways.
-Premises other than PPF's</td></tr>
<tr><td>Further Information
Related Documents</td><td>NZS 6801:2008 Acoustics – Measurement of Environmental Sound
NZS 6802:2008 Acoustics –Environmental Noise
NZS 6803:1999 Acoustics – Construction Noise
AS/NZS 2107 2000 Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors.
ISO 140-5 1998. Acoustics - Measurement of Sound Insulation in Buildings and of Building Elements - Part 5: Field measurements of airborne sound insulation of facade elements and facades
ISO 717-2 1996 Acoustics – Rating of sound insulation in buildings and of building elements – Part 2: Impact sound insulation</td></tr>
<tr><td>Key Noise Descriptor</td><td>$L_{A10\ (18\ hour)}$ centile L_{Aeq}
Time Average A-frequency weighted sound pressure level [$L_{Aeq\ (15\ minute),}$]
Maximum Sound Level [L_{AFmax}]</td></tr>
<tr><td>Proficiency Level</td><td>Persons using the standard are assumed to have an understanding of the science of acoustics, including measurement, assessment, monitoring and analysis. A level of understanding regarding road engineering is also required.</td></tr>
</table>

<table>
<tr><td>Full Name</td><td>NZS 6807:1994 Noise Management and Land Use Planning for Helicopter Landing Areas</td></tr>
<tr><td>Abbreviation</td><td>NZS 6807:1994</td></tr>
<tr><td>Copyright</td><td>Copyright of the document is the property of the Standards Council</td></tr>
<tr><td>Purpose</td><td>This Standard details procedures for the measurement and assessment of noise from helicopter landing areas and recommends land use planning measures where necessary to mitigate the adverse effects of noise on land uses surrounding the helicopter landing area. This standard provides details for the measurement and assessment of noise from existing or proposed helicopter landing areas and recommends land use planning measures under the Resource Management Act where necessary. Generally speaking the standard is not for infrequency landings that is the standard is only attended to apply to helicopter landing areas used for ten or more flight movements in any month or where flight moves are likely to result in L_{AFmax} levels exceeding 70 dBA at night time or 90 dBA day time in any residential zone or rural dwelling notional boundary. Flights for emergency purposes are exempted.</td></tr>
<tr><td>Key functions</td><td>
<table>
<tr><td>Assessment Procedures</td><td>√</td></tr>
<tr><td>Measurement Procedures</td><td>√</td></tr>
<tr><td>Prediction Methods</td><td>√</td></tr>
<tr><td>Guideline Noise Limits</td><td>√</td></tr>
<tr><td>Management Methods and Procedures</td><td>√</td></tr>
<tr><td>Compliance Methods and Procedures</td><td>√</td></tr>
<tr><td>Land Use Planning</td><td>√</td></tr>
<tr><td>Reporting Requirements</td><td></td></tr>
</table>
</td></tr>
<tr><td>Inclusions</td><td>Only noise resulting from helicopter operations shall be considered. This standard [NZS 6807] has been prepared taking into account the distinctive character of helicopter noise and the nature of operations from helicopter landing area.</td></tr>
<tr><td>Restrictions</td><td>The standard does not apply to
- emergency operations
- auxiliary operations such as ground maintenance which are outside the scope of the standard, NZS 6802 shall be used to assess these noise sources
Sound from airport activities except from aircraft taxiing and in-flight are within the scope of NZS 6802
Light aircraft flight and ground movements not at airports should be assessed using NZS 6802</td></tr>
<tr><td>Further Information

Related Documents</td><td>NZS 6801:2008 Acoustics – Measurement of Environmental Sound
NZS 6802:2008 Acoustics –Environmental Noise

NZS 6805:1992 Airport Noise Management and Land Use Planning</td></tr>
<tr><td>Key Noise Descriptor</td><td>Sound Exposure Level, A-weighed (SEL)
Sound Exposure [Pascal-squared seconds or “Pasques” (Pa^2s))
Night Weighted Sound Exposure (Pasques)
Single Event Sound Exposure
Maximum Sound Level [L_{AFmax}]
Equivalent continuous sound level [L_{eq}]
Day Night Level [L_{dn}]</td></tr>
<tr><td>Proficiency Level</td><td>Persons using the standard are assumed to have an understanding of the science of acoustics, including measurement, assessment, monitoring and analysis. A level of understanding regarding civil aviation and airport operations is also required.</td></tr>
</table>

Full Name	NZS 6808:2010 Acoustics –Wind Farm Noise
Abbreviation	NZS 6808:2010
Supersedes	NZS 6808:1998 Acoustics – The Assessment and Measurement of Sound From Wind Turbine Generators
Copyright	Copyright of the document is the property of the Standards Council
Purpose	The standard provides suitable methods for the prediction, measurement and assessment of sound from wind turbines. In the context of the Resource Management Act, the standard will provide reasonable protection for the protection of health and amenity and noise sensitive locations.
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 generally applies to wind farms consisting of wind turbines with a swept rotor area greater than 200 m^2 [for example, individual blade lengths greater than approximately 8m]. The standard includes Wind Turbine Generators located on land or sea [both horizontal and vertical]. In terms of the standard a wind farm is described as a wind turbine or a group of wind turbines installed in close proximity to one another and electrically interconnected to a common grid.
Restrictions	The standard does not cover: - Small wind turbines less than this size are covered under NZS 6801 and NZS 6802. - Sound from mechanical or electrical systems connected to wind turbines used for other purposes [such as pumping or milling] - Sound from on-site sources other than wind turbines [such as substation equipment or machinery used for construction, servicing and maintenance
Related Documents	NZS 6801:2008 Acoustics – Measurement of Environmental Sound NZS 6802:2008 Acoustics – Environmental Noise
Key Noise Descriptor	L_{Aeq} dB Time Average A weighted sound pressure level L_{A90} dB Background Sound Level and wind farm sound levels

Full Name	NZS 6809:1999 Acoustics – Port Noise Management and Land Use Planning
Abbreviation	NZS 6809:1999
Copyright	Copyright of the document is the property of the Standards Council
Purpose	The standard describes a method for the establishment of noise limits and associated land use controlled with the objective of protecting community health and amenity while recognising for the efficient operation use and development of ports
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 applies to new, existing or amendments to existing ports and includes port operations within the coastal marine area and on land. Port operations include ships at berth and activities on wharves and other structures within the costal marine area and on land.
Restrictions	Noise from vessels not at berth is excluded as is noise associated with construction or permanent port facilities.
Related Documents	-NZS 6801:2008 Acoustics – Measurement of Environmental Sound -NZS 6802:2008 Acoustics –Environmental Noise -NZS 6805:1992 Airport Noise Management and Land Use Planning -NZS 6807:1994 Noise Management and Land Use Planning for Helicopter Landing Areas
Key Noise Descriptor	Day-Night Level [L_{dn}] Time Average A-frequency weighted sound pressure level [$L_{Aeq(15min)}$] Maximum Sound Level [L_{AFmax}]

...Continued from Page 13

Court held

Appeal allowed, decision of the Council cancelled.

Plan Change 59 as notified, approved, subject to changes stated in the decision.

Parties directed to discuss proposed policies, maps, rules and urban design principles.

Costs reserved.

Disclaimer – This article has been provided to help raise an initial awareness of some recent cases involving acoustics issues. It does not purport to be a full listing of all decisions which have acoustic issues, nor does it replace proper professional advice.

ACOUSTIC CEILING TILES

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The new AMF Acoustic Range offers ceiling tiles with a choice of high and low sound absorption with a uniform face pattern.

- One face pattern for a spectrum of sound absorption values
- Tile options from low to high absorption
- Attenuation figures from 26 dB to 44 dB
- A combination of acoustic properties in one suspended ceiling
- Building material class A2-s1, d0 as per EN 13501-1

THERMATEX ACOUSTIC RANGE

Thermatex	NRC	dB
Alpha One	1.00	29
Silence	0.90	44
Alpha	0.90	26
Thermofon	0.85	28
Alpha HD	0.85	30
Acoustic	0.70	38
dB Acoustic 24mm	0.70	41
Acoustic RL	0.15	38

as per EN ISO 11654 / EN 20140-9 / ASTM C 423

For more information, contact Potter Interior Systems today!
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info@potters.co.nz

Five Minute Brain Teaser

1. From what Greek word does our word 'acoustics' derive?
2. Who in 20 BC wrote a treatise on the acoustic properties of theatres including discussion of interference, echoes, and reverberation?
3. What type of sound waves travel through the air?
4. What is the name for frequencies in the sound of a musical instrument which are not exact multiples of the fundamental frequency?
5. What is the Kaiser effect?
6. What is meant by the TIMBRE of a sound?
7. What is an 'acoustic reflex'?
8. What is TTS?
9. What does the symbol T20 stand for?
10. What is an 'electret' microphone?
11. What is the 'Lombard Effect'?
12. What does the symbol Ctr stand for?
13. Number theory is used in the design of what type of sound diffusor?
14. What type of acoustician uses the unit of $\mu Pa^2\ Hz^{-1}$ for sound power level? (Hint, read Dr Pine's paper in this issue.)

Upcoming Events

2014

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

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

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

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

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

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

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

2015

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

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

31 May - 3 June, Maastricht, Netherlands
Euronoise 2015
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/

CRAI Ratings

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.

CRAI Ratings (cont.)

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)	★★★★★

CRAI Ratings (cont.)

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