

40.4883.R2:ZDS

27<sup>th</sup> October, 2010

Communities NSW (Sport and Recreation)  
Locked Bag 1422  
SILVERWATER NSW 2128

**Attention:** Mr D. Clout

**REVIEW OF GDH COMPLIANCE NOISE MONITORING**  
**SOUTHERN HIGHLANDS REGIONAL SHOOTING COMPLEX**  
**WATTLE RIDGE ROAD, HILL TOP**

The purpose of this report is to present the results and findings of a review of a Compliance Noise Monitoring report (dated June 2010) prepared by GHD in relation to noise emission from the Southern Highlands Regional Shooting Complex at Hill Top.

As a result of my preliminary review I found errors in the compliance report. The report referred to previous testing (by GHD) and therefore I requested additional noise documentation that had been prepared for the subject site and was provided a Noise Assessment prepared by GHD P/L dated January 2008 (was contained in Volume 2 of an Environmental Assessment Report).

In conducting this review it is necessary to identify that I have qualifications and experience to conduct the acoustic review (see Annexure A).

Furthermore my acoustical experience includes the measurement of firearm noise. I have conducted assessments and compliance testing at more than 30 ranges over 30 years, including civilian and military rifle ranges (see Annexure B).

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**THE ACOUSTIC GROUP**

## **The GHD Compliance Report**

The introduction to the compliance report identifies that the measurements related to operations of an existing 800m rifle range and referred to conditions of approval A9 setting a noise limit in terms of a 75 dB (Lin) peak hold at the boundary to any existing property with a residential dwelling, or where the boundary is more than 30m, at the most affected location within 30m from the dwelling.

The condition as expressed in the compliance report is not in the format as previously issued by the SPCC/EPA with respect to Chapter 164 of the SPCC's Environmental Noise Control Manual (ENCM), where the application of the noise limit related to a logarithmic average of the noise level for each firearm classification.

The reference to the location of the noise monitoring position with respect to a residential dwelling must acknowledge the limitations of physical access for monitoring for such monitoring to occur at locations where the public may gain access rather than trespassing on private properties.

Section 2 of the compliance report identifies four monitoring locations that were used and would appear to accord to an accessible location with respect to residential properties for locations A1, A2 and A3, although with respect to location A4 as identified in the report the location is approximately 600m from the dwelling and therefore being closer to the range is likely to have a higher noise level than that that would be received at the residential location.

Section 2 indicates that the meter used for sound level measurement was a Larson Davis 831 which is a Type 1 meter and suitable for such measurements. Section 2.2 indicates a range of firearms and different firing positions during the course of the monitoring.



Section 2.3 indicates weather conditions at the time of the monitoring (which covered Friday 18<sup>th</sup> June, Saturday 19<sup>th</sup> June and Sunday 20<sup>th</sup> June 2010). The graph identified in Figure 2-2 would suggest that the average wind speeds would be higher than that desired for monitoring of a rifle range. One could expect wind gusts to be higher than the average wind speed and as such in my view would be unsuitable for monitoring of a rifle range in that there is a distinct possibility the meter could be measuring wind rather than the noise of the individual shots.

Section 2.4 indicates that on occasions when the firearm being discharged was audible there was no increase above the ambient noise level which is a situation that would be expected in relation to the subject site and distance to residential locations.

Table 2-1 identifies the maximum sound pressure level that was recorded at the four reference monitoring locations and an additional location identified as 4 Starlight Place. However the levels so recorded may not necessarily be attributed to firearms and in the second instance is not the level that would be checked against the SPCC target shooting criteria.

Table A1 indicates that under a west to west southwest wind the shooting was inaudible at locations A1, A3 and A4 and only 15 shots were audible at A2.

Table A1 does not provide the range of peak levels recorded without shooting to indicate the extent and magnitude of the wind affected results.

The results presented in Table A1 for location A2 do not indicate to which firearm the measured level relates to in that there are three firearm classifications identified from the 300m range with two levels provided in the A2 monitoring location, which may be attributed as 69 dB to the 16 gauge shotgun and 69.5 to the 7.62 NATO rifle. If one assumes that concept is to be applied then it would appear that the .22 Rimfire rifle would be inaudible.



If however the results for A2 are meant to be the only two shots that were detected (whilst those firearms were being discharged) and were not influenced by wind then as the remaining shots were inaudible or another 13 shots were audible but did not give rise to a measured value, then the logarithmic average of those results for the Friday 18<sup>th</sup> June testing would be significantly lower than 69 dB(A).

For Saturday 19<sup>th</sup> June, 2010 there are a series of results identified in Table A2 that indicate wind gusts produced peak levels of 75 to 85 dB (Lin) and the spread of noise levels from the 800m firing range had the majority of the measurements not giving rise to a measurable increase above the ambient level. Again the material is insufficient to determine the logarithmic average of the measurement results but if one takes the results that are provided for location A1 the logarithmic average is 77.9 of the reported results. If however one adds another 10 results of 68 dB (Lin) then the logarithmic average becomes 74.

Similarly for location A2 the logarithmic average of the tabled results is 77.8 but if one adds an additional 10 values of 68 dB (Lin) then the logarithmic average is less than 75.

For 4 Starlight Place the logarithmic average is 72 for the four shots that are identified but if one adds another 10 shots at 68 the logarithmic average becomes 69.5.

For location A3 the wind noise for 2 to 4m per second wind varied from 75 to 95 dB (Lin) but there were no measure results for the shots on that day as for location A4.

There is a second Table A2 related to Sunday 20<sup>th</sup> June and again indicates that background peak levels for location A3 varied from 65 to 85 and that of the 24 shots that were audible at location A3 13 were identified as giving rise to a noise level that would give rise to an average of 76.5. But if one added an additional 10 shots at 68 the logarithmic average becomes less than 75 dB (Lin).

Examination of the remaining locations would indicate even on the measured levels that were identified an average maximum of less than 75 dB (Lin).



The results in Table 1 for Friday 18<sup>th</sup> June occurred with a west south westerly wind whilst the results for the second table A2 (Sunday 20<sup>th</sup> June, 2010) also occurred under a west south westerly wind.

However the Friday results had shooting occurring from the 300m position whilst the Sunday shooting occurred from the 100m position.

In terms of noise propagation from rifle ranges there is a distinct directivity pattern which would result in the expectation for the 100m results to be lower than the 300m results which should be lower than the 800m results.

The compliance report does not identify this situation possibly because the authors of the report are not familiar with propagation of noise from rifle ranges or were not measuring the shots.

The meteorological conditions and the measurement results provided in the report indicate that there was excessive wind during the three days of surveying and in my opinion the measurements should not have been conducted because of those winds.

It is more than likely that the measurements contained in the compliance report for many of the events are actually measuring the wind rather than measuring the noise from the shooting. This becomes apparent in that the comments provided in the appended tables identify that there were quite a significant number of shots audible but not registering a peak value. Accordingly to get a difference in measured level of more than 15 dB for similar operations and firearms is outside the tolerance limit that would be expected in terms of a rifle range.

Therefore the use of measured values from the compliance noise monitoring are questionable and even become more apparent when one identifies that they have not been assessed in accordance with the SPCC procedures for the identification of noise from a rifle range.



As a result of the errors in the compliance noise monitoring report and what appears to be a general lack of comprehension in terms of noise emission associated with rifle ranges I requested the noise information related to the development application. A review of that material further highlights my concerns in relation to the noise assessment that has been conducted by GHD (2008) as discussed below.

## **The Site**

I am instructed that an 800 metre big bore range that is part of the subject complex has been in existence since 1982 in the land that was identified as part of a state forest.

The forest has been incorporated into a larger parcel of land under the control of the National Parks and Wildlife Service, and that the shooting complex is now identified as a separate parcel of land which is no longer under the control or jurisdiction of the National Parks and Wildlife Service.

The GHD assessment (January 2008) identified that the existing Hilltop rifle range was to become the Southern Highland Regional Shooting Complex by the addition of a 500 m rifle range, a 200 m rifle/pistol shooting range, a 50 m pistol range, a shotgun range, and an indoor air range.

In the context of noise emission the smaller ranges (when compared to the existing 800 m range) would be expected to generate lower levels of noise for residential receivers to the south east and similar or slightly higher noise levels for residential receivers to the north west.

However in any event the additional ranges to be provided on the complex would be additional to the existing range and noise limits would be governed by the existing noise criteria that would apply to the 800 m range.



## **Measurement of Rifle Noise**

In dealing with the assessment of noise from rifle ranges and pistol ranges that are located in an outdoor environment, the acoustic descriptor used for such assessments in New South Wales has been for more than 20 years based upon an energy average un-weighted (Linear) peak hold level.

This acoustic measurement is different to the general assessment procedure for noise matters that utilises the A-weighted FAST response level.

The technical basis for using an un-weighted measurement procedure is due to the very short time period associated with the pressure wave generated by the projectile being less than the rise times associated with the electronic filter that is used for A-weighted measurements. This means that passing a rifle shot noise event through an A-weighted FAST response filter will be inaccurate.

The National Acoustic Laboratories Report No. 84, February 1981 ISBN 642 06060 6, "Community reaction to noise from Hornsby Rifle Range" reviewed the measurement of rifle noise and proposed use of the un-weighted peak sound pressure level (LPEAK) or the A-weighted sound exposure level (ASEL) to be technically correct.

The use of 'A' frequency weighted maximum levels is not normally encountered in overseas criteria for impulsive type noise. On the contrary, use of 'C' frequency - weighted or Linear (un-weighted) peak hold levels or sound exposure levels has been the usual practice

The peak hold level measured for a rifle shot event is significantly greater than the A-weighted level (recorded for the same event) and therefore persons not aware of the differences, and used to general noise measurements expressed as a dB(A) level, may be concerned with noise levels quoted for the measurement of rifle and pistol noise.



Because one is measuring a pressure response, when an assessment location is removed from a rifle range the ambient noise levels may be similar to the noise being assessed. If there are any wind gusts the resultant un-weighted peak hold level can be higher than that generated by the rifles.

Where one has a mixture of disciplines utilising a shooting complex there will be a different range of noise levels experienced at receiver locations dependent upon the type of firearm being discharged and the location of the firing position with respect to the receiver location.

For rifle ranges the targets are at a set location but the firing position can be at different distances from the targets. For an 800 m range shooting can occur at firing positions from 100 m out to 800 m, generally on 100 m increments.

It is necessary to note that noise levels associated with rifle and pistol firearms have a highly directional component. For a monitoring position that is perpendicular to the midpoint of the range the average noise level of one type of firearm will vary dependent upon the position from which the firearm is discharged. Therefore in conducting an assessment of a big bore rifle range it is necessary to conduct measurements at the various firing positions that may be used by that discipline.

For smaller ranges the firing position may be a permanent position in which case it is not uncommon to have a structure over the firing position.

## **Noise Guidelines**

The GHD acoustic assessments prepared in relation to the Southern Highlands Regional Shooting Complex refer to shooting noise guidelines (“the guidelines”) issued by the (then) State Pollution Control Commission (“SPCC”) in the mid 1980s.



On reviewing the acoustic documentation it would appear the authors of the reports are not fully conversant with the noise guidelines and how they are applied to rifle ranges. Therefore it is necessary to provide information as to the development and application of those guidelines as it may very well be the situation that none of the authors of the acoustic reports were practising as acoustic consultants when the guidelines were developed or first issued.

The guidelines were published as Chapter 164 in the SPCC's *Environmental Noise Control Manual* and provide a sliding scale of noise levels depending on the number of operating days/nights per week. One set of noise targets are for existing ranges and a lower set of noise targets for future ranges.

I am familiar with the guidelines as I developed the original version of the guidelines in my capacity as a member of the State Shooters' Liaison Committee which was chaired by the SPCC and included representatives from the various shooting disciplines. I was appointed by the Sporting Shooters' Association of Australia to be their technical representative on the committee.

The first version of the guidelines was based on actual measurements of various rifle ranges (Seaham, Hornsby and Silverdale) and a noise assessment report for military use of Hornsby Rifle Range prepared for the Department of Defence by the National Acoustics Laboratories (identified above).

My draft guidelines were amended by the SPCC by lowering the recommended noise limits by 5 dB. Other than that adjustment the technical content of the guidelines are as I originally prepared for the committee.



After the guidelines were published, further assessments of rifle ranges came before the State Shooters' Liaison Committee in relation to ranges operated by the Shooting Supporters Association of Australia. Those assessments provided working examples of the guidelines resulting in the SPCC adopting the use of the energy average of the individual maximum levels (for each shooting discipline) to be then compared against the target guideline. Furthermore for ranges that utilised multi-disciplines the assessment was to look at the different categories of operations/firearms.

In 1989 the SPPCC were requested by the ENCC (Environmental Noise Control Committee) to look at the (then) Defence concept or Accumulation Method (APL) and Maximum Level criteria for shooting ranges. A preliminary discussion paper prepared by Mr Johnston and issued by Mr Wilkes confirms for the existing SPCC table "was based upon some averaging of measured results" and for determination of the APL it was suggested that when "the peak linear values have been measured, the results shall be grouped as suggested previously for different firing combinations".

Defence no longer subscribe to APL and have moved to a different metric (CAL) for artillery fire.

For indoor ranges the linear peak level was not used as in general indoor ranges had a significantly smaller separation distance to residential receivers. The matter of using dB(A) was raised in the December 1987 SPCC Shooting Association Liaison Committee meeting for further investigation. Subsequently the assessment of indoor ranges was in terms of the A-weighted level and a desired goal of inaudibility.

The SPCC has evolved over the years into the Environment Protection Authority ("EPA"), then the Department of Conservation ("DEC"), then the Department of Environment Conservation and Climate ("DECC") and currently the Department of Environment Conservation, Climate and Water ("DECCW").

When the guidelines were published rifle ranges were Scheduled Premises under the Noise Control Act and as such were under the jurisdiction of the SPCC.



With the formation of the EPA and gazettal of the Protection of the Environment Operations Act (“POEOA”) rifle ranges were no longer scheduled premises and therefore fell under the control of councils. Rifle range applications since 1992 have in New South Wales generally been assessed in accordance with the SPCC guidelines.

The principal intent of the SPCC/EPA *Environmental Noise Control Manual* was to address industrial noise, or activities that were Scheduled under the Act. Subsequently the EPA discontinued use of the *Environmental Noise Control Manual* when they issued their *Environmental Criteria for Road Traffic Noise* document and the *Industrial Noise Policy* document.

## The GHD DA Assessment

The assessment nominates the aforementioned noise guidelines as being Chapter 164 of the DECC Environmental Noise Control Manual.

In a technical sense this is incorrect as the first version of the ENCM was issued by the SPCC and a later version was identified as an EPA ENCM. There has never been a DECC ENCM.

In Section 3.1 the report identifies that monitoring of the existing environment was conducted using unattended environmental noise loggers which are of no assistance in terms of evaluating the acoustic environment the area with respect to rifle noise. The environmental noise loggers record the A-weighted noise level and therefore in terms of describing the existing acoustic environment for comparison with firearms that material is no assistance.

Section 3.2 of the report refers to attended noise monitoring where the Peak Hold Linear levels were recorded that were purported to be representative of the proposed new ranges. On page 15 of the report the authors identify that in their opinion the testing simulated a worst-case configuration because:



- *Firing was undertaken at the end of the firing range nearest to the rear target earth embankment. Firing would normally occur at a further set back distance from the target than that tested, providing further distance loss attenuation of sound at the nearest receivers; and*
- *The firing during testing was considered more elevated and exposed than the rest of the range, with less trees intervening between source and the receiver locations.*

The first opinion is incorrect and indicates the authors had no understanding of the directional characteristic of firearms and that if one looked at a polar plot of noise one would find an expansion of noise contours to the side of the line of fire as one moved from the firing position towards the target. Therefore the greater the distance between the firing bench and the target the wider the noise contours and therefore there was a fundamental error in the assumption as to predicted noise levels from the proposed ranges.

With respect to the second basis of the opinion I can accept the elevated position can give rise to higher noise levels than a position shielded by topography, but do not accept the concept that the trees may result in a substantial attenuation, particularly if one is considering shotguns where the firearm is not discharged in a horizontal plane but is normally angled up between 20° and 60° above the horizontal.

Section 3.2.2 refers to measurements conducted for military weapons that utilised the existing 800 m range with firing positions between 100 m and 400 m. One would expect by reference to locations B3 and B4 to have negligible noise due to the directional component of such firing, but I would have expected the results for locations B1 & B2 to be expressed in terms of the different firing positions.

Table 3-6 identifies peak noise levels measured at 8 m to the side of the sniper rifles with identification that the different firearms provided consistent results of 144- 145 dB. The narrow range of noise levels would not appear to agree with measurements that I have conducted at greater distances from those weapons which caused me to look at the instrumentation that has been used for assessment purposes.



Section 3.2 nominates to sound level meters used for attended measurements and claims that both meters are Type 1 accuracy.

The specification sheet for the Svan 943 SLM indicates it is a Type 2 meter with a maximum range of 133dB<sub>ARMS</sub> that can determine a peak level but does not include a peak detector as part of the averaging of the meter.

The SVAN 912 SLM in fact has a number of models (A & AE) which are both Type 1 meters but would appear to have a maximum peak detector level of 140 dB.

When one is seeking to record such high pressure levels to ensure the meter does not overload one either uses (for Bruel & Kjaer instrumentation) a passive attenuator between the microphone and the meter, or a microphone with a lower voltage output so as to not overload the sound level meter. For sound pressure levels in excess of 130dB normally one then chooses to use a smaller diameter microphone (¼ inch or 1/8 inch) that can record such levels without overloading the microphone or the measurement system.

On reviewing the DA assessment prepared by GHD I find a number of errors in the report that indicate a basic lack of technical understanding with respect to the measurement and assessment of noise from a rifle range.

From the GHD interpretation of the measurement results they have identified that the new ranges are to be assessed under the future range category and that on the basis of a maximum level of 71 dB the new rifle and shotgun ranges should be restricted to 5 days per week and one night per week. For the pistol range that generates lower noise emission levels the recommendation is to 7 days per week and a maximum night-time usage of three nights per week.

The report does not identify the permitted usage for the existing 800 m range, which by reference to Table 3-5 for shooting out to 400 m would be permitted to have seven days per week and two nights per week.



However, as identified above because the authors of the GHD report did not understand propagation of noise from rifle ranges as the predicted noise levels for other firing positions had not been obtained and therefore they underestimated that noise impact.

Therefore based on the above material it stands to reason that the compliance testing carried out by GHD in June 2010 would be fundamentally flawed because of the lack of understanding the matter of noise propagation and measurement of noise from a rifle range.

The provision of a noise criteria for a future range to accord with the condition of consent may be appropriate for the new ranges but under the SPCC guideline the 800m range is an existing range and the noise levels emitted from the use of that range would not change as a result of the construction of new ranges to the west of the existing range.

Therefore compliance testing in relation to the use of firing positions less than 400m for the existing 800m range are likely to comply with the nominated criteria however use of firing positions between 800m and 500m for the existing 800m range are likely to exceed the nominated criteria because the criteria for the existing range is incorrect.

## **Conclusion**

The compliance testing conducted by GHD in June 2010 is technically flawed by reason of the weather conditions prevailing at the time and that also the reporting has not identified the logarithmic value of the different firearm classifications shooting from different positions.

The application of the SPCC/EPA target shooting guidelines by SPCC/EPA after the guidelines were published was for a multi discipline range to identify the noise levels associated with the different classifications of firearms and then to work out the permissible usage of those firearms. For example the operation of Rimfire rifles is expected to give rise to a significantly lower noise level than that from a Big Bore or



Centerfire rifle and therefore the permissible use of that classification of firearm would be a different number of days as a result of the lower noise level.

There is a fundamental flaw in the original DA acoustic assessment by not considering that component.

I append a copy of the Linear Peak noise contours for the Hornsby rifle range (800 metre firing bench) from the NAL report for that range that show the propagation of such firearms.

It is recommended that for the purpose of compliance testing of the Southern Highlands Regional Shooting Complex that monitoring be conducted at the nominated reference locations A1 to A4 inclusive but that also intermediate monitoring be conducted between the range and the residential area so as to identify the number of shots that are fired on the range to thereby give a correct adjustment to the number of shots in determining the logarithmic average.

The compliance testing is subject to the weather conditions and should be abandoned when there is excess wind and for the exposed location the limit for noise monitoring may very well be an average level of 1.5m per second with a maximum of gusts of 4m per second because in effect the noise levels at residential receiver locations are (in the context of other rifle ranges) relatively low.

Yours faithfully,

**THE ACOUSTIC GROUP PTY LTD**

  
**STEVEN E COOPER**



## **ANNEXURE A: CURRICULUM VITAE**

### **STEVEN E. COOPER - DIRECTOR**



**DATE OF BIRTH:** 15 June 1952

**QUALIFICATIONS:** Bachelor of Science Engineering  
(Electrical) 1978, University of NSW  
  
Master of Science (Architecture) 1990,  
University of Sydney

**MEMBERSHIPS:** Member, Australian Acoustical Society  
  
Fellow, Institution of Engineers, Australia  
Chartered Professional Engineer  
  
Member, Institute of Noise Control Engineering  
  
Member of Standards Association of Australia  
Committee AV/10 – Whole Body Vibration (1986 to  
present), Committee EV/11 – Aircraft & Helicopter  
Noise (1986 to present), AV/4 – Architectural  
Acoustics (1996 – 2000), and Committee EV/10/4 –  
Railway Noise (1998 to October 2007)  
  
NSW Division, Australian Acoustical Society  
Membership Committee since 1978 to 1997

**EXPERIENCE:** The Acoustic Group Pty Ltd  
Incorporated in 2003  
  
Steven Cooper Acoustics Pty Ltd  
Incorporated in 1995  
  
James Madden Cooper Atkins Pty Ltd  
Incorporated in 1981  
  
James A. Madden Associates Pty Ltd  
Appointed Associate Director 1980  
Appointed Associate 1979  
Appointed Engineer 1978

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**THE ACOUSTIC GROUP**

The Acoustic Group was formed to provide specialised services and research in Acoustics and Vibration and draws on the considerable experience of Mr. Cooper from his position from 1982-1995 as Principal and Partner of James Madden Cooper Atkins and from 1995-2004 as Principal of Steven Cooper Acoustics. His particular areas of acoustical expertise include machine and vibration monitoring, acoustical design of auditoria, studios and entertainment venues, traffic and helicopter noise, laboratory instrumentation, precision analysis system, legal assignments and expert witness.

He has considerable experience in vibration measurement and assessment in industry for both Machinery Operating Condition and Occupational Exposure Levels.

His experience in the measurement and assessment of noise emission from industry and licensed premises is extensive having produced numerous assessment reports and noise control designs for clients, statutory bodies and courts. He has been an invited Guest Lecturer on Noise Assessment to NSW Policy Academy for their Noise Familiarisation Course run by the State Pollution Control Commission, a guest lecturer for the Faculty of Architecture at the University of NSW, and a lecturer on noise issues for seminars/workshops run by the Australian Industries Group and the Australian Environment Network.

He is the acknowledged leader in the measurement, assessment and design of helipad/heliport operations, aircraft noise assessments, and is a major contributor to various Australian Standards. Mr. Cooper is the recipient of an Engineering Excellence Award in the Environment Category from the Institution of Engineers in 1997 for the TRW No. 2 Forge Project.

Projects in which he has been involved include the ICI Botany Complex (Noise and Vibration), APM Matraville Paper Mill (Site noise control), Manildra Flour Mill, Sydney CBD, Granville & Gosford Heliports, ANEF Validation and NPD testing for F111, FA-18 aircraft, Iroquois, Squirrel, Sea King, Sea Hawk, Blackhawk, Super Seasprite and Tiger helicopters, acoustical assessments for Licensed Premises, Studios, Auditorias etc.

## **PAPERS & PUBLICATIONS**

“Design for Noise Reduction – Dual Occupancies” 5th Annual Conference, Local Government Planners Association of NSW, November 1979

“Is Exposure to High Levels of ‘Rock’ Music a Major Health Hazard to Patrons and Staff” 10th International Congress on Acoustics – Sydney, July, 1980

“Hornsby Shire’s General Sound Insulation Code for Residential Flat Buildings” 10th International Congress on Acoustics – Sydney, July, 1980

“Archiving Reproducing Piano Rolls” 10th International Congress on Acoustics – Sydney, July, 1980



“Road Traffic Noise and Local Government Controls”, Graduate School of the Built Environment, University of NSW, February, 1981

“Noise Levels of Rock Music and Possible Effects on Young People’s Hearing” Scientific Meeting NSW Division, Australian Acoustical Society, April, 1981

“Noise Assessment of Licensed Premises” NSW Police Noise Familiarisation Course, Policy Academy Sydney, July, 1981

“Noise Effects on Staff in Entertainment Venues” Australian Live Theatre Council, May, 1983

“Noise Pollution” Shout – August 1987, Journal of the Registered Clubs Association of NSW

“The Roles and Needs of Expert Witnesses”, Development, Local Government and Environmental Seminar for Sly & Russell, Sydney, November, 1987

“Noise Limits for Helicopters”, “Helicopters Noise and the Community”, “Flight Techniques to Reduce Noise”, Helicopter Noise Seminar – NSW Branch of the Helicopter Association of Australia, April, 1988

“Intensity Measurements of the Ampico/Duo Arts Parts 1 & 2” The AMICA News Bulletin (USA), Vol 25 No. 4, July, 1988

“Community Perceptions, Case Studies and Control of Noise” – Australian Conservation Foundation – Sydney Branch, September, 1988

“Helicopter Noise Assessment”, Australian Acoustical Society Conference, Victor Harbour, South Australia, November, 1988

“Noise Considerations for the Establishment of Helipads/Heliports”, Rotortech ‘89, Sydney, October, 1989

“An Investigation of the Alternatives to Sabine’s Equation in the Determination of Absorption Coefficients using the Room Method”, Master of Science Thesis, University of Sydney, March, 1990

“Noise Control – Decibels per dollars. A Practical Approach”, The Stock Feed Manufacturers’, Association of Australia Conference, Canberra, March, 1990

“Community Response to Aircraft & Helicopter Noise – Proposed PhD Research”, Technical Meeting of the Australian Acoustical Society, NSW Division being a Review of Acoustics Research at Sydney University, May, 1991

“A Practical Method for the Assessment of Noise Controls for Aircraft Noise Intrusion”, Second Sydney Airport Coalition Public Meeting, Petersham Town Hall, Sydney, September, 1991



“Are Regulatory Noise Limits in Australia Exterminating the Helicopter Industry?”, Inter-Noise 91, Sydney, December, 1991

“Consideration of Alternative Acoustic Criteria for Assessment of Aircraft Noise in Wilderness & National Park Areas”, Progress Report of Noise Criteria Working Group, Blue Mountains Fly Neighbourly Advice, July, 1994

“Are Regulatory Noise Limits in Australia Exterminating the Helicopter Industry?”, Second Pacific International Conference on Aerospace Science & Technology, Melbourne, March, 1995

“Sound Proofing of a Forge”, Acoustics Australia, Vol 26 (1998), No 2

“AS2021 – What Does it Mean Now?”, Australian Mayoral Aviation Council Conference 1998

“Upgraded Plants and Retrospective Application of Modified Noise Criteria – Case Studies”, Australian Industry Group, January, 1999

“Revision of Australian Standard AS2021”, Airport Operators Conference, Melbourne, May, 1999

“Living with Your Neighbour’s Noise”, Neighbourhood Disputes Seminar, LAAMS, Sydney, May, 2000

“What Triggers the New EPA Noise Policies – Tips & Traps”, Australian Environment Business Network Noise Pollution Seminar, June, 2001

“Practical Environment Management – Noise Issues”, Australian Environment Business Network Environment Management Practitioners Workshop, August 2002, November 2002, February 2003, May 2003, August 2003

“Environmental Issues Management – Noise”, Australian Industries Group Practical Methods and Technologies Seminar, October, 2002

“The INM Program is a much better program than HNM for helicopter modelling, but ....”, SAE A-21 Helicopter Noise Working Group Meeting, Las Vegas, March, 2004

“Noise Certification, is the Helicopter Industry selling itself short?”, HeliExpo 2004, Las Vegas, March, 2004

“Derivation & Use of NPD Curves for the INM”, Helicopter Noise Workshop, American Helicopter Society Conference, June, 2005

“Problems with the INM: Part 1 – Lateral Attenuation”, Noise of Progress Acoustics Conference 2006, New Zealand

“Problems with the INM: Part 2 – Atmospheric Attenuation”, Noise of Progress Acoustics Conference 2006, New Zealand



“Problems with the INM: Part 3 – Derivation of NPD Curves”, Noise of Progress Acoustics Conference 2006, New Zealand

“Problems with the INM: Part 4 – INM Inaccuracies”, Noise of Progress Acoustics Conference, 2006, New Zealand

“Reviewing the Role of the Expert in Land & Environment Court Cases”, NEERG Seminars, Sydney, August 2007

“JSF Aircraft Noise Issues for Australia”, F35 ESOH Working Group Meeting, Washington, September 2007

“Acoustic Experts - Noise Under Pressure?” Getting it Together in the Land & Environment Court: Compiling Joint Expert Reports, NEERG Seminars, Sydney, October 2007

“What can go wrong acoustically”, NEERG Seminar Dealing with DAs in 2009, Sydney, May 2009

“Community Response to Impulse Noise & Vibration”, Training Area Noise & Vibration Workshop, Department of Defence, Canberra, June 2009

“Acoustics & Noise”. Regulations & Implementation of DAs & SEPP65, NEERG Seminars, Sydney, March 2010

“INM Getting it to work Acoustically”, 20<sup>th</sup> International Congress on Acoustics, Sydney 2010.

“Military Aircraft Noise in the Community”, 20<sup>th</sup> International Congress on Acoustics, Sydney 2010.

“Sound Therapy Restores hearing – Fact or fiction? A personal experience of an acoustician”, 20<sup>th</sup> International Congress on Acoustics, Sydney 2010.

“Alternative Aircraft Metrics – Useful or like moving the deck chairs on the Titanic”, 20<sup>th</sup> International Congress on Acoustics, Sydney 2010.

#### **SPONSORED TECHNICAL REPORTS (Brief Selection only):**

Noise Radiation and Reduction on a Fibreglass Minesweeper – HMAS Rushcutter for Carrington Slipways P/L, JMCA Report 16.1650.R1

Occupational Vibration Exposure Levels on Euclid Dump Trucks and Coal Haulers at Utah Blackall Mine Queensland, JMCA Report 16.1648.R1-R3



Thermal Expansion and Misalignment on a Gas Turbine Alternator at Shell Clyde Refinery, JMCA Report 17.1716.R1-R3

Acoustic Appraisal and Control – ABC Perth TV & Radio Studio Complex, JMCA Report 17.1607.R3

Southern Arterial Route – Pyrmont to St. Peters for NSW Department of Main Roads, JMCA Report 16.1647.R1

Building Structure Vibration Department of Social Security, East Point Centre Computer Installation, JMCA Report 15.1542.R2

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Acoustical Assessment, Point Piper Marina, 38.4705.R9

Rail Traffic Noise Impacts, Residential Sub-division, Isedale Road, Braemar, 40.4865.R1

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## ANNEXURE B: S. Cooper Experience in relation to Shooting Ranges

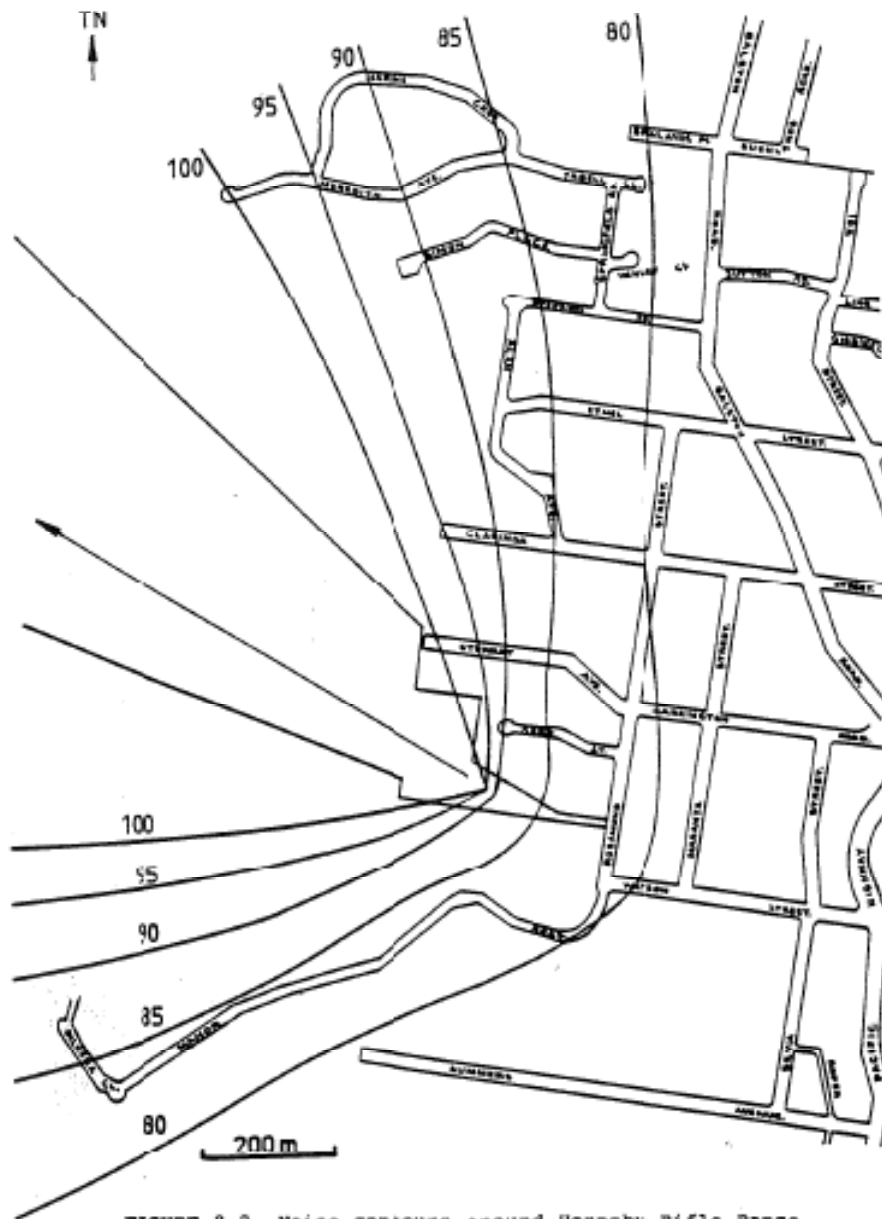
Measurement & Assessment		Assessment Only	
Condell Park Indoor Pistol Range	Roden Security Services	Tamworth Rifle Range	Sporting Shooters Association
Cecil Park Full Bore Range	Blacktown & District Clay Target Club	Canungra Rifle Range (QLD)	Sporting Shooters Association
Penrith Indoor Range	Shooters Paradise	Collinsvale Gun Club (TAS)	Collinsvale Gun Club
Silverdale Rifle Range	Sporting Shooters Association	Scotts Head Rifle Range	
JW Bruce Rifle Range, Seaham	Sporting Shooters Association	Purga Rifle Range (QLD)	Department of Defence
Goulburn Rifle Range	Sporting Shooters Association	Review of Shooting Guidelines (VIC)	Shooting Sports council of Victoria
ANZAC Rifle Range	Sporting Shooters Association		
Wagga Wagga Rifle Range	Sporting Shooters Association		
Batemans Bay Rifle Range	Sporting Shooters Association		
Brisbane Valley, Biana (QLD)	Sporting Shooters Association		
Fassifern Shooting Complex (QLD)	Sporting Shooters Association		
Eastern Creek Rifle Range	Blacktown & Districts Rifle Club		
Hornsby Rifle Range	Northern Districts Rifle Club		
Olympic Shooting Centre	Sydney Olympics 2000		
Kingswood Small Arms Range	Mr L Satara		
Kiama Albion Park Rifle Range	Kiama Albion Park Rifle Club		



Measurement & Assessment		Assessment Only	
Liverpool Rifle Range	Liverpool Rifle Club		
Tuncaster Small Bore Range	Lismore Pistol Club & Small Bore Rifle Club		
Coburn Rifle Range (VIC)	Sporting Shooters Association		
Nowra Rifle Range	Nowra Rifle Club		
Blue Mountains Rifle Range	Blue Mountains Gun Club		
St Marys Indoor Range	Sporting Shooters Association		
Lismore Pistol Range	Lismore Pistol Club		
Cecil Park Rifle Range	Hawkesbury Gun Club		
Hastings River Shooting Complex – 4 ranges	HRSC		
Majura Small Arms Range (ACT) – 7 ranges	Department of Defence		
Singleton Training Area	Department of Defence		



## ANNEXURE C: Hornsby Rifle Range Noise Contours



**FIGURE 8.2** Noise contours around Hornsby Rifle Range  
(Unweighted peak sound pressure level - LPEAK)

