SOLVING A BAFFLING PROBLEM AT WARRINGAH AQUATIC CENTRE

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ABSTRACT: Warringah Aquatic Centre has for 20 years been a major sporting and recreation drawcard for tens of thousands of people on the lower north shore and lower northern beaches of Sydney. Noise reverberation has always been a concern at the Centre, even though baffles were installed in the concrete ceiling about 15 years ago. When the baffles began to deteriorate over the past couple of years, the situation became critical. This article describes how the problem was overcome, in spite of considerable challenges.

1. INTRODUCTION

The Warringah Aquatic Centre at Frenchs Forest on Sydney's lower North Shore records about 360,000 visitors a year, from casual swimmers and families to aquarobics and swim class students and, of course, clubs and schools holding sporting carnivals.

The building is of concrete construction approximately 65 metres long, 50 metres wide and 9 metres high from the concourse around the pool to the underside of the effective ceiling which is profiled, with roof lighting and high and low levels. Tiered seating is provided on each side and at one end of the pool.

Noise levels in the pool had been deteriorating over some years and the problem became critical towards the end of 1998. Mr Gary Penfold, General Manager of the Centre described the problem: "Aquarobics and swim classes couldn't hear their instructors, and school carnivals were chaotic. We were getting more and more complaints."

Warringah Shire Council sought an acoustic assessment in early 1999. PKA Acoustic Consulting was asked to investigate:

- Existing reverberation times
- Existing ambient sound levels
- Pre-existing reverberation times
- Recommended reverberation times

The investigation was based upon site visits, acoustic measurements, drawings and photographs provided by Council as well as computer modelling and general acoustic calculations.

2. TESTING EXISTING AMBIENT NOISE

The old noise baffles were removed before a noise data logger (Acoustic Research Laboratories type EL-015) was set up on top of the fire hose reel cupboard next to the Manager's Office at one corner of a mezzanine level around the pool. The logger was set to update every 15 minutes and to operate from 5pm (1700 hours) on Friday, 5 March 1999 until 9.30am (0930 hours) on Friday, 12 March 1999.

Inspection of the graphs and figures indicated that the highest noise levels were recorded on the evening of Friday, 5 March, between the time the logger was set up and 11pm (2300 hours). The L_{Amax} (maximum RMS Sound Pressure Level) was 106.5 dB(A) during this period and the other parameters were:

L_1	102.0 dB(A)
L_{10}	95.4 dB(A)
L_{Aeq}	91.0 dB(A)
L_{90}	84.5 dB(A)

Other periods when L_{Amax} reached over 100 dB(A) were Saturday evening (103), Monday daytime (102), Tuesday daytime (103), Wednesday daytime (103), Thursday daytime (104).

From these measurements, it is obvious that noise levels in the pool centre were extremely high and close to being unacceptable under the requirements of Worksafe Australia, namely 85dB(A) for eight hours.

Using the data logger information, the noise exposure level was calculated as follows for representative eight-hour periods during each day.

	9am - 5pm L_{Aeq} dB(A)	2pm - 10pm L_{Aeq} dB(A)
Saturday, 6 March	76	79
Sunday, 7 March	74	73
Monday, 8 March	83	81
Tuesday, 9 March	82	78
Wednesday, 10 March	83	80
Thursday, 11 March	83	78

On three occasions, employees were exposed to 83 dB(A), just below the statutory 85 dB(A) L_{Aeq} limit.

Reverberation times in the enclosed pool were determined using large 800mm inflated balloons that were pricked with a pin, the resulting burst being recorded through a Sennheiser "Dummy Head" microphone system onto a Sony DAT recorder type TCD-D7.

3. ANALYSING THE ACOUSTIC TESTS

The recordings were analysed by audio input into a computer. The digital recordings were transferred to computer wave files and analysed using SIA Smart-Pro to obtain the octave banded reverberation times for the pool enclosure.

The following results were obtained:

Octave band centre freq (Hz)	125	250	500	1k	2k	4k
Reverberation time (seconds)	6.0	6.0	6.4	6.6	6.5	5.0

Reverberation times in the enclosed pool after baffles were originally installed were estimated as an average of about 2.5 seconds, based upon descriptions provided by pool staff together with photographs of the original acoustic treatment.

If the reverberation time could be reduced from 6 seconds to about 2.3 seconds, the maximum sound level would be reduced by about 4 dB, from 83 to 79 dB(A).

Following this analysis, PKA Acoustic Consulting submitted a report to Warringah Shire Council recommending the installation of 672 baffles below the ceiling in Stage 1 of a noise reduction program. The report predicted that reverberation would be reduced to 2.16 seconds. The report went on to recommend the installation of a further 318 baffles in Stage 2 if noise levels could not be reduced to a satisfactory level in Stage 1.

Computer modelling on a Macintosh, running Bose Modeller Version 4.7, was used to assist in determining the extent and layout of acoustic absorbing material. Bose Modeller is a sound system design program usually used to place loudspeakers in a room or auditorium. PKA Acoustic Consulting has adapted the product to model predicted reverberation times versus actual. The dimensions and existing materials of the pool area were entered into the modeller and the existing reverberation times predicted. These agreed very closely with those measured, so no further adjustments to the model were necessary.

A variety of alternative sound absorbing treatments were then entered into the modeller and a number of permutations of acoustical treatments were tried.

Eventually, traditional baffles were recommended. These were constructed of powder-coated metal perforated on both faces and the edges, with infill of medium-density glasswool. Each baffle, measuring 1200mm long by 1000mm high and 110mm thick, was covered with 50-micron black polythene sheeting to prevent deterioration by moisture. Deterioration of the original baffles had, to some extent, been caused by moisture in the swimming centre. Low frequency noise absorption is slightly enhanced by the polythene sheeting while mid and high frequency absorption is reduced.

The deduced acoustic performance of the baffles per square metre of surface area was:

Octave-band centre freq (Hz)	125	250	500	1k	2k	4k
Absorption coefficient (sabins)	1.03	0.67	0.60	0.57	0.61	0.70

The completed design positioned 650 rectangular baffles to hang vertically, approximately 100mm below the ceiling around the pool. The layout is shown in Figure 1.

4. INSTALLATION

Warringah Shire Council called for tenders to supply baffles and install them as recommended by John Andrew's report. The successful tenderer, Alliance Noise & Energy Management, recommended a number of changes to the original concept outlined by Council. A key recommendation

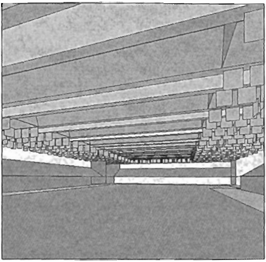

Figure 1 Computer-generated perspective view showing recommended positions for the baffles at Warringah Aquatic Centre. In fact, some baffles were moved from the rear of the building and suspended over the pool.

was to suspend the baffles on brackets hooked over the skylight openings rather than drilling masonry anchors into the reinforced concrete roof which presented a risk of moisture damage in the long term. Alliance also recommended a novel approach to installation. The workers would enter the building from the roof, lifting off skylights and working from suspended gantries rather than from scaffolds and hydraulic lifts within the pool enclosure.

Two working platforms were designed and built, then lowered through the skylight openings travel along tracks below ceiling height. The gantries provided a safer option for installation workers than scaffolds or lifts and allowed work to be undertaken without interfering with normal activity in and around the pool, if desired. The gantry system provided the managers of the centre the option of remaining open throughout the installation process. In the end, however, management decided to close the pool during September and October 1999 to undertake comprehensive refurbishment, including replacing tiles, doors and the skylights in the roof. The gantries allowed all this work to go ahead simultaneously. It also allowed the installer to place some baffles directly over the pool, which had not originally been envisaged in Stage 1 of the PKA report. Some of the baffles originally specified to hang in an area immediately above tiered seating were moved to the area above the pool.

Spacing of the baffles varied, partly because of the roofing design and partly to accommodate other items suspended from the roof, such as lighting and public address fixtures. Three basic spacings were approved: two metres and four metres along the length of the pool and approximately 3.5 metres across.

Suspension of the baffles was achieved by a system of specially fabricated brackets, T-bars and stainless steel wires. Fabrication of the majority of components was done off site to reduce time on site. With corrosion of the original baffles in mind, Alliance heavily anodised the aluminium components and inserted nylon bushes between all aluminium and stainless steel connections to prevent electrolysis.

"The Alliance design solutions were imaginative and appropriate for us, both in terms of installation methods and the final product," said Gary Penfold. "It was important to us —given the other work going on at the same time—that the installation teams were professional, thorough and solution-oriented. They were working with other teams around them at all times, as well as teams of workers refurbishing all the change rooms and replacing virtually every door in the Centre."

"The new system has transformed the Centre," said Mr Penfold. "Before the new baffles were installed, we could not have a normal conversation around the pool," he said. "Everyone had to shout to be heard as the noise reverberated. Now, the Centre is a much more pleasant environment. We can talk in quite normal tones."

John Thornton, Managing Director at Alliance Noise & Energy Management, said: "The Warringah Aquatic Centre had a noise problem that is not unique. Our challenge was to ensure a long-term and aesthetically pleasing solution that we could erect with a minimum of fuss. When people are working 10 metres above a concrete floor or pool, safety is a major issue. Developing the working platforms solved both the safety issue and made the work much more simple than scaffolding or hydraulic lifts."

5. CONCLUSION

PKA Acoustic Consulting returned to the Centre at the end of November to complete a new set of reverberation measurements.

The test demonstrated that noise levels were consistently lower around the pool, with reverberation times averaging between 2.1 and 2.3 seconds throughout the eight locations. Across the octave band, reverberation times ranged from 1.4 seconds at 125Hz in one location to 2.7 seconds at 1,000 Hz at another.

Octave-band centre freq (Hz)	125	250	500	1k	2k	4k
Reverberation time (seconds)	1.6	2.2	2.4	2.5	2.4	2.0

The overall average reverberation time was 2.19 seconds with 650 baffles installed, compared with the prediction of 2.16 seconds with 672 baffles.

The desired result had been achieved in a single stage.