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Hearing Conservation in the Primary Aluminium Industry

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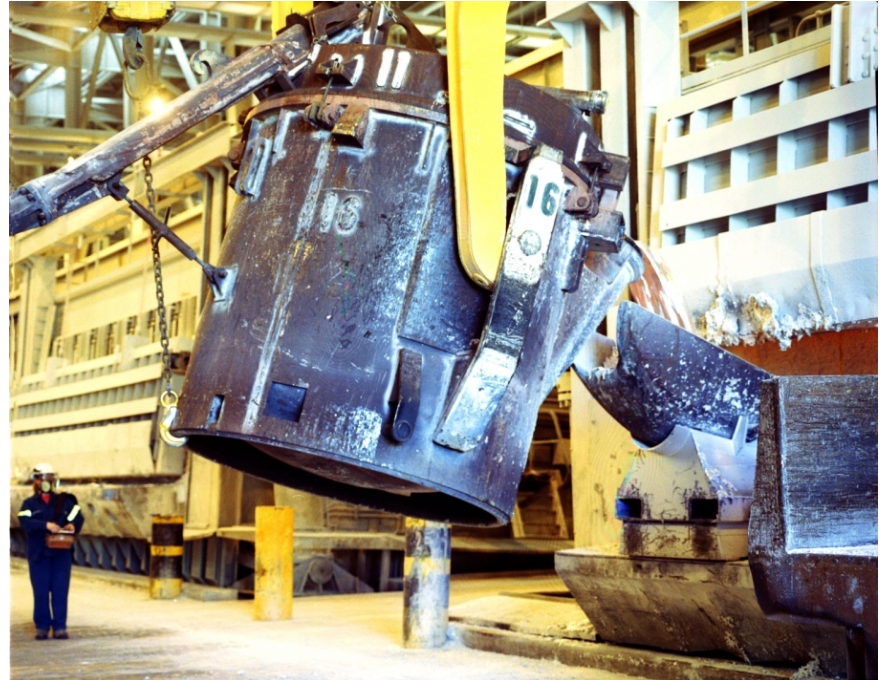
Introduction

- Exposure to noise in industry is ubiquitous and noise induced hearing loss (NIHL) has been an intractable problem.
- In the US ~ 22 million workers are exposed to hazardous noise levels and NIHL is one of the most common work-related diseases ¹.
- Over 30 years the prevalence of hearing impairment in US industry has remained fairly constant at about 20%, while the incidence has fallen by almost 50% ².
- Hearing conservation efforts are having some effect – but there is clearly room for improvement.



Hearing Conservation at Alcoa of Australia 2006 - 2013

- Over the period 2006 – 2013 Alcoa of Australia introduced a number of new hearing conservation initiatives including quantitative fit testing of hearing protection.
- We have seen a substantial and sustained decline in the incidence of 10dB age-corrected hearing shifts over this period.



Alcoa of Australia Locations 2006 - 2013

Western Australia

Huntly Bauxite Mine

Willowdale Bauxite Mine

Kwinana Alumina Refinery

Pinjarra Alumina Refinery

Wagerup Alumina Refinery

Victoria

Portland Aluminium Smelter

Point Henry Aluminium Smelter

Anglesea Power Station



Existing Hearing Conservation Program in 2006

These mandated elements of Alcoa's global health standard on hearing conservation had been in place for years:

- Annual audiometry – for personnel whose noise exposure for 12 or more days per year equals or exceeds 85dB(A)Leq8h, a 15min short-term exposure limit of 100dB(A), or a sound pressure level of 140dB linear peak.
- Audiometry every 3 years – for $\geq 82\text{dB(A)}\text{leq}8\text{h}$ but $< 85\text{dB(A)}\text{Leq}8\text{h}$ (12 or more days per year).
- Noise exposure assessments including sound level surveys and personal dosimetry where the above values are exceeded.
- Hearing conservation training and hearing protection for all employees meeting the noise exposure criteria for audiometry.
 - Education on the potential harmful effects on hearing of exposure to noise.
 - Explanation of the hearing conservation and noise control program.
 - Explanation of hearing protectors including the advantages/disadvantages of various types, the attenuation provided, selection, fitting, use and care.
 - Explanation of the purpose of audiometric testing, the procedure and the importance of participation as a way of detecting early signs of hearing loss to prevent hearing impairment.

Audiometry

- Audiometry is conducted at Alcoa medical centres by OHN's trained and certified in audiometry.
- Audiometers and hearing booths are tested and certified annually.
- Audiometric data are uploaded to the Occupational Health Manager (OHM) medical records database.
- US OSHA criteria for classifying hearing shifts are applied to the audiometric results.



Audiometric 10dB Hearing Shifts

- An age-corrected 10dB hearing shift is a pure tone audiometric threshold decrement of 10dB or greater from the last baseline averaged across the frequencies of 2, 3 and 4kHz, with age correction applied to the result.
- Baseline is either the audiogram on commencing employment or the audiogram at the time of the last age-corrected confirmed 10dB hearing shift if there has been one in the same ear.



Audiometric 10dB Hearing Shifts

- Any age-corrected 10dB hearing shift requires a repeat test undertaken within the next 30 days after a noise-free interval of 14h to exclude temporary threshold shift.
- If the retest confirms the shift it is referred to as an age-corrected confirmed 10dB hearing shift.



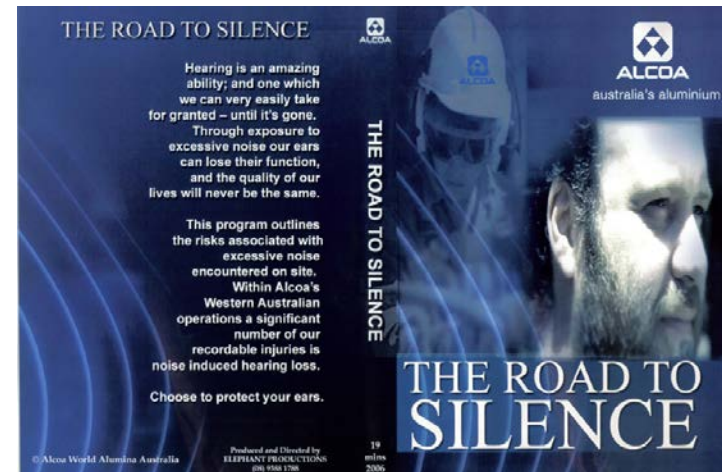
Methods

- For each of the mines, refineries and smelters the number of age-corrected confirmed 10dB hearing shifts was determined for each year (2006 – 2013) and divided by the number of employees undergoing audiometry in the same year. This figure multiplied by 100 gave the age-corrected confirmed 10dB hearing shift rate (% per year).
- Yale University found the age-corrected confirmed 10dB hearing shift rate in non-noise exposed US Alcoa employees is 1%.
- If this “background” 1% shift rate could be attained in noise-exposed employees, occupational NIHL would have been minimised.
- Based on this concept, Alcoa Inc has set a global target for the year 2020: the age-corrected confirmed 10dB hearing shift rate should be <1% per year.
- “Background” hearing shifts are due to non-occupational noise exposures and various diseases known to cause hearing loss.

Hearing Conservation Initiatives 2006 - 2013

From 2006 – 2013 Alcoa of Australia introduced a range of hearing conservation initiatives

- Noise summits and hearing promotion campaigns to motivate and educate employees about the cause and consequences of NIHL.
- “The Road to Silence” educational DVD on NIHL.



Hearing Conservation Initiatives 2006 - 2013

From 2006 – 2013 Alcoa of Australia introduced a range of hearing conservation initiatives

- The FitCheck (Michael and Associates Inc) insert-type hearing protector measurement system to quantify ear plug noise attenuation in each employee. This is undertaken every 2 years. In 2014 the 3M™ E-A-R fit equipment was introduced.
- Provision of a broad range of hearing protection devices.



Hearing Conservation Initiatives 2006 - 2013

From 2006 – 2013 Alcoa of Australia introduced a range of hearing conservation initiatives

- Adoption of non-age-corrected 10dB hearing shifts as an early warning of an impending age-corrected confirmed 10dB hearing shift³. This triggers a personal hearing conservation review with the supervisor and occupational hygienist.
- Bimonthly audits of hearing protector compliance.
- Visual walkway signage.
- Personalised hard hat stickers to remind employees which ear plugs gave them good FitCheck attenuation.



Hearing Conservation Initiatives 2006 - 2013

From 2006 – 2013 Alcoa of Australia introduced a range of hearing conservation initiatives

- Requirements that all operating centres identify engineering control projects and complete them when practicable.
- A “Buy Quiet” approach to procurement of new equipment.
- Personal noise indicator badges (3M™ NI 100) with green or red flashing lights to indicate the realtime noise level is below or above 85dB(A).
- Use of noise dosimeters to confirm a 14h noise-free interval before confirmation audiometry.



Noise Exposure Assessment

- SEG noise data were interrogated.
- Noise exposures are classified as 'unacceptable' at Alcoa if the exposure for the SEG has a >5% probability of exceeding the OEL on any day.
- Alcoa Inc set specific noise exposure reduction targets during two cycles within the study period.
- For 2006 – 2008 the target was a 20% reduction in the noise magnitude, or number, of unacceptable SEGs.
- For 2009 – 2011 the target was 100% of engineering projects identified by the location as achievable at the start of the cycle.



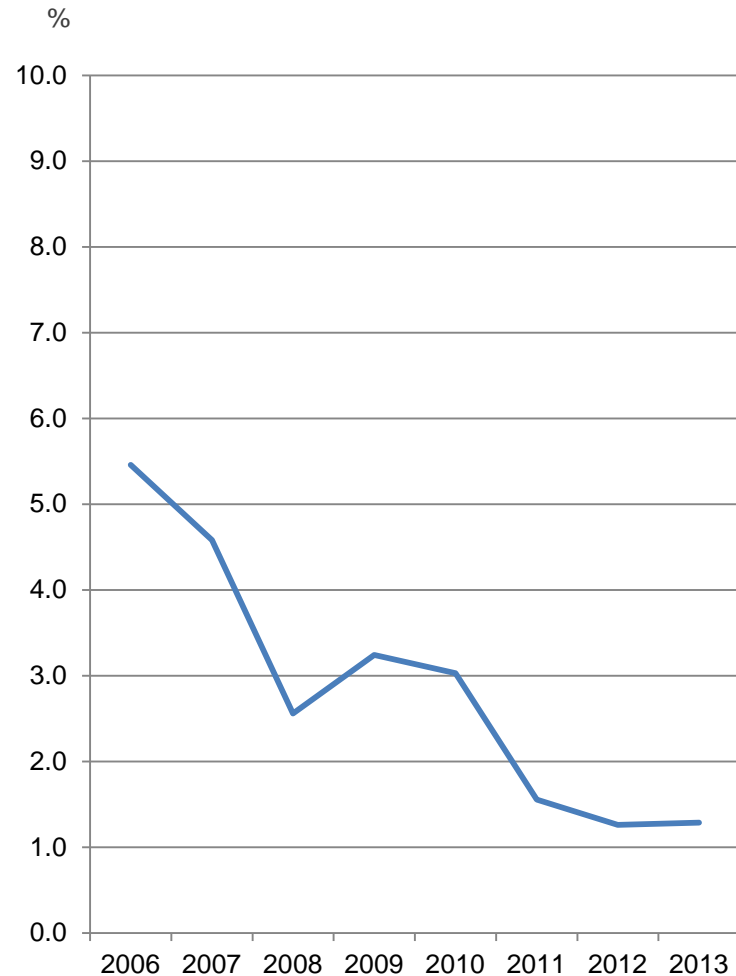
Noise Exposure Assessment

- Noise exposure data were analysed for each location and for the Australian operations as a whole across each of the three year cycles.



Audiometric Results: Alcoa of Australia

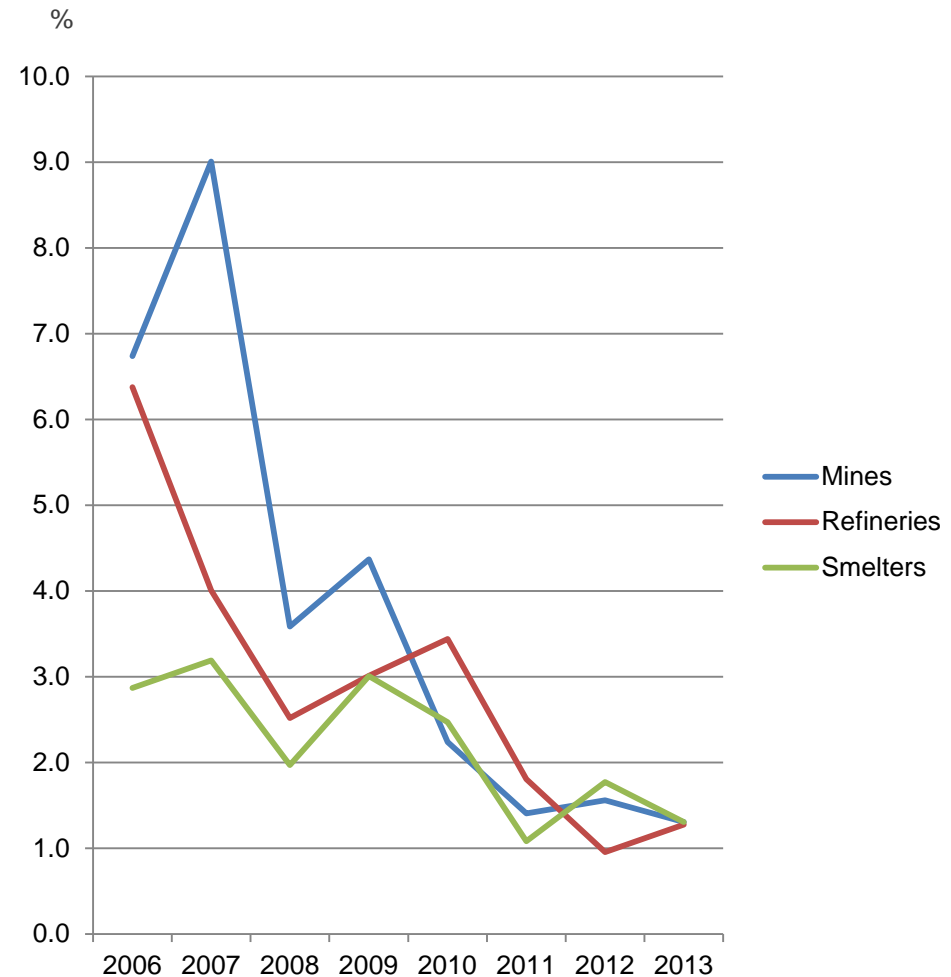
- In 2011 there were 865 employees in the mines, 2994 in refineries and 1246 in smelters. Audiometric surveillance was required for 796 mining employees (92%), 2631 refinery employees (88%) and 1091 smelter employees (88%).
- When all of the operations were considered in aggregate, there was a statistically significant decline in the age-corrected confirmed 10dB hearing shift rate from 5.5% per year in 2006 to 1.3% per year in 2013.



Trend: $P < 0.001$

Audiometric Results: Mines, Refineries and Smelters

- The declines in shift rates were particularly marked for the mines and refineries, which started at higher baseline shift rates than the smelters.
- All declines were statistically significant.
- The shift rate remained below 2% per year for the mining, refining and smelting operations throughout the three most recent years of 2011 – 2013, indicating a degree of consistency and durability.



Trend: Mines $P < 0.001$, Refineries $P < 0.001$, Smelters $P < 0.05$

Noise Reductions For 'Unacceptable SEGs: 2006 – 2008 Cycle

	Anglesea Power Station	Kwinana Refinery	Pinjarra Refinery	Point Henry Smelter	Portland Smelter	Western Australian Mining	Wagerup Refinery	All locations
Baseline 'unacceptable' noise SEGs (n)	9	15	81	35	44	24	75	283
Baseline GM % OEL	192	476	372	287	308	337	253	
End of cycle GM % OEL	177	442	353	246	223	311	244	
Reduction from baseline (%)	8	7	5	14	27	8	4	10
Baseline equivalent [dB(A)]	86.8	90.8	89.7	87.6	87.9	88.3	88.0	88.0
End of cycle equivalent [dB(A)]	86.5	90.4	89.5	86.9	86.5	87.9	87.9	87.6

Noise Reductions For 'Unacceptable SEGs: 2009 – 2011 Cycle

	Anglesea Power Station	Kwinana Refinery	Pinjarra Refinery	Point Henry Smelter	Portland Smelter	Western Australian Mining	Wagerup Refinery	All locations
Baseline 'unacceptable' noise SEGs (n)	8	133	114	45	46	43	55	444
Baseline GM % OEL	191	141	175	229	224	175	196	
End of cycle GM % OEL	238	128	158	198	214	157	186	
Reduction from baseline (%)	-25	10	10	13	4	11	5	8
Baseline equivalent [dB(A)]	86.8	85.5	86.4	86.6	86.5	85.4	86.9	85.5
End of cycle equivalent [dB(A)]	87.8	85.1	86.0	86.0	86.3	84.9	86.7	85.1

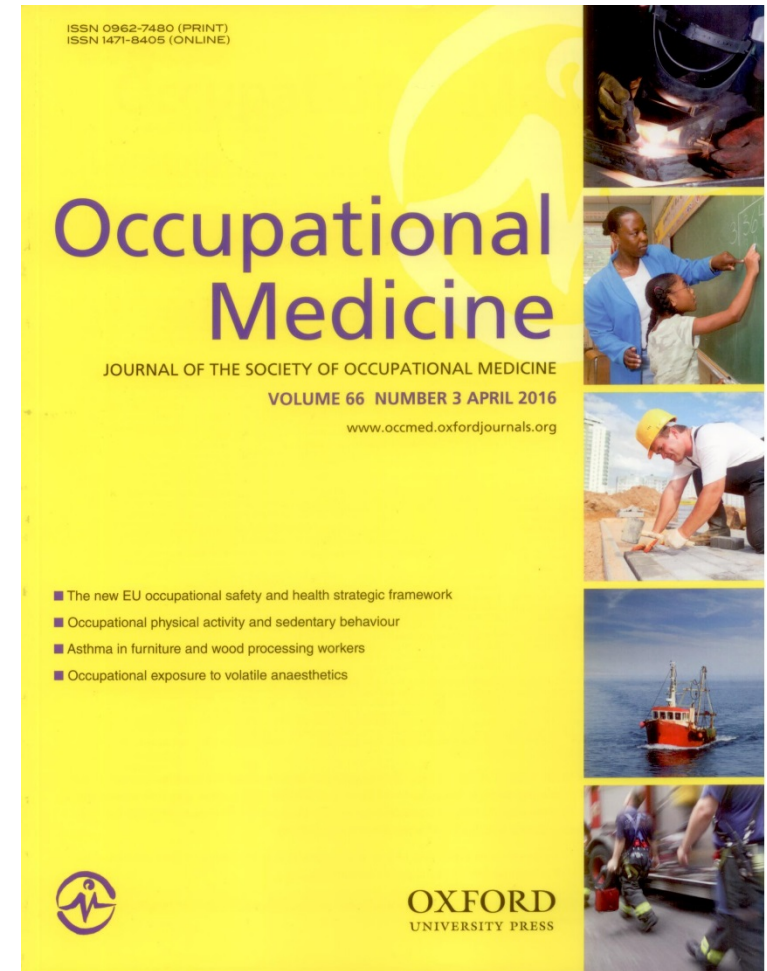
Note: The number of baseline unacceptable SEGs in this second cycle is higher than the first. Reorganization led to increased numbers of smaller work groups. Many of these new SEGs had lower noise exposures. This had the impact of lowering the average unacceptable noise Level from one cycle to the next.

Conclusions

- The 2013 results approximate the 'background' 1% per year shift rate found previously in non-noise exposed US Alcoa employees.
- This suggests occupational NIHL has been minimised at Alcoa of Australia's mines, refineries and smelters.
- It is likely that quantitative fit testing of hearing protection attenuation and educational initiatives had the greatest impact of all the initiatives.
- The overall noise reductions were modest (10% in the 2006 – 2008 cycle and 8% in the 2009 – 2011 cycle). These reductions probably contributed to the declines in hearing shift rates – although probably less so than the improved use of hearing protection. The modest magnitude of reductions indicate that even with a high degree of focus, engineering controls are difficult and expensive.
- It is likely that the hearing conservation initiatives could be deployed relatively easily and at modest cost in other industries with noise-exposed employees.

More Details in Published Paper ⁴

- Donoghue AM, Frisch N, Dixon-Ernst C, Chesson BJ, Cullen MR. Hearing conservation in the primary aluminium industry. *Occup Med (Lond)* 2016;**66**:208-214. Epub 2015 Oct 15.
- Open Access Link (Free to Download):
<http://occmmed.oxfordjournals.org/content/66/3/208.full.pdf+html>



Acknowledgments

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