

The Significance Of Noise
Exposure Of Divers
During
Typical Diving Operations
In The Norwegian Sector
Of The
North Sea

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Noise in the workplace

Excessive noise causes:

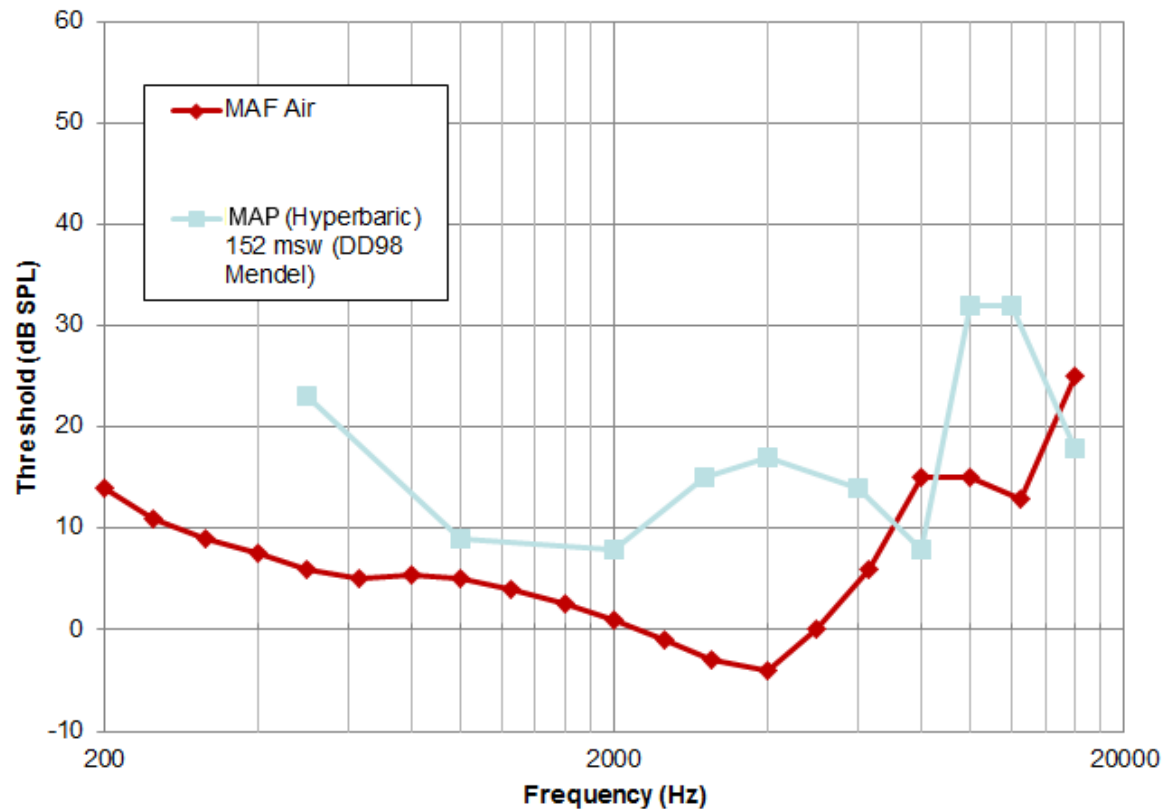
- Temporary and permanent deafness
- Interference with communication and sensory cues
- Poor task performance
- Stress and illness



Legislation to prevent occupational hearing loss

- Legislation in the US, Europe and elsewhere limits noise exposure in the workplace to a maximum “dose” equivalent to 85 dB(A) for 8 hours; **no legislative exclusion for diving**
- dB(A) measurements are weighted by a model of human atmospheric hearing (higher levels of low and high frequency sound are permissible). Human hearing is less sensitive in hyperbaric gas, so in our project we have assumed there is a corresponding degree of protection
- Our survey; conformed to the legislative approach but “corrected” the dB(A) by modifying noise measurements to allow for change in hearing sensitivity (*Note: this correction varies with both frequency and depth*)

Hyperbaric Human Hearing Threshold



Mean hyperbaric hearing thresholds across nine divers from Mendel *et al* (2000) DD98 experiment at 152 msw, *versus* human free field hearing threshold.

Measurement Equipment

Rugged equipment had to be developed/certified for use in hyperbaric/helium environment



- Safety was paramount consideration
- Hydrophones inside and outside helmet recorded noise during dive
- Noise post-processed to yield dB(A)_h corrected noise level; software “hyperbaric sound level meter” developed

Fitting Measurement Equipment

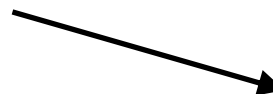
Inside helmet

- Hydrophone fitted under neck dam
- Positioned next to ear
- Sealed with silicone 'fin' wrapped around the cable



Outside helmet

- Hydrophone fitted to the top of the helmet with tip inline with face plate



Enclosure

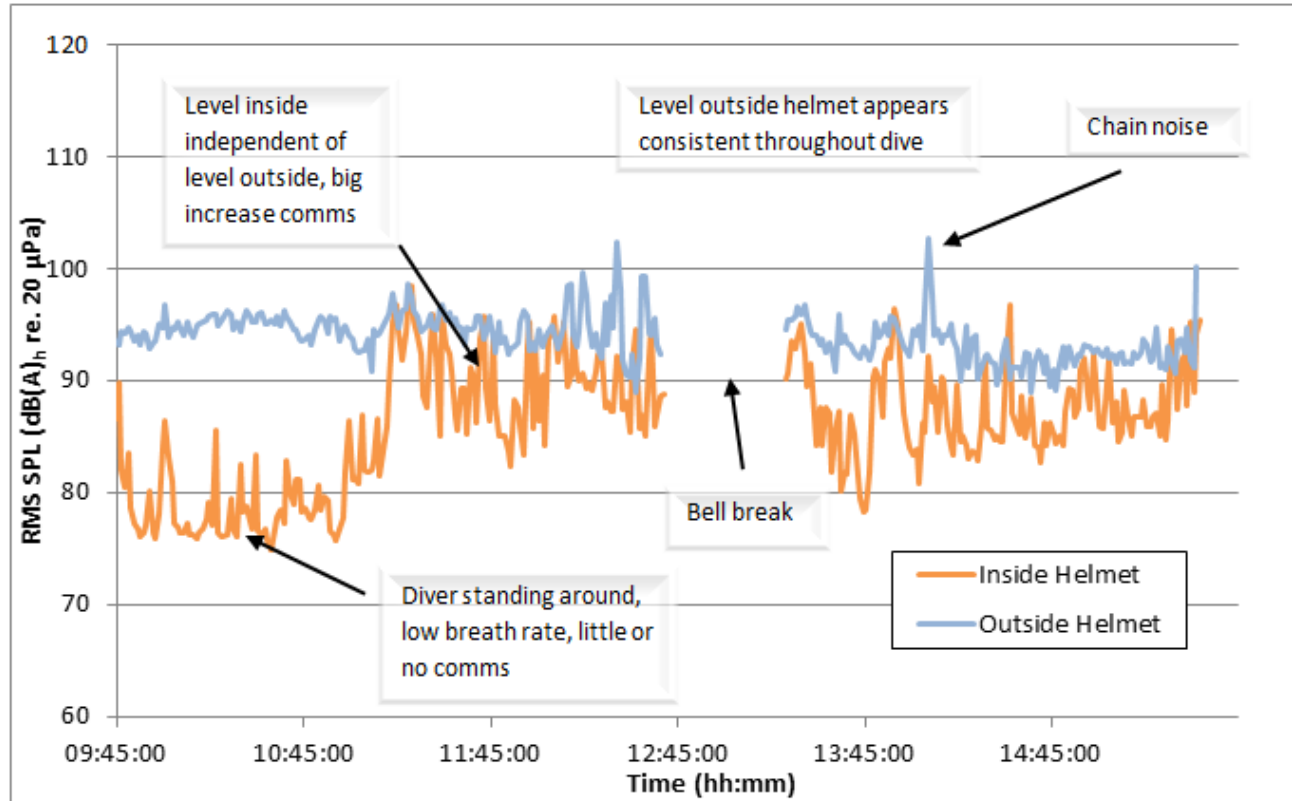
- Strapped to diver's harness/waist in a netted bag
- Loose hydrophone cables velcro tied – to avoid snagging



Typical noise time history during a dive

Time in water: 5 hours 10 minutes dive

Activity – Tie ins. Depth = 120 msw



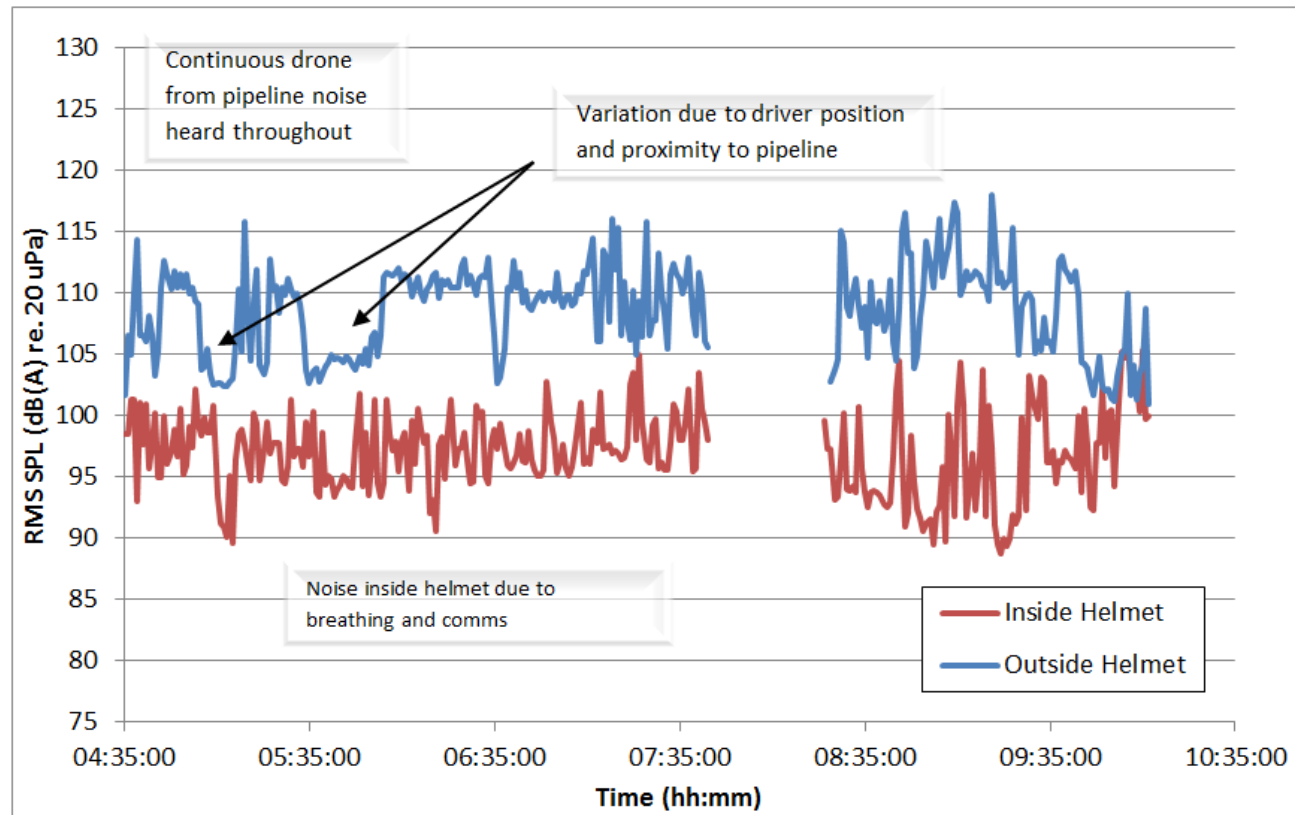
Average corrected level inside over 5h 10min :

$L_{eq} = 88.6 \text{ dB(A)}_h$ Time to daily dose: 3h 27min

Typical noise time history during a dive

Time in water: 4 hours 22 minutes dive

Activity – Tie ins, Depth = 120 msw



Average Level Inside over 4h 22min: $L_{eq} = 97.8$ dB(A)

Time to daily dose: 25min

Project scope was limited

- Atmospheric exposure
- Press/depress
- Saturation facilities
- Habitats
- **Helmet noise**
 - + diver tool noise
 - + waterborne environmental noise

Noise control and hearing conservation programme

Monitor noise in areas that can contribute to diver's noise exposure

Project area

Does total noise dose exceed 85 dB(A) Lep equivalent?

Yes

No

Noise dose 85 dB(A) 8 hr exceeded, mandatory actions:

Equipment: Noise control for area or equipment, minimise noise at source, control exposure

Training: Knowledge of health benefits, proper use of equipment

Medical: Audiometry, maintenance of records,

Review: Is new and better equipment available?

Voluntary health programmes

Conclusions

1. The noise doses received by divers while undertaking helmet diving were found to exceed legislative limits, even when weighted for hyperbaric exposure, and despite other noise exposure (living/sleeping quarters, press/depress//bell etc.) not being included in the daily total noise dose
2. Confirmatory research is required to provide further measurements and, critically, to properly specify hyperbaric hearing thresholds; analysis is currently based on one set of results from Mendel *et al* (2000)

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