Seismic Surveys & Diving

June 2023

Summary - There may be effects from the Regia MSS to divers utilising the area. As per the Diving Medical Advisory Committee (DMAC) a simultaneous operations (SIMOPS) plan will be developed. If you dive along the Victorian coast between Portland and Apollo Bay, we want your input into the SIMOPS Plan.

Sound propagation is a complex process influenced by the medium through which the sound waves travel. In both air and water, sound propagates as mechanical waves, requiring a medium for travel (Rossing, Moore, and Wheeler, 2002). However, the unique properties of these media—air and water—result in differing sound propagation characteristics.

Speed: Sound travels faster in water than in air due to the greater density and incompressibility of water. On average, the speed of sound in air is around 343 meters per second (at 20°C and sea level), whereas in water, it's around 1,500 meters per second (Lurton, 2010).

Energy Transmission and Intensity: The energy, or intensity (loudness) of a sound is measured on the decibel (dB) scale. It requires about 60 times more energy to transmit a sound through air than through water. This energy difference contributes to a 61.5 dB difference between sounds transmitted through air and water, implying that a sound intensity of 120 dB in water would correspond to an intensity of roughly 60 dB in air. This difference is crucial when comparing sounds in the ocean with sounds in the air (Webb 2021).

Attenuation: Despite the energy difference, sound waves attenuate or lose energy less in water, enabling sounds to travel much longer distances under the sea than in the air (Urick, 1983). For example, low-frequency sounds (around 1 kHz) can travel for hundreds of miles in the ocean, whereas in air, they would lose most of their energy within a mile or so.

Frequency Response: Water more efficiently propagates low-frequency sounds than high-frequency sounds due to less attenuation. Conversely, in air, high frequencies are attenuated more rapidly, leading to a more balanced sound across different frequencies (Rossing, Moore, and Wheeler, 2002).

Refraction: Sound wave refraction in water can be influenced by temperature, pressure, and salinity gradients, resulting in more complex sound paths (Jensen, Kuperman, Porter, and Schmidt, 2011). In air, these effects are less pronounced, and sound travels more directly from the source to the receiver (Morfey, 2001).

The propagation of sound is a multifaceted process in both air and water, with factors such as the medium's properties, temperature, pressure, and frequency of sound playing significant roles.

Seismic Sound

Underwater acoustic emissions from a seismic source are characterised by high energy pulses of low frequency sound. The frequency of the sound produced from each seismic pulse is primarily less than 2 kHz, with the highest levels at frequencies in the range of 10-500 Hz (McCauley 1994).

This range overlaps with the lower end of the frequency spectrum for human hearing, which typically spans from 20 Hz to 20 kHz (Masterton et al., 2011). However, underwater auditory threshold curves indicate that the human auditory system is most sensitive to waterborne sound at frequencies between 400 Hz to 1 kHz (Parvin et al. 1994). Therefore, while divers may not be able to hear seismic survey sounds as clearly as higher-frequency sounds, the intense low-frequency sounds used in seismic surveys can still pose potential risks to their hearing and overall wellbeing. Additionally, it's worth noting that sound perception can be subjective and variable among individuals, so individual sensitivity and response to seismic survey frequencies may vary.

Impact of Underwater Sound on Divers/Swimmers

The propagation of sound in water has specific implications for divers/swimmers. The main parameters to consider are the sound pressure level (SPL), frequency of the sound, and exposure duration.

Sound Pressure Level: High sound pressure levels can potentially harm divers, however, a sound pressure level for physical injury has not been established due to ethical research protocols. Parvin (2005) reported vibration in forearms and thighs at 180 dB re 1 µPa but no physical injury.

Frequency: Underwater auditory threshold curves indicate that the human auditory system is most sensitive to waterborne sound at frequencies between 400 Hz to 1 kHz (Parvin et al. 1994) and these frequencies have the greatest potential for damage. The auditory threshold of hearing under-water was lowest at 1 kHz (70 dB re 1 µ Pa SPL) and increased for lower and higher frequencies to around 120 dB re 1 µPa at 20 Hz (Parvin 1998).

Duration of Exposure: The duration of exposure to the sound source is also critical. Longer exposure times to intense sounds can result in auditory fatigue and can increase the risk of hearing damage.

Physiological Effects: Apart from hearing damage, high-intensity underwater sound can also have other physiological effects on divers. These may include vertigo, nausea, disorientation, and in extreme cases, lung and sinus damage due to resonance effects.

Psychological Effects: High noise levels underwater can cause stress and anxiety, impair communication, and decrease the diver's ability to perceive and react to environmental signals, compromising safety (Hildebrand, 2009).

The propagation of sound underwater and the consequent effects on divers are complex and multifactorial. Both the immediate and long-term impacts on divers' health and safety need to be considered, particularly in environments with high levels of anthropogenic noise, such as near marine construction sites or busy shipping lanes.

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Acoustic Modelling for the Regia Marine Seismic Survey

As detailed in the Regia MSS acoustic modelling report, the human health assessment threshold of 145 dB re 1 µPa to assess sound exposure to people swimming and diving is based on controlled experiments exposing divers to tonal signals (Parvin, 2005). It is a lower and precautionary safety criterion for recreational divers and swimmers and does not imply that this level is associated with the onset of injury.

The aim of releasing the acoustic modelling is to identify diver/swimming locations where received sound levels could be above the 145 dB re 1 µPa safety criteria. This information is then used to refine the survey area. Initial modelling undertaken identified that received levels at Little River and Taylors Beach could be above the safety criteria, while other areas are below the criteria. If there is a location where people frequently dive or swim, lets us know as we will be undertaking more acoustic modelling soon.

Receiver ID	Sensitive receiver	SPL (L_p; dB re 1 µPa)	Distance between receiver location and modelled site (km)	Associated Modelled Site
1	Lady Julia Percy Island	153.4	9.35	1
2	Southern Right Whales Migration and resting BIA	133.9	44.5	2
3	Discovery Bay	113.2	72.1	11
4	Portland	87.4	58.6	2
5	Little River and Taylors Beach	153.1	9.58	1
6	Port Fairy Bay	121.5	23.9	3
7	Twelve Apostles Marine Park	124.6	91.7	1
8	Aire River Beach	107.5	103.5	3

Seismic Surveys and Diver Safety

Seismic surveys, often used in underwater exploration for oil and gas resources, generate intense, low-frequency sound waves that can pose risks to divers. There are a range of strategies and safety protocols that will be included in a co-designed simultaneous operations (SIMOPS) plan as recommended by the Divers Medial Advisory Committee (DMAC) Guideline 12. They include:

Prior Notification: Before conducting a seismic survey, operators should notify relevant parties, including commercial, recreational, and scientific diving groups in the area. This allows divers to avoid the area during survey operations.

Exclusion Zones: Seismic operators should establish exclusion zones around their operations. Divers should not enter these zones during active seismic surveys. The size of these zones can vary, but they should be large enough to ensure that sound levels within the zone do not exceed safe limits for divers.

Monitoring: Continuous monitoring for diver activity around the seismic survey area can be performed using on-board spotters, radar, or Automatic Identification System (AIS) data. If divers are detected within the exclusion zone, the seismic source should be shut down immediately.

Gradual Ramp-up: A technique called 'soft-start' or 'ramp-up' is often used at the start of seismic surveys. The seismic source starts at a low energy level and gradually increases to full power over 20-30 minutes. This provides a warning to any divers in the area and allows them to move away from the source before it reaches full intensity.

Communication Channels: Keeping open communication channels with diving operations and alert systems in the region allows for real-time sharing of information and swift response to any potential safety issues.

Diver Safety Briefings: Divers operating in areas with potential seismic survey activities should be briefed on the associated risks and advised on safety procedures, such as recognizing and responding to ramp-up signals.

By adhering to these practices, seismic survey operators can help ensure the safety of divers, while divers themselves can take steps to avoid potential hazards associated with seismic surveys.

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