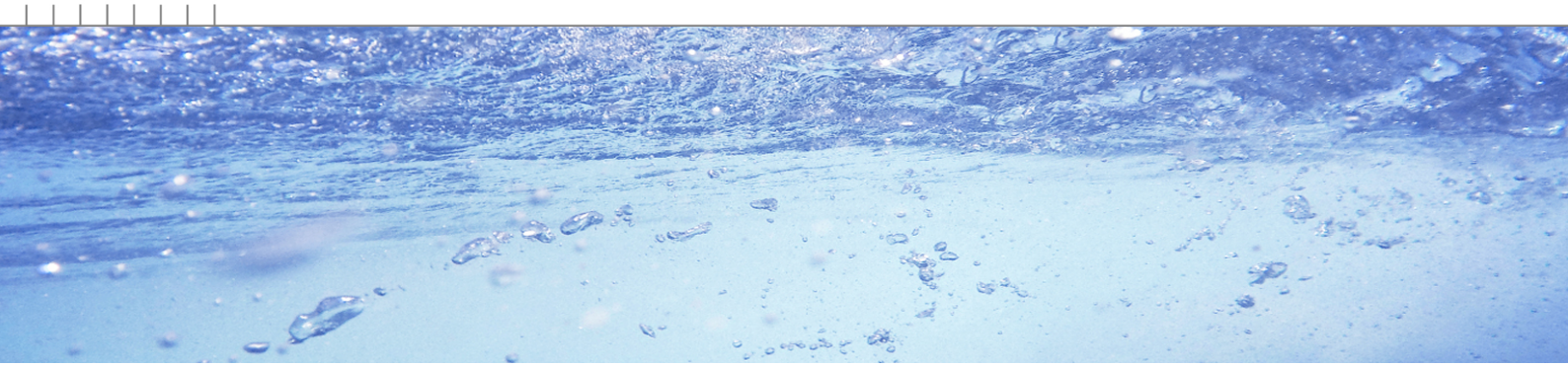

Bubbles JIP

This Joint Industry Project aims at achieving more efficient and effective use of bubble curtains for noise mitigation in offshore installation projects. Research is focussing on better understanding and engineering of bubble screen use within specific projects, to control noise levels and therefore reduce risks.

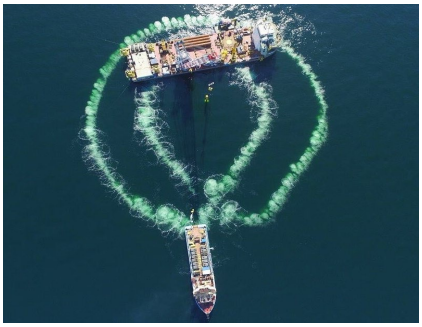

*Figure 1: Example of a double bubble curtain**

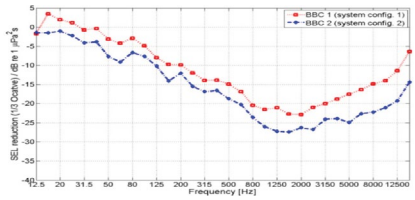

*Figure 2: Noise attenuation of bubble curtains***

* *Boskalis. 'Wikinger Project' Germany. A Double Big Bubble Curtain (DBBC) is deployed around the Giant7 floating piling vessel.*

** *Bellmann, M. A.; "Overview of Existing Noise Mitigation Systems for Reducing Pile-driving Noise", Inter-noise, Melbourne, Australia, 2014.*

Problem statement/ description

During installation of monopiles and jackets at sea the noise generated by high energy pilling may harm the marine environment. There are different methods to reduce these noise levels. One of these mitigation methods is the use of bubble curtains. These bubble curtains are generated by using a loop hose on the seabed, pressurised by air compressors on a support vessel, enclosing the pile driving location. An example is shown in figure 1. Due to regulations this type of bubble curtains is often used in German coastal areas. German experiments have evaluated the noise reductions of different methods, an example is shown in figure 2. The current practice of bubble curtains is mainly based on experience within previous projects and this experience is only available within a limited number of companies offering this service. Due to lack of understanding of the working principles and practical application there are large variations in the performance of the application of bubble curtains. For offshore contractors and (renewable) energy companies a better understanding would enable better engineering of the curtains, leading to reduced costs of the curtains and reduced sound levels for the local environment.

Fundamental knowledge of the working mechanisms of the bubble curtains is limited which hinders optimisation. Optimisation is, however, necessary to increase the efficiency of the bubble curtains and for example reduce the number of compressors and/or fuel use (and consequently reduce the CO_2 footprint).

As part of the 'Paris Convention' many new wind turbines will be installed in the North Sea and around the world. More efficient and effective use of bubble curtains is important to reduce throughput time, costs, environmental impact and moreover the influence on marine life. To achieve this MARIN is initiating the Bubbles Joint Industry Project.

Planning
The Bubbles JIP started Q2 2020 and will have a duration of 2 years.

The findings of the Bubbles JIP will be summarized in a 'Best practice' reference document.

- Overview of the gained understanding of the working principles of sound propagation and bubble curtain development and noise mitigation principles of bubble curtains.
- Recommended bubble curtain size and parameters.
- Recommended engineering methodology (including hose engineering) in the preparation of the installation of an offshore wind farm.

Budget
The total secured budget for the bubbles JIP is 1.2 million Euro.

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Research questions

The Bubbles JIP will address the following research questions:

- Understand the current practice of bubble curtain generation.
- Improve the understanding of the sound propagation of piling noise through water and soil.
- Improve the understanding of the physical principle of noise attenuation by air bubbles.
- Determine the parameters influencing the noise attenuation by air bubbles (hose length, hose diameter, nozzle size, nozzle distance, number of compressors and flow rate).
- Develop the technology to measure the bubble size distribution and concentration.
- Understand the bubble generation and bubble growth over the water depth, also under the influence of waves and current.
- Provide an overview of the typical noise levels and frequency ranges that may harm the marine environment in the North Sea.
- Develop a guideline for bubble curtain generation based on physical understanding that can be adjusted to the local system.

Approach/ scope

The work plan consist of 8 work packages (WP's). The scope is split up as follows:

- WP1: Problem definition, noise sensitivity of marine life
  Overview of the different regulations and typical sound sensitivities of different types of sea life based on existing knowledge and literature at (future) offshore windfarm locations.
- WP2: Theory and numerical models (acoustics and hydrodynamics)
  Numerical modelling of noise generation and propagation during piling with a bubble curtain.
- WP3: Development of (laboratory and field) measurement technology
  Bubble & noise generation methodology, bubble & noise measurement technique and methodology.
- WP4: Laboratory tests (acoustics and hydrodynamics)
  Consisting of systematic variation tests and representative bubble curtain tests.
- WP5: Process system modelling
  Using existing models to improve the generation for the required distribution and size of bubbles such that they can be used for effective noise mitigation during piling
- WP6: Field measurements
  Analysing available full-scale measurement data and perform medium-scale tests on bubble curtain characteristics and noise measurements in a harbour.
- WP7: "Best practice"
  Summarising the results from above work packages in a practical guideline for the industrial partners.
- WP8: Management
  Day-to-day project management, organisation of meetings and progress reporting to GROW/RVO.