

**MITIGATING THE IMPACT OF PILE-DRIVING NOISE ON HARBOR PORPOISE (*PHOCOENA PHOCOENA*) DURING FOUNDATION INSTALLATION AT BORKUM RIFFGRUND 1 OFFSHORE WIND FARM**

B. Jung<sup>2</sup>, H. van Vessem<sup>2</sup>, D.Schiedek<sup>3</sup>, G. Fischer<sup>3</sup>, J.Vindahl Kringelum<sup>3</sup>, T. Bendixen<sup>3</sup>, P. Rodríguez-Oitabén<sup>4</sup>

Federica Pace

f.pace@bakerconsultants.co.uk

Baker Consultants Marine Ltd  
Unit 1, Cromford station, Matlock, Derbyshire, UK"

<sup>2</sup>IHC Hydrohammer, The Netherlands; <sup>3</sup>DONG Energy Wind Power, Denmark; <sup>4</sup>Geosea nv, Belgium

Since the implementation of the Marine Strategy Framework Directive (MSFD) at European level, the introduction of energy including underwater noise (Descriptor 11 of the MSFD) needs to be monitored and its impact assessed. Each member state of the European Union has introduced its own guidance to comply with the MSFD; Germany has imposed strict thresholds for underwater noise emissions associated with piling activities that need to be respected during the installation of offshore wind farms. At Borkum Riffgrund 1 Offshore Wind farm, located in German waters approximately 25 km offshore, underwater noise levels were monitored throughout the installation of its 77 monopiles to assess the efficiency of the mitigation strategy implemented. Noise mitigation was carried out using the IHC Noise Mitigation System (NMS), a double walled cylinder designed to hold the pile in place whilst simultaneously reducing the noise transmitted through the water column. The outer wall of this cylinder is attached to the inner wall using rubber blocks and a volume of air is present between the two to minimize the transfer of sound from inner wall to outer wall. The IHC NMS had been used on previous projects but never for monopiles of such diameter (6 metres) and some modifications were made to improve its performance.

Underwater noise measurements were carried out during the installation of the foundations, between January and August 2014, using bottom mounted autonomous recorders. The results showed consistent noise levels being recorded throughout installation and in different directions around each monopile. Reference measurements were carried out with and without the NMS to determine its efficiency, as according to the StUK4 guidance.

The NMS performance was good, after some adaptations in the beginning and in general a noise reduction of 13-15 SEL was reached. The third-octave band analysis highlighted the difference in measured levels at 750m with and without NMS.. The damping was particularly good at higher frequencies where harbour porpoises are most sensitive. The reduction in noise levels in the frequency bands between 250 Hz - 20 kHz was between 18 and 32 dB re 1?Pa2 SEL. At around 10kHz, the measured noise levels with NMS were overlapping with the ambient background noise meaning that the components of piling at those frequencies are no longer significant and fade in the background.