Annex Q Dogger Bank C: Marine Mammal Compliance Report (Turbines)

Project Title	Dogger Bank C
Date:	23/01/2026

Dogger Bank C

Marine Mammal Mitigation Compliance Report

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Executive Summary

The installation of the 87 monopile foundations of Dogger Bank C (DBC), the third phase of Dogger Bank Wind Farm, took place between 23rd April 2025 and 8th September 2025. The vessel that installed the foundations was the Seaway 7 *Strashnov*.

A Marine Mammal Mitigation Protocol (MMMP) was implemented during the installation of the foundations with the aim of mitigating any impacts of underwater noise on marine mammals. A Marine Mammal Mitigation Team (MMMT) consisting of five Marine Mammal Observers (MMObs), Passive Acoustic Monitoring Operators (PAM-Ops) and Acoustic Deterrent Device Operators (ADD-Ops) were deployed on the installation vessel to implement the mitigation. The MMMT were present throughout piling operations.

The mitigation, as per the MMMP, consists of visual and acoustic (during the hours of darkness and poor visibility) monitoring, deployment of an Acoustic Deterrent Device (ADD), a soft-start (low-energy blows and ramp-up (gradual increase in hammer energy)), before piling at full hammer energy commenced.

There were two visual sightings and no acoustic detections of marine mammals throughout the piling operations. The sightings did not occur during the operational piling, nor in the Mitigation Area, therefore, did not require any additional mitigation actions further to those already defined in the MMMP.

Four instances of non-compliance with the MMMP were recorded during piling operations; two occurred due to strike rate exceedances during the soft-start phase, one was associated with a hammer energy exceedance, and one resulted from the omission of a gradual ramp-up procedure.

Additional mitigation actions were carried out at 6 piling locations, which included the reactivation of the ADD following delays to soft-start and signal issues with the GPS, the implementation of the Piling Mitigation Procedure (PMP) from Step 2 following a break of >10 mins and < 2 hrs and implementation of the PMP from Step 1 following breaks of > 2 hrs.

It is considered that the mitigation implemented was sufficient to mitigate for permanent auditory damage to marine mammals.

The DBC piling campaign was completed successfully with mitigation measures effectively implemented.

Table of Contents

Executive Summary 2
Abbreviations 5
Key terms 5
1 Introduction 8
1.1 Site description 8
1.2 Requirement for this report 9
2 Vessel used for piling 12
3 Mitigation 13
3.1 Monitoring and Mitigation Equipment 13
4 Results 16
4.1 Data used to inform this report 16
4.2 Mitigation as applied 16
4.3 Details of additional mitigation actions and non-compliances 17
4.4 Marine mammal observations and detections 18
5 Evaluation of applied mitigation 20
6 References 21
Appendix A – Details of piling for 87 monopile foundations 22
Appendix B – JNCC Marine Mammal Recording Forms – see separate excel form 'P2014_DBC_MMO PAM Log_2025' 25
Appendix C – Mitigation summary for 87 monopile foundations 26
Appendix D – Testing and deployment information of the ADD 27
Appendix E – Details of non-compliance and additional mitigation actions 30

List of Figures

Figure 1 Dogger Bank C offshore wind farm site 9
Figure 2 Locations of marine mammal sightings on site and during transit to and from site 19

List of Tables

Table 1 MMMP key mitigation measures 13
Table 2 VPAM system technical specifications 14
Table 3 ADD technical specifications 15
Table 4 Comparison of parameters presented in the MMMP against actual piling operations 16
Table 5 Summary of marine mammal sightings/acoustic detections 18
Table 6 Piling Location, Coordinates, Date and Time of Piling 22
Table 7 Summary of the mitigation conducted for 87 pile monopile foundations 26
Table 8 Summary of the ADD testing and activation / deactivation (Time in UTC) 27
Table 9 Non-Compliances 30
Table 10 Additional Mitigation Actions 30

Abbreviations

ADD	Acoustic Deterrent Device
ADD-Op	Acoustic Deterrent Device Operator
BNC	Bayonet Neil-Concelman Connector
DBC	Dogger Bank C
DBWF	Dogger Bank Wind Farm
dML	deemed Marine Licence
EPS	European Protected Species
GPS	Global Positioning System
HF	High Frequency
HLV	Heavy Lift Vessel
HPU	Hammer power pack
HSE	Health, Safety and Environment
JNCC	Joint Nature Conservation Committee
kJ	Kilojoule
LF	Low Frequency
MA	Monitoring Area
MMO	Marine Management Organisation
MMOb	Marine Mammal Observer
MMMP	Marine Mammal Mitigation Protocol
MMMT	Marine Mammal Mitigation Team
MPA	Marine Protected Area
NC	Non-Compliance
OEP	Offshore Execution Procedure
OCM	Offshore Construction Manager
PAM-Op	Passive Acoustic Monitor Operator
PMP	Piling Mitigation Procedure
PSR	Piling Summary Report
PTS	Permanent Threshold Shift
SAC	Special Area of Conservation
VPAM	Vertical Passive Acoustic Monitoring
WTG	Wind Turbine Generator

Key terms

Acoustic Deterrent Device Operator (ADD-Op)	A trained member of the team who operates the Acoustic Deterrent Device (ADD).
Low-energy blows	The first and second part of the soft-start procedure consists of low-energy blows ≤400 kJ.
Monitoring Area (MA)	The area around each pile location to be monitored in the pre-piling watch, and where possible during any breaks in piling or soft-start by either Marine Mammal Observers (MMObs) or Passive Acoustic Monitoring Operator (PAM-Op). This area is 600 m from the pile location in all directions (360˚ area).
Marine Mammal Mitigation Team (MMMT)	The team undertaking the marine mammal mitigations, including MMObs, PAM-Op, and ADD-Op.
MMObs	Trained members of the team who will observe the MA.
Operational piling	The period of piling following the completion of the pre-piling watch, ADD

	activation and the soft-start procedure, where piling is undertaken as required to install the pile. During the operational piling time, the hammer energies must remain within consented limits of 4,000 kJ.
VPAM	Vertical Passive Acoustic Monitoring: acoustic monitoring of the MA.
PAM-Op	A trained member of the team who will setup and use the PAM equipment to undertake acoustic monitoring of the MA.
PMP	The Piling Mitigation Procedures (PMP) are the flowcharts that set out the required mitigation. These can be found in the MMMP.
Pre-piling watch	The period prior to piling commencing, during which observations are undertaken visually by the MMObs or acoustically by the PAM-Op of the MA to determine if marine mammals are present in the MA.
Ramp-up	A ramp-up is a gradual increase in hammer energy up to a defined maximum over a period of time. The ramp-up is carried out in the last 5 minutes of the soft-start procedure and first 45 minutes of operational piling.
Slow-start	The first part of the soft-start procedure and comprises of 5 minutes of low-energy blows of ≤400 kJ at a rate of up to 1 blow per minute.
Soft-start	The procedure used to commence piling at a lower hammer energy. The soft-start procedure consists of three phases (slow-start for 5 mins, low-energy blows for 10 mins and ramp-up for 5 mins) and lasts for a minimum of 20 minutes.

1 Introduction

1.1 Site description

The Dogger Bank Offshore Development Zone, located in the North Sea between 125 and 290 km off the east coast of Yorkshire, extends over approximately 8660 km² and water depths range from 18 m to 63 m (see Figure 1). DBC is the third phase of the Dogger Bank Wind Farm (DBWF), which is being developed by the Joint Venture between SSE, Equinor and Vårgrønn. DBC will comprise 87 WTGs, installed on monopile foundations and linked to an Offshore Substation Platform (OSP) via subsea inter-array cables. The OSP, which will house both the offshore converter station and the offshore substation, will convert the power from High Voltage Alternating Current (HVAC) to High Voltage Direct Current (HVDC). This will then be exported via an offshore export cable (approximately 260 km long) from the wind farm site to the landfall north of Marske-by-the-Sea. From the landfall, power will be exported via an HVDC electrical cable (approximately 7 km long) to a new onshore converter station at Lackenby. From the onshore converter station, the power will be carried via an HVAC cable (approximately 2 km long) to the existing National Grid Lackenby substation. DBC will have an installed generation capacity of 1.2GW, has a development area of around 311 km² and is 233 km at its closest point to land. Connection will be at the existing Lackenby Substation at Teesside.

DBC is approximately 24 km north-east of the Southern North Sea Special Area of Conservation (SAC) summer area. This SAC is part of the European Natura 2000 network and is designated to protect Harbour Porpoise (JNCC, 2022). The area is also significant for common minke whales and white-beaked dolphins, providing them with a habitat that supports their survival and reproduction (JNCC, 2002). The SAC's designation and management aim to protect biological communities within the shallow UK waters of the Dogger Bank (MMO, 2022).

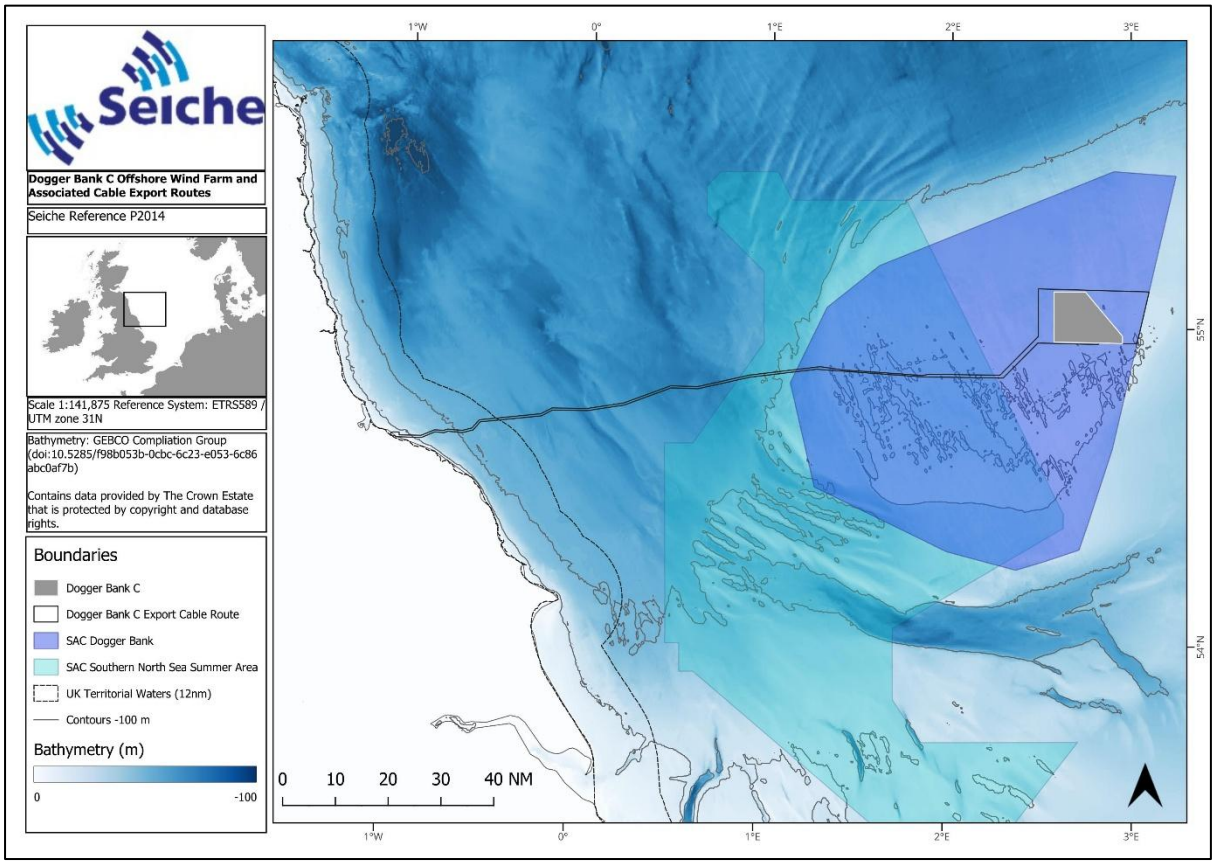

Figure 1 Dogger Bank C offshore wind farm site

1.2 Requirement for this report

The purpose of this report is to demonstrate compliance with the Marine Mammal Mitigation Protocol (MMMP) (LF700013-CST-DOG-PLN-0060) and fulfil commitments made relating to mitigation compliance reporting; as well as to satisfy Condition 7 of the DBC construction Wildlife Licence (L/2025/00100/1). This report covers the installation of all 87 of DBC's monopiles, installed between 23rd April and 8th September 2025. The mitigation that was carried out for the installation of the pin-piles is covered in a separate report (LF700013-CST-DOG-REP-0338).

The requirement for this report is stipulated in both the MMMP and the DBC Wildlife Licence. Details of both of these requirements are provided in the following sections.

1.2.1 *MMMP*

The monopile foundations for DBC are installed by impact piling. This is considered a noisy activity with the potential risk to permanently damage the auditory organs of marine mammals that are present in the North Sea.

To mitigate this risk, a MMMP was produced and agreed with stakeholders and regulators, as stipulated in Condition 16(e) of deemed Marine Licence (dML) 1 (Schedule 8 of the DCO). The aim of the MMMP is to reduce the risk of underwater noise causing permanent auditory injury / permanent shift in hearing sensitivity (Permanent Threshold Shift (PTS)) in all marine

mammal species in and around DBC. For this reason, the MMMP sets out several sequential mitigation measures that are to be adhered to during piling activities, based on the Joint Nature Conservation Committee (JNCC) 2010 'Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise'. The MMMP also sets out how the mitigation carried out will be reported to the regulator, the Marine Management Organisation (MMO), to ensure that the agreed mitigation was adhered to, that it was effective, and to detail any incidences of non-compliance (and how it was ensured these would not occur again).

The installation of the 87 monopiles was conducted under version 2 of the MMMP, which was approved by the MMO on 9th December 2024. This superseded the previous version which was approved by the MMO on the 30th July 2024.

1.2.2 *Wildlife Licence*

In England, marine mammals are afforded protection under 'The Conservation of Habitats and Species Regulations 2017' (as amended) in inshore waters and 'The Conservation of Offshore Marine Habitats and Species Regulations 2017' (as amended) in waters between 12 and 200 nautical miles. Collectively known as the 'Habitats Regulations', these were amended in 2019 by 'The Conservation of Habitats and Species Regulations' (Amendment) (EU Exit) to ensure habitat and species protection and standards derived from EU Law continue to apply after withdrawal from the European Union.

All cetacean species in UK waters are protected as European Protected Species (EPS) (Annex IV) under the Habitats Regulations. These regulations make it an offence to deliberately or recklessly capture, injure or kill, deliberately disturb, damage or destroy a breeding site or resting place. Harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*) are also listed under Annex II, which require the designation of SACs. All cetaceans are also protected by the 'Wildlife and Countryside Act 1981' and 'The Countryside and Rights of Way Act 2000', which protects them from killing or injury and intentional or reckless disturbance.

This means that where activities may cause disturbance or injury to a protected species, a Wildlife Licence is required unless mitigation measures are sufficient to reduce the risk of committing an offence to negligible levels.

For piling at DBC, a Wildlife Licence was required for the disturbance to EPS. Whilst the mitigation measures in the MMMP ensure there was no potential for injury to cetacean species (namely harbour porpoise, bottlenose dolphin, white-beaked dolphin (*Lagenorhynchus albirostris*) and minke whale (*Balaenoptera acutorostrata*)), there remained a potential for disturbance. The Wildlife Licence for DBC (L/2025/00100/1) was issued by the MMO in March 2025.

Condition 7 of the Wildlife Licence states that:

"Licence Holder must submit a written report of actions taken under licence no later than one month after the expiry of the Licence, even if no action is taken. The report must include location coordinates of piling, date and time, as well as details of mitigation used. Failure to make reports may result in the licence being revoked and/or the refusal to grant subsequent Licences. This must be submitted via MCMS returns process no later than one month after the expiry of the Licence"

The deadline for this condition is "*no later than 1 month after the expiry of the licence*". The

expiry for the DBC wildlife licence is 31st December 2025 and the deadline for the condition is, therefore, the 31st January 2026.

This report is being provided to the MMO to fulfil commitments made in the MMMP with regards to mitigation compliance reporting, and to satisfy the above-mentioned Wildlife Licence condition for the 87 monopiles that were installed at DBC.

2 Vessel used for piling

The HLV Seaway Strashnov installed all 87 of DBC's WTG foundations, between 23rd April and 8th September 2025. The locations of the monopiles as well as the date and time of piling activities, are provided in Appendix A, Table 6.

3 Mitigation

Mitigation measures for marine mammals are detailed in the MMMP. For this reason, they are not provided again in detail in this document. Rather, this document's main focus is the compliance of the piling activities at DBC with the MMMP.

Table 1 sets out a summary of the key mitigation procedures of the MMMP, for ease of reference.

Table 1 MMMP key mitigation measures

Piling Mitigation Procedures (PMP)	
Monitoring Area (MA)	600 m
Pre-watch Monitoring	34 minutes
ADD Activation period	29 minutes*
Soft-start (three phases)	20 minutes
1) A 'slow start' of 5 mins of low energy blows ≤400 kJ at a strike rate of 1 blow per min.	
2) 10 mins of low energy blows ≤400 kJ at a strike rate of up to 30 blows per min.	
3) 5 mins ramp-up to 880 kJ at a strike rate of 30 blows per min	
Operational Phase Ramp-up (maximum operational energy must not be reached before the end)	45 mins
Maximum operational hammer energy	4,000 kJ

* The ADD may be on for an additional 4 minutes to allow for operational contingency, if required and if the MA is not clear of MMs during final 20 mins of ADD activation, extend ADD activation by up to 10 mins.

The implementation of the mitigation measures was undertaken by the MMMT.

3.1 Monitoring and Mitigation Equipment

3.1.1 *VPAM System Hardware*

The VPAM system is a single hydrophone system that can be deployed over any static vessel or platform. The system comprised of a single channel hydrophone cable (100 m) element and a 10-bar depth sensor, at the end of a 100 m cable, a buffer box (containing power interface and processing unit), a 12 V battery pack and a laptop computer running the industry standard software PAMGuard. A deck cable of 100 m length provides connection between the hydrophone cable and the onboard acquisition unit. The VPAM station was located on the bridge of the Seaway 7 *Strashnov.*

The buffer box provides power and connection for the hydrophone cable and transfers the sound signal into high and low frequency ranges through filters to allow for further processing. High Frequency (HF) sound is fed through an internal National Instruments sampling card that

outputs via a USB socket to the laptop running PAMGuard. Low Frequency (LF) sound is output via a Bayonet Neil-Concelman (BNC) connector and the amplified headphone socket on the front panel of the Buffer Box. Technical specifications for the VPAM system can be found in Table 2.

Table 2 VPAM system technical specifications

Specification	
Length	100 m
Depth Rating	100 m (not connector)
Diameter	12 mm over cable, 32 mm over mouldings, 30 mm over connectors
Weight	17 kg
Connector	Amphenol 4 pin
Hydrophone	Sphere – broadband (20-150 kHz, 3 dB points)
Hydrophone Sensitivity	-166 dB re 1 v/µPa

3.1.2 *VPAM System Software*

The PAM-Op monitored for marine mammals aurally using headphones listening to the lower audible frequencies and visually by observing the processed sound using the PAMGuard software installed on the laptop. HF and LF sound were processed using two individual PAMGuard windows running simultaneously. PAMGuard configuration comprised of a spectrogram displaying up to 24 kHz to monitor tonal sounds, such as delphinid whistles which is also monitored aurally. A click detector displaying pulse signals in the HF bandwidth (20-190 kHz) was also displayed on an amplitude versus time window. Classifiers were applied to the click detector to assist with identification of clicks from different species groups, for example a narrow-band high frequency classifier with a test band of 120-140 kHz was used to identify clicks from harbour porpoise. Additional modules within the configuration included a sound recorder, radar display, clip generator, and map display, with data stored in a (Standard Query Language) SQLite database and binary format for offline processing and reporting.

3.1.3 *VPAM System Deployment*

The VPAM system was deployed from the starboard side of the HLV Seaway *Strashnov*.

The hydrophone cable was deployed to mid-water depth for optimal acoustic monitoring, with the cable marked up with regular distances during mobilisation to enable deployment to the correct depth. A taut weighted rope system was attached to the cable to ensure it remained close to the vessel and not dragged by its currents.

3.1.4 *ADD Operations*

Lofitech Seal Scarer ADDs were used on the project to act as a deterrent for marine mammals from entering the MZ. The ADD system was deployed from the starboard side of the HLV Seaway Strashnov. The Lofitech ADD system comprised of a control unit and transducer. The control unit contained a pulse generator and an amplifier to transmit random bursts of audio

frequency signals from the transducer, which is converted into intense sound. The ADD transmits sound at 191 dB re 1 µPa @ 1 m at an optimal frequency of between 10 and 20 kHz. Specifications for the ADDs used can be found in Table 3.

Table 3 ADD technical specifications

Specification		
Length of Transducer Cable	100 m	
Diameter	Waterproof self-contained unit. 60 cm x 30 cm x 40 cm	
Weight	12 kg	
Power	Auto Marine 12 V batter (90-120 Ah)	
Power Consumption	Approximately 0.4 A/12 V	
Acoustic Output	**Manufacturer Specifications**	**Field Validation (McGarry et al. 2017, 2020)**
Source Level	191 dB re 1 µPa @ 1 m	204 dB re 1 µPa @ 1 m
Frequency Range	Approximately 10 – 20 kHz	14.6 kHz fundamental, harmonics at 29.2 kHz, 43.6 kHz, and 72.8 kHz
Acoustic Range	300 m radius from source	Displacement >1 km depending on species
Duty Cycle	500 ms pulse with variable inter pulse length	752 ms pulse with variable inter pulse length
Device Testing	-	Suggest testing device using suitable hydrophone and visualisation
Functionality	On/Off switch, no further settings or soft start	

4 Results

4.1 Data used to inform this report

The information presented within this report and used to confirm compliance, has been drawn from:

- Piling Summary Reports (PSRs)
- JNCC Forms (Appendix B)
- Data compiled by the MMMT

4.2 Mitigation as applied

A comparison of the modelled/predictive piling parameters that were accounted for in the MMMP and the Wildlife Licence, against the actual piling parameters is provided in Table 4. This comparison demonstrates that piling parameters were less than anticipated and in accordance with the MMMP (therefore, in accordance with the consented limits).

Details of additional mitigation actions and non-compliances can be seen in Section 4.3 and a summary of the actual mitigation measures conducted for the 87 monopile installations, to demonstrate compliance with the MMMP, and therefore the Wildlife Licence, are provided in Appendix C (Table 7).

A summary of ADD use to include testing, activation and deactivations is provided in Appendix D (Table 8).

Furthermore, as per the MMMP and in accordance with the JNCC guidance relating to mitigation, JNCC forms were completed for each piling event and, therefore, each mitigation event, which detailed the mitigation conducted as well as any marine mammal sightings. These forms are provided as a separate document, see Appendix B.

Table 4 Comparison of parameters presented in the MMMP against actual piling operations

Parameter	Assumption in MMMP	Actuals	Comparison
No. of piles installed in a 24-hour period	3	1 pile installed in a 24-hour period: 2 piles	2% of the 87 piles
		2 piles installed in a 24-hour periods: 10 piles	11% of the 87 piles
		3 piles installed in a 24-hour periods: 75 piles	86% of the 87 piles
Piling duration (incl. soft start) per pile	3 hours and 15 minutes (including soft-start)	Max: 3 hrs 17 mins*	1% more of the assumed piling duration
		Average: 1 hr 27 mins	39 % of the assumed piling duration
		Range: 0 hr 56 mins – 3 hrs 17 mins	n/a
Maximum soft-start	1) A ‘slow start’ of 5 mins of low energy blows ≤400 kJ at a strike rate of 1 blow per min.		
	400 kJ	Max: 115 kJ	Used 29% of the assumed energy

Parameter	Assumption in MMMP	Actuals	Comparison
hammer energy (kJ)		Average: 115 kJ	Used 29% of the assumed energy
		Range: 115 kJ	n/a
	2) 10 mins of low energy blows ≤400 kJ at a strike rate of up to 30 blows per min.		
	400 kJ	Max: 313 kJ	Used 78% of the assumed energy
		Average: 233 kJ	Used 58% of the assumed energy
		Range: 115-313 kJ	n/a
	3) 5 mins ramp- up to 880 kJ at a strike rate of 30 blows per min.		
	880 kJ	Max: 737 kJ	Used 87% of the assumed energy
		Average: 409 kJ	Used 48% of the assumed energy
		Range: 115-737 kJ	n/a
	Apart from 2 occasions, blow rates during soft-start were complaint with the limits in the MMMP. See Section 3.3 for further information.		
Maximum hammer energy in first 45 mins of operational ramp-up	<4000 kJ	Max: 3601 kJ	Used 90% of the assumed energy
		Average: 1773 kJ	Used 44% of the assumed energy
		Range: 453-3601 kJ	n/a
Maximum operational hammer energy (kJ)	4000 kJ	Max: 4132 kJ**	Used 3 % more than assumed energy
		Average: 2112 kJ**	Used 53% of the assumed energy
		Range: 887-4132 kJ	

*Operations at only 1 pile location (F04) exceeded the duration assumed in the MMMP. The next longest duration for piling was 2 hours and 21 minutes at pile location F12.

**Hammer Energy levels were exceeded on one occasion at 4132 kJ, see Section 4.3 for further information. The next highest hammer energy was 3832 kJ.

4.3 Details of additional mitigation actions and non-compliances

Details of all non-compliances and mitigation procedures undertaken throughout the project and actions taken to resolve the issue are provided in Appendix E, see Tables 9 and 10, respectively.

In summary, there were four non-compliances reported during the project:

- Two for strike rates exceeding the limits of the MMMP (P07 & P35)
    - P07 – During the last 2 minutes and 37 seconds of phase 3 of the soft-start; ramp up, the strike rate was 31 in one minute and 32 in the next, which is above the limit of 30 strikes per minute as per the MMMP.
    - P35 – During the last 3 minutes and 07 seconds of phase 3 of the soft start the strike rate was 31, which is above the limit of 30 strikes per minute as per the MMMP.
- One for hammer energy levels being 4132 kJ, which exceeds the limit of 4000 kJ as per the MMMP (P33).

- One for ramp-up not being completed (E11).

Although four NCs have been reported during the piling campaign, overall, the average strike rates and average hammer energy levels for all piles remained within the consented limits outlined in the MMMP.

4.4 Marine mammal observations and detections

Throughout the duration of the monopile installation at DBC, there were a total of 2 visual sightings, with 2 individuals sighted. There were no acoustic detections of marine mammals. A summary of the visual sightings is provided in Table 5 and the distribution of marine mammal sightings during the piling campaign is shown in Figure 2.

The two sightings were made on an incidental watch, outside of piling operations and are detailed below.

- Sighting 1 - 18/08/2025:
  - There was one incidental sighting of a dead probable minke whale (approx. length: 7-8 m) during transit, approximately 55 nm south of DBC. The whale was sighted at 10:15 UTC by the bridge officer on watch at an initial distance of 1500 m. The closest distance from vessel was 800 m. The whale was floating on its back, with a white underside and some ventral pleats visible. A moderate to high state of decomposition was observed along with bloating and brown discolouration. No mitigation action was required as the vessel was in transit, 7 hours away from site.
- Sighting 2 - 24/08/2025:
  - There was one incidental sighting of a grey seal by the MMMT on pile location F11. It was prior to the 2-hour notice for piling at 15:02-15:18 (UTC). The animal was outside the MA, 860 m from the vessel at the closest point and travelled slowly, passing parallel to the vessel. No mitigation action was required.

Table 5 Summary of marine mammal sightings/acoustic detections

Species / group	Number of acoustic detections	Effort Sightings	Number of incidental sightings	Total number of individuals	Number of mitigation actions implemented
Minke Whale	-	-	1	1	0
Grey Seal	-	-	1	1	0
Total	**0**	**0**	**2**	**2**	**0**

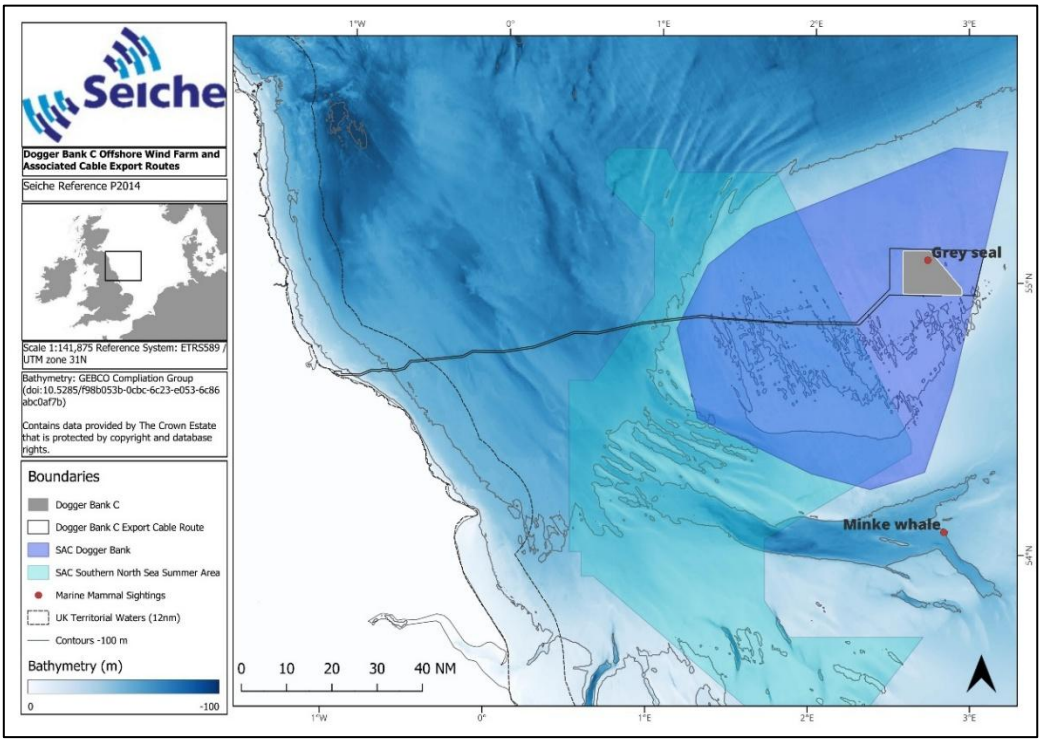

Figure 2 Locations of marine mammal sightings on site and during transit to and from site

5 Evaluation of applied mitigation

The mitigation measures implemented for the installation of the monopiles at DBC were deemed sufficient and effective in minimising the risk of injury to marine mammals in the area. No marine mammals were observed during piling operations.

From an operational perspective, there were no delays that were caused by marine mammals being present in the MA in the period immediately prior to piling. This may suggest that use of the ADD was effective in deterring marine mammals from entering the MA when activated.

The operational piling parameters were within the assumptions made in the MMMP with minor exceptions, as set out in Table 9. These exceptions were related to ground conditions/technical issues that were identified and addressed before the next piling event to avoid a re-occurrence. They do not change the conclusion of the effectiveness of the mitigation used throughout the piling campaign.

Aside from four instances where operational parameters did not remain within the consented limits defined in the MMMP, overall piling activities at DBC were undertaken in accordance with the MMMP requirements and the prescribed mitigation measures for the protection of marine mammals.

Key elements that are considered to have contributed to the successful campaign have been identified:

- The lessons learned from the DBA & DBB campaigns contributed to the success of the DBC campaign. These include extensive communications, pre-mobilisation workshops and involvement of MMMT during drafting of the MMMP.
- Maintaining excellent communication between the MMMT and installation teams onboard each vessel allowed for effective implementation of the MMMP throughout the installation of the monopiles and allowed the team to efficiently and promptly address any issues that arose.
- Continuous open dialogue between the MMMT, vessel installation crew, Seiche project manager, and DBWF allowed for constant monitoring of the marine mammal mitigation effectiveness and enabled progressive improvements to be made in relation to the overall implementation of the marine mammal mitigation.
- Utilising personnel that were multi-skilled allowed suitable coverage of visual and acoustic monitoring and operation of the ADD, with the installation crew on hand to deploy and activate the second ADD and support ADD and VPAM deployment and recovery where needed.

6 References

JNCC. 2022. Dogger Bank MPA | Advisor to Government on Nature Conservation | JNCC

Marine Management Organisation (MMO). 2022. Decision Document: Dogger Bank SAC, April 2022. Downloaded from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1069134/Dogger_Bank_SAC_Decision_Document.pdf

Appendix A – Details of piling for 87 monopile foundations

Table 6 Piling Location, Coordinates, Date and Time of Piling

Pile Number	Latitude	Longitude	Date	Start of Piling UTC (hrs:mm)	End of Piling UTC (hrs:mm)
P06	54.987698	2.926116	23/04/2025	12:39	14:10
P05	54.998402	2.910430	23/04/2025	21:45	23:25
P08	54.958276	2.942250	26/04/2025	19:50	21:19
P10	54.958832	2.898273	27/04/2025	04:27	05:50
E04	55.010668	2.782011	27/04/2025	16:28	17:46
P09	54.958552	2.920590	30/04/2025	10:27	11:47
F01	54.977571	2.884656	30/04/2025	18:40	20:34
E03	54.999981	2.797736	01/05/2025	04:09	05:52
F03	54.998967	2.853260	08/05/2025	03:17	04:50
E01	54.978600	2.829162	08/05/2025	15:38	17:25
E02	54.989291	2.813453	09/05/2025	01:59	03:24
E02			09/05/2025	05:52	06:25
P07	54.976992	2.941795	13/05/2025	05:35	07:02
P12	54.959370	2.853607	13/05/2025	15:45	17:19
F02	54.988270	2.868962	14/05/2025	00:22	01:48
P14	54.959892	2.808956	19/05/2025	13:35	14:40
F04	55.009661	2.837550	19/05/2025	21:19	00:36
P17	54.960649	2.741969	20/05/2025	09:19	11:06
D01	54.979572	2.773791	25/05/2025	17:00	18:20
P11	54.959099	2.875940	28/05/2025	00:52	02:15
C01	54.980624	2.718369	28/05/2025	12:03	13:29
P13	54.959638	2.831289	04/06/2025	11:36	13:17
P35	55.103296	2.579305	05/06/2025	00:14	01:45
D08	55.054319	2.663549	05/06/2025	09:12	10:13
D03	55.000939	2.742335	08/06/2025	01:03	02:24
D02	54.990256	2.758068	08/06/2025	08:47	10:13
P16	54.960407	2.764303	08/06/2025	15:45	17:06
P15	54.960152	2.786637	11/06/2025	08:33	09:43
C02	54.991301	2.702630	11/06/2025	16:37	17:50
D04	55.011619	2.726595	11/06/2025	23:49	00:47
C06	55.033989	2.639591	14/06/2025	18:02	19:26
D06	55.032973	2.695089	15/06/2025	00:54	02:12
D07	55.043647	2.679323	15/06/2025	08:12	09:52
P38	55.115826	2.630127	18/06/2025	01:09	02:14
P37	55.115756	2.607708	18/06/2025	08:27	09:37
P39	55.115892	2.652545	21/06/2025	11:48	13:10

Pile Number	Latitude	Longitude	Date	Start of Piling UTC (hrs:mm)	End of Piling UTC (hrs:mm)
D09	55.064989	2.647766	21/06/2025	18:48	20:03
P40	55.115954	2.674965	22/06/2025	03:25	05:32
P32	55.064746	2.579709	25/06/2025	00:53	02:16
C07	55.044656	2.623810	25/06/2025	08:02	09:24
P34	55.090446	2.579440	25/06/2025	16:53	18:14
P33	55.077596	2.579574	28/06/2025	08:21	10:11
E12	55.096093	2.655905	28/06/2025	17:07	18:09
E07	55.042718	2.734784	29/06/2025	00:10	01:36
D11	55.086323	2.616176	01/07/2025	17:11	18:33
D10	55.075657	2.631975	02/07/2025	00:26	01:28
E09	55.064074	2.703258	02/07/2025	11:14	12:21
P36	55.115682	2.585289	05/07/2025	19:48	21:06
E11	55.085422	2.671698	06/07/2025	05:05	06:01
E06	55.032037	2.750535	06/07/2025	14:45	15:48
P47	55.051892	2.831872	09/07/2025	09:12	10:52
B04	55.013565	2.615797	09/07/2025	20:19	21:32
P18	54.960897	2.719650	10/07/2025	05:52	07:07
P27	55.000495	2.580381	13/07/2025	07:59	09:26
P28	55.013345	2.580247	13/07/2025	15:36	17:03
P31	55.051896	2.579844	13/07/2025	23:24	00:51
C03	55.001976	2.686883	17/07/2025	10:14	11:29
C04	55.012649	2.671127	17/07/2025	17:08	18:21
C05	55.023320	2.655363	18/07/2025	00:08	01:20
E10	55.074749	2.687482	20/07/2025	16:59	18:15
F10	55.073786	2.743112	21/07/2025	00:05	01:39
P01	55.041198	2.847600	21/07/2025	08:44	10:53
P41	55.116011	2.697384	24/07/2025	16:00	17:47
F12	55.095144	2.711566	24/07/2025	23:14	00:04
			25/07/2025	05:39	07:10
F09	55.063103	2.758873	25/07/2025	13:25	14:56
P20	54.961369	2.674980	28/07/2025	04:30	06:09
E05	55.021354	2.766277	28/07/2025	15:28	16:56
F08	55.052419	2.774625	28/07/2025	22:43	00:48
P23	54.962053	2.608004	03/08/2023	11:10	11:15
			03/08/2023	13:06	14:30
P25	54.974794	2.580649	03/08/2025	21:12	22:48
B02	54.992231	2.647330	15/08/2025	18:27	19:30
P24	54.962275	2.585668	16/08/2025	01:28	02:48
P26	54.987645	2.580515	16/08/2025	09:55	11:12

Pile Number	Latitude	Longitude	Date	Start of Piling UTC (hrs:mm)	End of Piling UTC (hrs:mm)
F06	55.031044	2.806104	18/08/2025	20:44	22:23
F07	55.041733	2.790369	19/08/2025	03:54	05:58
F11	55.084466	2.727343	24/08/2025	18:23	19:49
P03	55.019804	2.879032	25/08/2025	03:12	04:50
P02	55.030502	2.863320	25/08/2025	10:51	12:15
P30	55.039045	2.579978	28/08/2025	08:51	09:59
P29	55.026195	2.580113	28/08/2025	16:08	17:23
P04	55.009104	2.894735	29/08/2025	02:05	03:34
P22	54.961835	2.630324	02/09/2025	05:48	07:12
P21	54.961604	2.652660	02/09/2025	12:54	13:52
P19	54.961140	2.697315	02/09/2025	20:23	21:27
A01	54.984212	2.614828	05/09/2025	18:22	19:23
B03	55.002899	2.631567	06/09/2025	01:22	02:33
			06/09/2025	02:47	03:00
			06/09/2025	03:20	04:01
B01	54.981561	2.663084	06/09/2025	11:36	12:41
F05	55.020354	2.821831	08/09/2025	21:52	23:31

Appendix B – JNCC Marine Mammal Recording Forms – see separate excel form 'P2014_DBC_MMO PAM Log_2025'

Appendix C – Mitigation summary for 87 monopile foundations

Table 7 Summary of the mitigation conducted for 87 pile monopile foundations

Step of the PMP		**Totals**	
Step 1 Preparation		ADD tested **87** times, prior to each pile being installed	
Step 2 Monitoring	MMObs	**142** hours and **45** minutes of visual monitoring. **2** marine mammals sighted, see Table 6.	
	PAM	**143** hours **56** minutes of acoustic monitoring **0** marine mammals detected.	
Step 3 ADD activation		ADD Activated **94** times*	
		45 hours and **10** minutes of ADD activation	
Step 4 soft-start	1) A 'slow start' of 5 mins of low energy blows ≤400 kJ at a strike rate of 1 blow per min.	**07** hours and **29** minutes^	Step 4 total = **30** hours and **21** minutes
	2) 10 mins of low energy blows ≤400 kJ at a strike rate of up to 30 blows per min.	**14 hours** and **50** minutes	
	3) 5 mins ramp- up to 880 kJ at a strike rate of 30 blows per min.	**08** hours and **52** minutes	
Step 5 Operational Piling		**126** hours and **39** minutes of operational piling	
Step 6 Breaks in Soft Start	< 10 mins	**416** Breaks across **86** pile locations	
	> 10 mins, < 2 hours	**1** across **1** pile locations	
Step 6 Breaks in Operational piling	< 10 mins	**27** breaks across **12** pile locations	**31** breaks in total across all pile locations
	> 10 mins, < 2 hours	**2** breaks across **1** pile locations	
	> 2 hours	**2** breaks at **2** pile location	

*ADD activated more than the number piles due to delayed soft-start and breaks of > 2 hours, see Table 8 in Appendix D for further details

^Increased soft-start times as a result of additional soft-starts being carried out due to technical issues with the hammer at E02, F12 and signal issues with GPS at P23.

Appendix D – Testing and deployment information of the ADD

ADD deployment depth for first deployment from each vessel was 24 m below the surface of the water and 6.5 m below the deck.

Table 8 Summary of the ADD testing and activation / deactivation (Time in UTC)

Pile location	Date	ADD tested (hr:min)	ADD activated (hr:min)	ADD deactivated (hr:min)	Duration of ADD activation (hr:min)
P06	23/04/2025	06:05	12:07	12:36	00:29
P05	23/04/2025	18:27	21:14	21:43	00:29
P08	26/04/2025	17:06	19:18	19:47	00:29
P10	27/04/2025	01:51	03:57	04:26	00:29
E04	27/04/2025	13:49	15:57	16:26	00:29
P09	30/04/2025	03:44	09:55	10:24	00:29
F01	30/04/2025	16:19	18:09	18:38	00:29
E03	01/05/2025	01:38	03:38	04:07	00:29
F03	08/05/2025	00:23	02:47	03:16	00:29
E01	08/05/2025	13:15	15:07	15:36	00:29
E02	09/05/2025	23:52	01:28	01:57	00:29
E02			05:21	05:50	00:29
P07	13/05/2025	03:27	05:05	05:34	00:29
P12	13/05/2025	12:40	15:15	15:44	00:29
F02	13/05/2025	21:24	23:13	23:42	00:29
F02			23:52	00:21	00:29
P14	19/05/2025	10:44	13:01	13:30	00:29
F04	19/05/2025	20:26	20:48	21:17	00:29
P17	20/05/2025	07:07	08:49	09:18	00:29
D01	25/05/2025	14:14	16:27	16:56	00:29
P11	28/05/2025	21:47	00:13	00:42	00:29
C01	28/05/2025	09:20	11:33	12:02	00:29
P13	04/06/2025	10:21	11:05	11:34	00:29
P35	05/06/2025	22:26	23:44	00:13	00:29
D08	05/06/2025	06:26	08:42	09:11	00:29
D03	08/06/2025	23:02	00:33	01:02	00:29
D02	08/06/2025	06:03	08:16	08:45	00:29
P16	08/06/2025	14:06	15:15	15:44	00:29
P15	11/06/2025	05:58	08:00	08:29	00:29
C02	11/06/2025	14:11	16:07	16:36	00:29
D04	11/06/2025	21:59	23:19	23:48	00:29
C06	14/06/2025	16:01	17:32	18:01	00:29
D06	15/06/2025	22:59	00:24	00:53	00:29
D07	15/06/2025	06:24	07:42	08:11	00:29
P38	18/06/2025	23:16	00:38	01:07	00:29

Pile location	Date	ADD tested (hr:min)	ADD activated (hr:min)	ADD deactivated (hr:min)	Duration of ADD activation (hr:min)
P37	18/06/2025	06:12	07:57	08:26	00:29
P39	21/06/2025	10:00	11:18	11:47	00:29
D09	21/06/2025	16:45	18:18	18:47	00:29
P40	22/06/2025	01:18	02:55	03:24	00:29
P32	25/06/2025	23:00	00:23	00:52	00:29
C07	25/06/2025	05:50	07:31	08:00	00:29
P34	25/06/2025	14:15	16:23	16:52	00:29
P33	28/06/2025	05:55	07:51	08:20	00:29
E12	28/06/2025	15:04	16:37	17:06	00:29
E07	29/06/2025	21:53	23:40	00:09	00:29
D11	01/07/2025	11:53	16:41	17:10	00:29
D10	02/07/2025	22:06	23:57	00:26	00:29
E09	02/07/2025	08:33	10:43	11:12	00:29
P36	05/07/2025	17:51	19:16	19:45	00:29
E11	06/07/2025	02:50	04:35	05:04	00:29
E06	06/07/2025	12:23	14:14	14:43	00:29
P47	09/07/2025	06:07	08:41	09:10	00:29
B04	09/07/2025	16:41	18:23	18:52	00:29
B04	09/07/2025		19:45	20:14	00:29
P18	10/07/2025	03:25	05:22	05:51	00:29
P27	13/07/2025	05:36	07:30	07:59	00:29
P28	13/07/2025	14:11	15:07	15:36	00:29
P31	13/07/2025	22:14	22:54	23:23	00:29
C03	17/07/2025	07:40	09:45	10:14	00:29
C04	17/07/2025	15:14	16:39	17:08	00:29
C05	18/07/2025	21:40	23:35	00:04	00:29
E10	20/07/2025	15:10	16:30	16:59	00:29
F10	21/07/2025	21:39	23:35	00:04	00:29
P01	21/07/2025	06:36	08:10	08:39	00:29
P41	24/07/2025	14:28	15:31	16:00	00:29
F12	24/07/2025	21:22	22:44	23:13	00:29
F12	25/07/2025		05:09	05:38	00:29
F09	25/07/2025	11:29	12:55	13:24	00:29
P20	28/07/2025	01:27	04:01	04:30	00:29
E05	28/07/2025	13:34	14:59	15:28	00:29
F08	28/07/2025	20:57	22:12	22:41	00:29
P23	03/08/2023	09:07	10:40	11:09	00:29
P23			11:42	12:08	00:26
P23			12:36	13:05	00:29

Pile location	Date	ADD tested (hr:min)	ADD activated (hr:min)	ADD deactivated (hr:min)	Duration of ADD activation (hr:min)
P25	03/08/2025	19:41	20:43	21:12	00:29
B02	15/08/2025	16:35	17:58	18:27	00:29
P24	16/08/2025	23:23	00:58	01:27	00:29
P26	16/08/2025	08:12	09:25	09:54	00:29
F06	18/08/2025	18:52	20:14	20:43	00:29
F07	19/08/2025	02:03	03:24	03:53	00:29
F11	24/08/2025	16:09	17:53	18:22	00:29
P03	25/08/2025	01:21	02:42	03:11	00:29
P02	25/08/2025	08:53	10:21	10:50	00:29
P30	28/08/2025	07:01	08:21	08:50	00:29
P29	28/08/2025	14:19	15:38	16:07	00:29
P04	29/08/2025	00:13	01:35	02:04	00:29
P22	02/09/2025	03:53	05:18	05:47	00:29
P21	02/09/2025	11:01	12:24	12:53	00:29
P19	02/09/2025	18:19	19:53	20:22	00:29
A01	05/09/2025	16:47	17:52	18:21	00:29
B03	06/09/2025	23:09	00:23	00:39	00:16
B03			00:52	01:21	00:29
B01	06/09/2025	07:40	11:07	11:36	00:29
F05	08/09/2025	20:12	21:23	21:52	00:29

Appendix E – Details of non-compliance and additional mitigation actions

NCs during the piling campaign at DBC are set out in Table 9 and details of additional mitigation actions taken are outlined in table 10 below.

Table 9 Non-Compliances

Pile	Cause	Details of NC
P07	Strike rate exceeded	There was one NC during the last 2 minutes 37 seconds of phase 3 of the soft start where the strike rate was 31 & 32 blows per minute, which is above the limit of 30 as per the MMMP. The strike rates were not known until the piling was complete and the data logs were provided to the MMMT.
P35	Strike rate exceeded	There was one NC where in the last 3 minutes and 07 seconds of phase 3 of the soft start where the strike rate was 31 blows per minute, which is above the limit set in the MMMP. The strike rates were not known until the piling was complete and the data logs were provided to the MMMT.
P33	Maximum hammer energy level exceeded	During piling, the hammer energy exceeded the consented maximum energy of 4000 kJ, reaching 4132 KJ. The hammer was set to 3800kJ, and blows varied between 3821kJ and 3971kJ over ~ 4 minutes, MENCK High Pressure Units (HPUs) were operating at higher pressure. When the over pressure protection shut down the HPUs, residual energy combined with new energy prepared for the next blow, resulted in the 4132kJ strike. To prevent a reoccurrence of this, the maximum energy to be used was set to 3700kJ – this enabled a greater “buffer zone”, so if the shutdown of the HPUs did occur again, the resulting maximum energy would be kept below 4000kJ.
E11	Lack of gradual ramp up	There was one non-compliance due to the lack of a gradual ramp up: At 16 minutes into operational ramp up, where energy levels increased sharply over a period of one minute (24 strikes) from 1518 kJ to 2504 kJ (05:41:55 – 05:42:53). This was due to a sudden increase in hardness of the ground, and the hammer energy was increased quickly to keep the pile moving and avoid hammer rebounds.

Table 10 Additional Mitigation Actions

Pile	Category of Mitigation Action	Cause	Detail of Mitigation Action(s)
F02	ADD Reactivation	Soft Start delayed	The soft-start was delayed due to the hammer moving off the pile during a pile slide under its own weight prior to soft start. The ADD was deactivated for 10 minutes and then reactivated.
B04	ADD Reactivation	Soft Start delayed	Due to soft sediments, under the weight of the hammer and prior to soft start, there was a large pile slide resulting in the pile self-penetrating to a depth of 13.3m. This led to a pile inclination that was beyond the specifications for the project. The vessel attempted to correct the inclination, but it was not achieved within 10 minutes of ADD deactivation (18:52 UTC), resulting in a delayed soft start and the reactivation of the ADD.

Pile	Category of Mitigation Action	Cause	Detail of Mitigation Action(s)
P23	ADD Reactivation	Signal issues with the GPS	The ADD was activated three times during the installation of P23, two of which were mitigation actions. During soft start, the gripper operators noticed a problem with the signal from the GPS positioning and soft start operations were stopped at 11 minutes into piling. After 21 minutes of no piling, the signal issue was resolved and the ADD was activated for the 2nd time. After 26 minutes of ADD activation, further GPS signal issues occurred, resulting in an early termination of the ADD. After 28 minutes, the signal issue was resolved and the ADD activated for the 3rd time for the full 29 minutes, after which operations commenced as normal with a soft start. Overall, the issue with the GPS signal resulted in a break in piling during soft start of >10 min (1 hour and 44 minutes and 46 seconds) and an incomplete ADD activation; therefore, 1 break in piling was registered and two mitigation actions occurred.
B03	ADD reactivation and breaks of > 10 mins to < 2 hrs	Technical Issues	Due technical issues the soft-start was delayed and the ADD was deactivated after 16 minutes (00:23 – 00:39 UTC). The issues were with the Baltec connector (the tool that connects the crane master with the hammer), which prevented the hammer being lifted. After a break of 13 minutes, the ADD was reactivated again for a full 29 minutes (00:52 – 01:21 UTC) and soft start commenced at 01:22 UTC. During operational piling, the hammer power bank had sensor issues resulting in two breaks of > 10 minutes and < 2 hours: The first break was 14 minutes in duration (02:33 – 02:47 UTC). Piling resumed with 5 single blows less than 400 kJ. The second break was 20 minutes in duration (03:00 – 03:20 UTC). Piling resumed with 6 single blows less than 400 kJ.
E02	Break of > 2 hrs and ADD reactivation	Hammer integrity issues	There was a break of > 2 hrs due to technical issues, which was 1 hour and 25 mins into operational piling. Piling mitigation procedures were implemented with the ADD being reactivated for 29 minutes, followed by a soft start with several single blows to maintain hammer integrity. Due to hammer integrity issues caused by striking a stationary pile at energies lower than those required to move it, the vessel conducted the soft start in a manner to maintain hammer integrity whilst staying within the limits of the MMMP. The soft start consisted of 10 single blows at 115 kJ. Once the 20-minute soft start was complete, the hammer team ramped up in sequence from 115 kJ to the required energy, reaching 2378 kJ to get the pile moving and without reaching the hammer “refusal rate”*.
F12	Break of > 2 hrs	Minor hydraulic fluid on the hammer hose	15 minutes into the operational piling, piling was paused due to a minor hydraulic fluid leak on the hammer hose. A break of >2 hrs took place to fix the issue (00:04 to 05:39 UTC). Once fixed the PMP was implemented with the ADD being reactivated for 29 minutes, followed by a soft start with several single blows to maintain hammer integrity.

Pile	Category of Mitigation Action	Cause	Detail of Mitigation Action(s)
P17	Long soft start	Technical Issues	Ten minutes into the soft start a problem occurred with the primary survey system. The system was shut down and the survey team switched to the backup survey system. Because of this, it was not possible to complete the third phase of the soft start in the required time (30 blows up to 880 KJ over 5 mins) and it was for this reason the third phase was extended until a proper ramp-up was carried out. The technical fault that related to the survey system was investigated and remedied.

*The refusal rate of piles during installation is a critical factor in determining the success of a piling project. It is typically defined as the number of blows required to drive a pile to a certain depth or to a predetermined bearing resistance. In general, the refusal rate is a measure of the pile's ability to penetrate the ground and achieve the required bearing.