Revolution Wind Pile Driving Monitoring Plan (Foundations)

Submitted To:

National Marine Fisheries Service

Office of Protected Resources

Silver Spring, MD;

National Marine Fisheries Service

Greater Atlantic Regional Fisheries Office – Protected Resource Division

Gloucester, MA;

Bureau of Ocean and Energy Management

Washington D.C.; and,

Bureau of Safety and Environmental Enforcement

Washington D.C.

Submitted By:

Revolution Wind, LLC

Revolution Wind | Powered by Ørsted & Eversource

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List of Abbreviations and Acronyms

µPa	microPascal(s)
re 1 µPa	referenced to a pressure of 1 microPascal
AMAR	autonomous multichannel acoustic recorder
APC	American Power Conversion
ASL	above sea level
BA	Biological Assessment
BBC	big bubble curtain
DBBC	Double big bubble curtain
BiOp	Biological Opinion
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
COP	Construction and Operations Plan
CPA	closest point of approach
dB	decibel(s)
DMON	Acoustic digital monitor
DP	Designated person
DOI	Department of the Interior
DWW	Deep Water Wind
ESA	Endangered Species Act
EST	Eastern Standard Time
FAD	free air delivery
FEIS	Final Environmental Impact Assessment
FFT	fast Fourier transform
FLT	flange lifting tool
FOV	Field of view
FR	Federal Register
GARFO	Greater Atlantic Regional Fisheries Office
GPS	global positioning system
HARP	high-frequency acoustic recording package
HSD	Hydro-sound Damper
HSE	Health, Safety and Environment
HTI	Hydroacoustic Technology Inc.
Hz	Hertz
ITR	Incidental Take Regulation
ITS	Incidental Take Statement
ID	identification number
IR	infrared
kHz	kilohertz
kJ	kilojoule(s)
km	kilometer(s)
Lease Area	BOEM-designated Renewable Energy Lease Area OCS-A 0486
LOA	letter of authorization
m	meter(s)
MA-WEA	Massachusetts Wind Energy Area
MARU	marine acoustic recording unit
MCPG	motion compensated pile gripper
MF	mid-frequency
mm	millimeter(s)
min	minute

MMPA	Marine Mammal Protection Act
M/V	motor vessel
MW	megawatt
MWS	Marine Warranty Surveyor
NARW	North Atlantic right whale
NAS	noise abatement systems or noise attenuation systems
NCEI	National Centers for Environmental Information
NMFS	National Marine Fisheries Service
NTL	Notice to Lessees
OCM	Offshore Construction Manager
OCS	Outer Continental Shelf
OPR	Office of Protected Resources
Orsted	Orsted Wind Power North America LLC
OSS	offshore substation
PAM	passive acoustic monitoring
PDC	project design criteria
PDMP	Pile Driving Monitoring Plan
POC	point of contact
Project	Revolution Wind Offshore Wind Farm Project
PSO	Protected Species Observer(s)
PTS	permanent threshold shift
Q2	second quarter
Q3	third quarter
QA	quality assurance
QC	quality control
RI-MA-WEA	Rhode Island/Massachusetts Wind Energy Area
rms	root mean square
ROC	Rehearsal of Concept
ROD	Record of Decision
RSA-ORCA	Multi-channel subsea acoustic recorder
RWF	Revolution Wind Farm
RWSAS	Right Whale Sighting Advisory System
SAS	Sightings Advisory System
SEL_{cum}	cumulative sound exposure level
SFV	sound field verification
SNR	Signal to Noise Ratio
SPL	sound pressure level
SPL_{pk}	peak sound pressure level
SPL_{rms}	root-mean-square sound pressure level
SZ	shutdown zone
TTS	temporary threshold shift
US	United States
USACE	United States Army Core of Engineers
USFWS	United States Fish and Wildlife Service
UTC	Coordinated Universal Time
UXO	unexploded ordnance
VHF	very high frequency
WEA	Wind Energy Area
WM	Works manager
WTG	wind turbine generator

1 Introduction

Revolution Wind, LLC (Revolution Wind) (formerly Deep-Water Wind [DWW] Rev I, LLC), a 50/50 joint venture between Orsted North America Inc. and Eversource Investment, LLC, proposed to construct and operate the Revolution Wind Farm (RWF) Project (hereinafter referred to as the Project). Revolution Wind has developed this Pile Driving Monitoring Plan (PDMP or Plan) for impact pile driving of the foundation monopiles (MPs) at the RWF, for review and concurrence by the Department of the Interior (DOI) and the National Marine Fisheries Service (NMFS) prior to commencing installation activities. This Plan is submitted pursuant to Condition 5.4.8 and 5.4.9 of the Approval of the Construction and Operations Plan (COP) for the Project, the Revolution Wind Incidental Take Rule [88 FR 72562] issued by the NMFS Office of Protected Resources (OPR) on 20 October 2023, as well as the Endangered Species Act (ESA) Section 7 Consultation Biological Opinion (BiOp) issued by NMFS-Greater Atlantic Fisheries Office (NMFS-GARFO) on 21 July 2023. Additional details on these conditions are included in Table 1.This Plan provides protocols and guidelines for mitigation and monitoring activities to minimize potential impacts on marine mammals and sea turtles.

Table 1. Relevant Conditions from COP Approval, Final ITR, LOA, and BiOp

Condition	Detail
COP Condition 5.4.8	The Lessee must submit a Marine Mammal and Sea Turtle Monitoring Plan for Pile Driving and UXO Detonation to BOEM, BSEE, and NMFS GARFO at least 180 days before any pile driving or UXO detonation[1] is planned. BOEM, BSEE, and NMFS GARFO will review the plan and provide comments within 45 days of receipt of the plan. NMFS GARFO's comments to BOEM, BSEE, and the Lessee will assess whether the plan is consistent with the requirements outlined in the July 21, 2023, BiOp and its ITS.
COP Condition 5.4.9	The Lessee must submit the Reduced Visibility Monitoring/Nighttime Pile Driving Monitoring Plan (or plans if separate plans are submitted) to BOEM, BSEE, and NMFS GARFO at least 180 days before impact pile driving is planned to begin unless a longer time period is identified in the MMPA Letter of Authorization. BOEM, BSEE, and NMFS GARFO will review the Reduced Visibility Monitoring Plan/Nighttime Pile Driving Monitoring Plan and provide comments within 45 days of receipt of the plan. NMFS GARFO's comments to BOEM, BSEE, and the Lessee will assess whether the plan is consistent with the requirements outlined in the July 21, 2023, BiOp and its ITS.
LOA Condition 3(c)(15)	Revolution Wind must submit a Foundation Installation Pile Driving Marine Mammal Monitoring Plan to NMFS OPR for review and approval at least 180 days prior to planned start of pile driving and abide by the Plan if approved. Revolution Wind must obtain both NMFS OPR and NMFS Greater Atlantic Regional Fisheries Office (GARFO) Protected Resources Division's concurrence with this Plan prior to the start of any pile driving. The Plan must include a description of all monitoring equipment and PAM and PSO protocols (including number and location of PSOs) for all pile driving. No foundation pile installation can occur without NMFS' approval of the Plan
Final ITR § 217.274 (c)(15)	Revolution Wind must submit a Pile Driving and Marine Mammal Monitoring Plan to NMFS Office of Protected Resources for review and approval at least 180 days prior to planned start of pile driving and abide by the Plan if approved. LOA Holder must obtain

Condition	Detail
	both NMFS Office of Protected Resources and NMFS Greater Atlantic Regional Fisheries Office Protected Resources Division's concurrence with this Plan prior to the start of any pile driving. The Plan must include a description of all monitoring equipment and PAM and PSO protocols (including number and location of PSOs) for all pile driving. No foundation pile installation can occur without NMFS' approval of the Plan.
BiOp Terms and Condition (T&C) 10(c):	Marine Mammal and Sea Turtle Monitoring Plan – Pile Driving and UXO Detonation. BOEM, BSEE, and/or Revolution Wind must submit this Plan (or Plans, if separate Pile Driving and UXO/MEC detonation is planned. BOEM, BSEE, and/or Revolution Wind must obtain NMFS GARFO's concurrent with this Plan(s) prior to the start of pile driving for foundation installation or carrying out any UXO.MEC detonation.
BiOp T&C 10(d):	BOEM, BSEE, and/or Revolution Wind must submit this Plan or Plans (if separate Daytime Reduced Visibility and Nighttime Monitoring Plans are prepared) to NMFS GARFO at least 180 calendar days before impact pile driving is planned to begin. BOEM, BSEE, and Revolution Wind must obtain NMFS GARFO's concurrence with this Plan(s) prior to the start of pile driving. .

[1] The UXO/MEC detonation monitoring plan will be submitted separately from the PDMP given the separate anticipated commencement dates of each individual activity.

1.1 Permits and Agreements

Permits and agreements pertaining to the Project will define the mitigation and monitoring requirements through the various stages of the construction process. The permits and agreements in place for the Project are provided in Table 2. The requirements laid out in the most updated versions of all documents are reflected in the Plan. Any questions arising in the field regarding mitigation and monitoring should directly reference the applicable permits and agreements.

Table 2. Permits and agreements associated with protected species monitoring and mitigation within the Project Area.

Document Title	Issuing Organization	Issue/Revision Date	Acronym Used	Link (if available)
Final Incidental Take Rule (88 FR 72562)	NMFS- OPR	October 20, 2023	ITR	https://www.govinfo.gov/content/pkg/FR-2023-10-20/pdf/2023-22056.pdf
United States Department of Interior Fish and Wildlife Service Biological Opinion	USFWS	May 30, 2023	BiOp	Not available at this time.
Endangered Species Act Section 7 Consultation Biological Opinion	NMFS- GARFO	July 21, 2023	BiOp	https://repository.library.noaa.gov/view/noaa/51759
Revolution Wind Farm and Revolution Wind Export Cable Final Environmental Impact Statement	BOEM	July 21, 2023	FEIS	https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Revolution_Wind_FEIS_Vol1-and-2.pdf
Revolution Wind Construction and Operations Plan and Appendices	Revolution Wind	March 1, 2023	COP	https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Revolution%20Wind%20COP%20Volume%201%20March%202023_v2_508c.pdf
Revolution Wind Farm and Revolution Wind Export Cable – Development and Operation Biological Assessment	BOEM for USFWS	November 16, 2022	BA – USFWS	https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/RevWind_USFWS_BA_0.pdf
Revolution Wind Farm and Revolution Wind Export Cable – Development and Operation Biological Assessment	BOEM for NMFS-GARFO	January 2023	BA – NMFS	https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/RevWind_NMFS%20BA.pdf
Record of Decision	BOEM	August 21, 2023	ROD	https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Revolution-Wind-Record-of-Decision-OCS-A-0486_3.pdf
Revolution Wind Farm and Revolution Wind Export Cable– COP Approval	BOEM	November 17, 2023	COP Approval	https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Cond%20of%20COP%20Appr_REV%20OCS-A%200486_0.pdf.
Offshore Wind Site Assessment Programmatic ESA Consultation	NMFS	June 29, 2021	PDC	https://media.fisheries.noaa.gov/2021-12/OSW-surveys-NLAA-programmatic-rev-1-2021-09-30-508-.pdf

1.2 Zone Definitions

Throughout this Plan, zones are described that identify either an impact range or areas within which mitigation and/or monitoring occurs. The size of the zones and the mitigation measures (if necessary) taken within each zone will be activity- and species-specific. Here, protected species includes marine mammals, sea turtles, and fish. The zones applicable during this Project are defined below.

- **Potential Injury Zone** – For marine mammals, the potential injury zone is defined as the distances within which Level A Harassment[1] may occur. The PTS thresholds for marine mammals ((frequency-weighted cumulative sound exposure level (SEL_{cum}) and unweighted peak sound pressure level (SPL_{pk}))) are defined by NMFS (2018). Potential injury thresholds for sea turtles were developed by the US Navy using dual criteria (SEL_{cum} and SPL_{pk}) along with auditory weighting functions in conjunction with SEL thresholds as defined by Finneran et al. (2017). This includes, but is not limited to, the area ensonified by a sound source to an acoustic isopleth defined by the threshold at which onset of PTS in hearing may occur in marine mammals and sea turtles. For fish without swim bladders, fish with swim bladders, fish with swim bladders not involved in hearing, and fish with swim bladders involved in hearing, the auditory injury thresholds (SPL_{pk} and SEL_{cum}) are recommended by Popper et al. (2014). For fish equal to or greater than 2 grams and fish less than 2 grams, the auditory injury thresholds (SPL_{pk} and SEL_{cum}) are recommended by NMFS GARFO (2020). Marine mammals and ESA-listed species observed within the applicable potential injury zone(s) during impact pile driving may constitute a take[2].
- **Behavioral Harassment Zone** – The behavioral harassment zone for marine mammals is defined as the distance within which Level B[3] harassment may occur. For non-explosive, intermittent sources like impact pile driving, the Level B harassment threshold is defined by NMFS as the unweighted root-mean-square (rms) sound pressure level (SPL_{rms}) of 160 decibels (dB) referenced to (re) 1 microPascal (µPa) (NMFS 2022). The behavioral harassment threshold for sea turtles is defined by NMFS GARFO as a SPL_{rms} of 175 dB re 1 µPa from non-explosive, intermittent sources (McCauley et al. 2000; Finneran et al. 2017). The behavioral disturbance threshold for ESA-listed fishes was developed by the NMFS GARFO (Andersson et al. 2007; Wysocki et al. 2007; Mueller-Blenkle et al. 2010; Purser and Radford 2011) and set at a SPL_{rms} of ≥150 dB re 1 µPa from non-explosive, intermittent sources (Andersson et al. 2007; Wysocki et al. 2007; Mueller-Blenkle et al. 2010; Purser and Radford 2011).
- **Clearance Zone** – The area that must be visually and/or acoustically clear of protected species prior to starting pile driving. Protected Species Observers (PSOs) and monitoring technologies such as passive acoustic monitoring (PAM) or infrared systems will be used to visually clear the clearance zone of protected species. Clearance zones may also be

[1] Level A refers to marine mammal harassment as defined in the Marine Mammal Protection Act (MMPA) that could potentially cause permanent threshold shift (PTS) or auditory injury.
[2] Take as defined under the ESA means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct". Take under the MMPA means to "harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.
[3] Level B refers to marine mammal harassment as defined in the MMPA that could potentially cause behavioral disturbance.

implemented prior to restarting the source after a shutdown of sound-producing activities. The size of the clearance zone is dependent on the activity and permit conditions. The clearance zone will be specific to species and/or faunal groups.

- **Shutdown Zone (SZ)** – The area within which a protected species sighting/detection will trigger an equipment shut down, power down, or other active mitigation measures defined in the permit conditions once a source is active. The size of the shutdown zone is dependent on the activity and permit conditions. Shutdown zones will be specific to species and/or faunal groups.

2 Project Description and Pile-Driving Summary

2.1 Project Description

Revolution Wind has proposed to construct and operate a 704 megawatts (MW) wind energy facility located in federal and state waters in the designated Bureau of Ocean Energy Management (BOEM) Renewable Energy Lease Area OCS-A 0486 (Lease Area). The RWF will consist of 79 positions for the installation of 65 wind turbine generators (WTGs) connected by a network of Inter-Array Cables and up to two Offshore Substation (OSS) each supported by one MP foundation connected by an OSS-Link Cable. WTGs will be situated in an approximate 1.15 mi (1 nm, 1.8 km) by 1.15 mi (1 nm, 1.8 km) grid, aligned with layouts proposed for other projects in the Rhode Island/Massachusetts Wind Energy Area (RI-MA WEA) and Massachusetts Wind Energy Area (MA WEA). The water depths in the Lease Area range from 24–50 m (78.7–164 ft).

Each WTG and OSS will be installed on MP foundations that will be driven using an impact hammer with a maximum hammer energy of 4,000 kJ. The underwater acoustic analysis and exposure modeling assumed WTG MP foundations supported by a tapered MP foundation that is 8 m on top and 12 m diameter at the mudline (7/12 m) and each OSS supported by a tapered 7 m (top) to 15 m (mudline) MP foundation (7/15 m). The final engineering design of the MP results in diameters of 9.5 – 10 m for WTG MPs and 10 m for OSS MPs. Installation of a single MP foundation is expected to require a maximum of 4 hours of active impact hammering, which can occur either in a continuous 4-hour interval or intermittently over a longer period of time. It is anticipated that a maximum of three WTG MP foundations can be driven into the seabed per day assuming 24-hour pile driving operation[4]. Installation of the OSS MP foundation will be similar to the WTG MP foundations; however, OSS MP foundations are larger in diameter and require a larger number of hammer strikes over a longer period. Foundation installation is estimated to begin in Q2 2024 through Q3 2024 over the course of ~5 months. A noise abatement systems (NAS) consisting of simultaneous use of a double big bubble curtain (DBBC) and a Helmholtz resonator (AdBm) will be deployed during each pile driving event to reduce sounds propagated into the marine environment. Information on components of the NAS are provided in Appendix A.

[4] 24-hour pile driving operations are subject to NMFS' approval of the *Nighttime Monitoring Plan for Pile Driving*.

2.2 Monopile Installation

2.2.1 WTG Monopile Foundations

Figure 1 provides a conceptual example of the WTG support structures (i.e., towers and foundations) which will be designed to withstand 500-year hurricane wind and wave conditions, and the external platform level will be designed above the 1,000-year wave scenario. A WTG MP foundation typically consists of a single steel tubular section, with several sections of rolled steel plate welded together. A transition piece (TP) may be fitted over the top of the MP and secured via a bolted connection. Secondary structures on each WTG MP foundation will include a boat landing or alternative means of safe access (e.g., Get Up Safe – a motion compensated hoist system allowing vessel to foundation personnel transfers without a boat landing), ladders, a crane, and other ancillary components. The TP may either be installed separately following the MP installation or the MP and TP may be fabricated and installed as an integrated single component. If the MP and TP are fabricated and installed as an integrated component, the secondary structures will be installed on the TP subsequently and in separate smaller operations. The TP will be painted yellow and marked according to United States Coast Guard (USCG) requirements.

17 MPs will include installation aids to allow safe installation. Installation aids are internal rings secured to the inner wall of the MPs at the lowest or second lowest can. The aids are designed to break off after the self-weight penetration process, when seabed resistance increases (typically after 10 m of penetration). The remaining MPs will not have any special features for the installation process.

The WTG MPs will be installed to a maximum penetration depth of 40 m (131 ft). Installation of each MP will include a 20-minute soft start where lower hammer energy is used at the beginning of each pile segment during pile driving activity to provide additional protection to mobile species (e.g., whales, dolphins, porpoises) in the vicinity by allowing them to vacate the area prior to the commencement of pile driving activities.

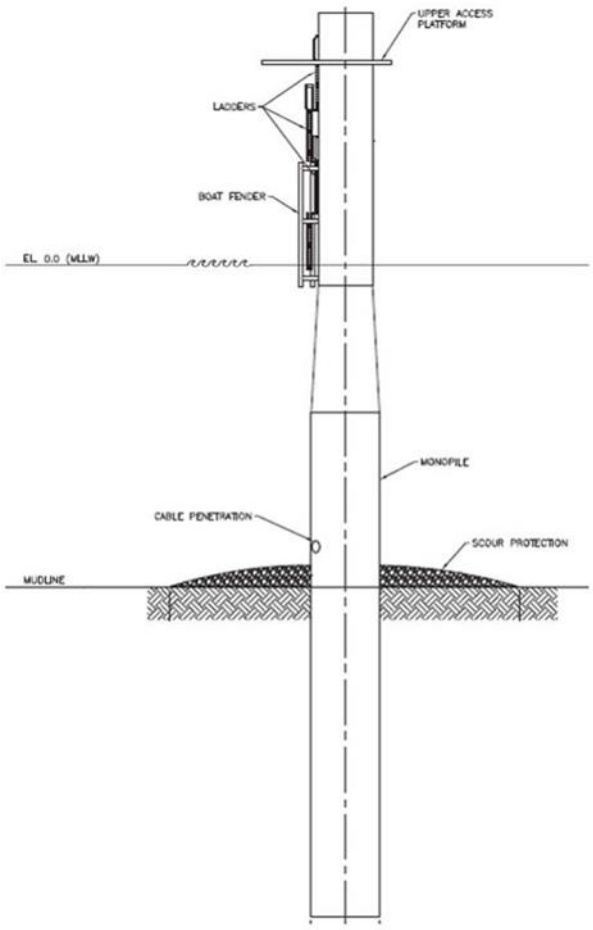


Figure 1. Schematic drawing of a WTG MP foundation

2.2.2 OSS Monopile Foundations

OSS MP foundations will be similar to the WTG MP foundations; however, OSS MP foundations will include a Module Support Frame between MP and the Topside (Figure 2). Two MPs will be installed to a target penetration depth of 50 m. One OSS MP foundation will be installed per day, for a total of two days of pile driving. As was described in section 2.2.1, installation of each MP will include a 20-minute soft start where lower hammer energy is used at the beginning of each pile segment during pile driving activity.

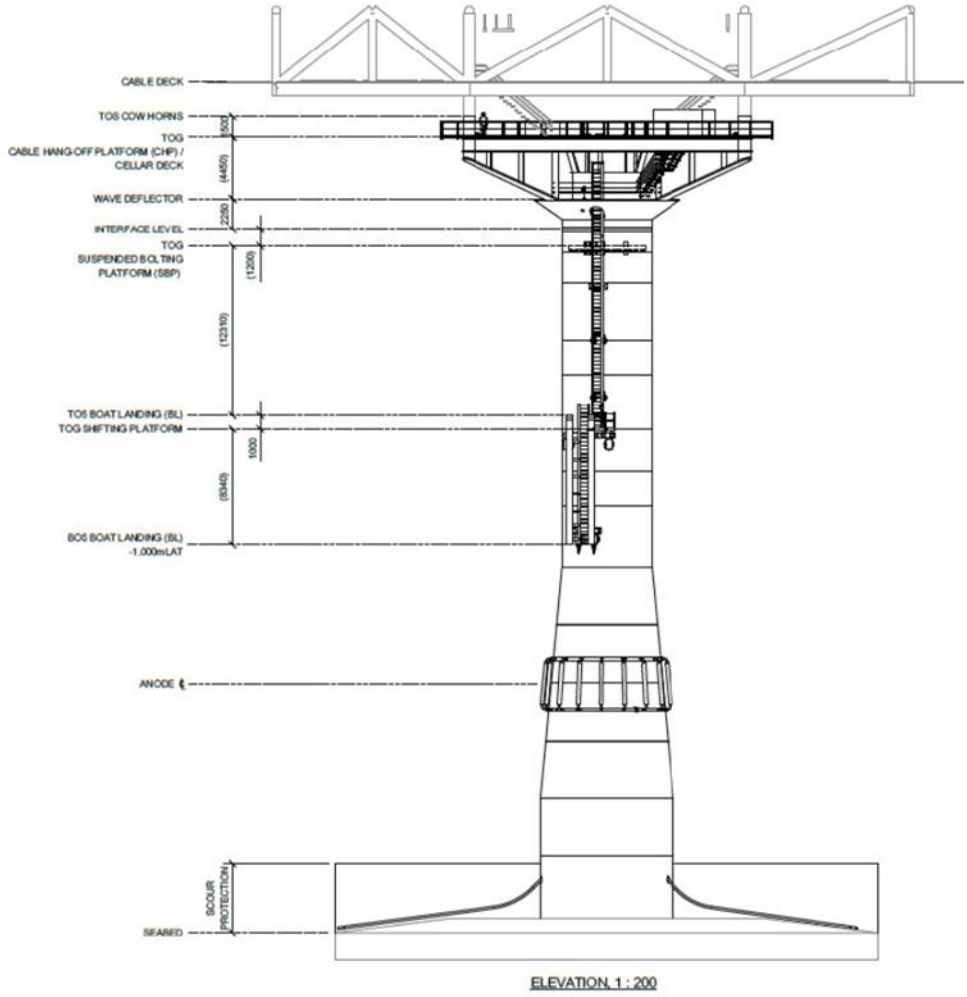


Figure 2. Example MP OSS foundation concept, including module support frame.

2.2.3 Sequence of Events for Pile Driving

The MPs will be driven into the seabed using a Menck 4400 S hydraulic hammer with a maximum hammer energy of 4,000 kJ (Figure 3). The MP will be lifted with the main crane from the upending lane into the motion compensated pile gripper frame (MCPGF), positioned overhead the target installation location and lowered to self- penetration depth. After de-coupling the Pile Flange Lifting tool, the piling hammer will be lifted from deck and placed on the MP. The pile will be driven to the required depth. Once the target depth is reached the hammer will be retrieved, placed on deck and disconnected from the main crane.

The sequence of event from foundation transport to foundation Installation is summarized in Table 3. The MP foundations are transported by the Heavy Transport Vessel (HTV) directly to the field. The MP foundations will be transferred from the HTV to the upend hinge on the Heavy Lift Vessel (HLV), synonymous to the Bokalift 2 (BL2), or intermediately stored in Cradles onboard the BL2. The bubble curtain vessel will deploy double bubble curtain rings before the HLV moves into MP installation position. At the same time PAM for marine mammals and sound field verification (SFV) acoustic

measurement moorings will be deployed around the foundation and subsequent recording and monitoring will begin.

Pile initiation begins when the HLV moves into installation position and the MPs are upended using the Upend Hinge and transferred to the Motion Compensated Pile Gripper (MCPGF). The MCPGF horizontally restrains the pile and ensures installation within the required tolerances. The bubble curtain vessel connects to the rings and starts performing noise mitigation. After lowering the MP to self-weight penetration, the hydraulic hammer (Menck 4400S) will be installed on the top of the MP. Once the MP is stabbed and self-weight penetration is achieved it is no longer technically feasible to safely reverse operations and the MP must be driven to its final penetration. Pile driving will only commence after the Lead PSO has confirmed that that clearance zone has been cleared by the PSOs and PAM operators of all applicable visual or acoustic detections of marine mammals and sea turtles for the required period of time. The hydraulic hammer is used to drive the MP to final penetration, initially with soft starts then with the required energy for installation. The soft start will include a minimum of 20 minutes of 4–6 strikes/min at 10–20 percent of the maximum hammer energy. During piling, monitoring will be undertaken to detect marine mammals and sea turtles and if required a shutdown will be initiated (see Section 3.9 for further details). After piling is completed the monitoring systems and DBBC will shut down and the support vessels will relocate them to the next location, where the cycle will restart.

Figure 3. Menck 4400S hydraulic hammer

Table 3. Sequence of events for each pile installation.

1	Starting points: • BL2 set up at installation location • MP in hinge with FLT connected; • Sufficient weather window available[5]; • Upend hinge ready for use • Survey equipment ready for use • Hammer ready for use • MCPG activated and ready for use; • DBBC ready for use • NAS ready for use.
2	Go/no-go meeting: OCM, Client Rep. and MWS must agree that it is considered safe to progress with the upending. MWS to issue a Certificate of Approval (CoA)  **Operational Hold Point**
3	Upend MP in MP hinge
4	Bring MP into MCPG
5	Lower MP onto seabed
6	Close MCPG
7	Start AdBm air compressor and lower AdBm/NAS
8	Lift hammer and stab on top of MP
9	Confirm DBBC operation
10	Engage AdBm/NAS air compressors
11	Start hammer energy recording Commence pile driving with single blows with low energy until automatic setting can be engaged
12	Drive pile to final penetration or refusal depth, whichever may come first
13	Discontinue DBBC and AdBm/NAS operation
14	Raise AdBm/NAS
15	Open MCPG

3 Mitigation and Monitoring

There are seven primary mitigation and monitoring components associated with impact pile driving for MP foundations:

[5] Typically, it is required to have a minimum of 10.5 hours of acceptable conditions to carry forward with a pile installation. This acceptable timeframe is subject to change based on field conditions and is at the discretion of the contractor responsible for pile installation.

1. Vessel-based visual PSOs and associated visual monitoring tools stationed on the installation vessel and additional protected species (PSO) vessels;
2. Visual monitoring during daylight and reduced visibility conditions;
3. Visual monitoring during nighttime;
4. PAM monitoring;
5. Noise abatement systems (NAS);
6. Acoustic measurement data collection (SFV to validate the modeled ranges to the potential injury and behavioral harassment isopleths on which clearance and shutdown zones and take estimate, are based;
7. Data recording and reporting.

3.1 Mitigation and Monitoring Zones

The mitigation and monitoring zones are based on the results of underwater sound propagation modeling of potential injury and behavioral harassment ranges for modeled piling scenarios. A further description on how these zone sizes were determined is explained within the Revolution Wind Final Rule (88 FR 72562 2023). These mitigation and monitoring zones may be modified, with NMFS-OPR and BOEM approval, based on measurements of the received sound levels during piling operations as described in the *Sound Field Verification Plan*. No impact pile driving is planned for the months of December through April; however, installation in December may only occur, upon NMFS approval, in the case of unexpected delays.

Table 4: Threshold ranges and mitigation and monitoring zones during WTG impact pile driving in Summer (May through November).

			Monitoring and Mitigation Zones (m)			
Species	**Level A Zone (m) (SEL_{cum})**	**Level A Zone (m) (SPL_{pk})**	**Level B Harassment Zone[1]**	**Clearance and Shutdown Zone**	**Minimum Visibility Zone**	**Vessel Separation Distance (m)**
Low-frequency Cetaceans						
Fin whale*	2,230	≤10	3,833	2,300	2,300	500
Minke whale	1,510	≤10	3,833	2,300	2,300	100
Sei whale*	1,810	≤10	3,833	2,300	2,300	500
Humpback whale	2,660	≤10	3,833	2,300	2,300	100
North Atlantic right whale*	1,930	≤10	3,833	See Table 8	2,300	500
Blue whale*	2,230	≤10	3,833	2,300	2,300	500
Mid-frequency Cetaceans						
Sperm whale*	-	≤10	3,833	2,300	2,300	500
Atlantic spotted dolphin	-	≤10	3,833	NAS	2,300	50
Atlantic white-sided dolphin	-	≤10	3,833	NAS	2,300	50
Common dolphin	-	≤10	3,833	NAS	2,300	50
Risso's dolphin	10	≤10	3,833	NAS	2,300	50
Bottlenose dolphin	-	≤10	3,833	NAS	2,300	50
Long-finned pilot whale	-	≤10	3,833	NAS	2,300	50
High-frequency Cetaceans						
Harbor porpoise	1,340	160	3,833	1,400	2,300	50
Phocid Pinnipeds in Water						
Gray seal	440	≤10	3,833	500	2,300	50
Harbor seal	240	≤10	3,833	500	2,300	50
Sea Turtles						
Leatherback sea turtle*	120	-	1,018	200	200	100
Loggerhead sea turtle*	30	-	1,018	200	200	100
Kemp's ridley sea turtle*	120	-	1,018	200	200	100
Green sea turtle*	210	-	1,018	200	200	100

* denotes species listed under the Endangered Species Act; dB = decibel; SEL_{cum} = cumulative sound exposure level SPL_{pk} = peak sound pressure level.

NAS (Noise Abatement System) means that the zone is small enough that it will be encompassed by the bubble curtain.

1 Level B harassment zone values are based on the modeled single strike SPL acoustic range isopleths to 160 dB re 1 µPa and 175 dB re µPa for behavioral disturbance of marine mammals and sea turtles respectively.

Table 5: Threshold ranges and mitigation and monitoring zones (including minimum visibility zone(s)) during WTG impact pile driving in Winter (December only).

			Monitoring and Mitigation Zones (m)			
Species	**Level A Zone (m) (SEL_{cum})**	**Level A Zone (m) (SPL_{pk})**	**Level B Harassment Zone[1]**	**Clearance and Shutdown Zone**	**Minimum Visibility Zone**	**Vessel Separation Distance (m)**
Low-frequency Cetaceans						
Fin whale*	4,380	≤10	4,271	4,400	4,400	500
Minke whale	3,450	≤10	4,271	4,400	4,400	100
Sei whale*	3,670	≤10	4,271	4,400	4,400	500
Humpback whale	6,290	≤10	4,271	4,400	4,400	100
North Atlantic right whale*	3,970	≤10	4,271	See Table 8	4,400	500
Blue whale*	4,380	≤10	4,271	4,400	4,400	500
Mid-frequency Cetaceans						
Sperm whale*	-	≤10	4,271	4,400	4,400	500
Atlantic spotted dolphin	-	≤10	4,271	NAS	4,400	50
Atlantic white-sided dolphin	-	≤10	4,271	NAS	4,400	50
Common dolphin	-	≤10	4,271	NAS	4,400	50
Risso's dolphin	-	≤10	4,271	NAS	4,400	50
Bottlenose dolphin	-	≤10	4,271	NAS	4,400	50
Long-finned pilot whale	-	≤10	4,271	NAS	4,400	50
High-frequency Cetaceans						
Harbor porpoise	2,330	160	4,271	2,400	4,400	50
Phocid Pinnipeds in Water						
Gray seal	810	≤10	4,271	900	4,400	50
Harbor seal	500	≤10	4,271	900	4,400	50
Sea Turtles						
Leatherback sea turtle*	290	-	1,519	200	200	100
Loggerhead sea turtle*	30	-	1,519	200	200	100
Kemp's ridley sea turtle*	130	-	1,519	200	200	100
Green sea turtle*	370	-	1,519	200	200	100

* denotes species listed under the Endangered Species Act; dB = decibel; SEL_{cum} = cumulative sound exposure level SPL_{pk} = peak sound pressure level.

NAS (Noise Abatement System) means that the zone is small enough that it will be encompassed by the bubble curtain.

[1] Level B harassment zone values are based on the modeled single strike SPL acoustic range isopleths to 160 dB re 1 µPa and 175 dB re µPa for behavioral disturbance of marine mammals and sea turtles respectively.

Table 6: Threshold ranges and mitigation and monitoring zones (including minimum visibility zone(s)) during OSS impact pile driving in Summer (May through November).

			Monitoring and Mitigation Zones (m)			
Species	**Level A Zone (m) (SEL_{cum})**	**Level A Zone (m) (SPL_{pk})**	**Level B Harassment Zone[1, 2]**	**Clearance and Shutdown Zone**	**Minimum Visibility Zone**	**Vessel Separation Distance (m)**
Low-frequency Cetaceans						
Fin whale*	1,570	≤10	4,100	1,600	1,600	500
Minke whale	940	≤10	4,100	1,600	1,600	100
Sei whale*	1,220	≤10	4,100	1,600	1,600	500
Humpback whale	1,790	≤10	4,100	1,600	1,600	100
North Atlantic right whale*	1,250	≤10	4,100	See Table 8	1,600	500
Blue whale*	1,570	≤10	4,100	1,600	1,600	500
Mid-frequency Cetaceans						
Sperm whale*	-	≤10	4,100	1,600	1,600	500
Atlantic spotted dolphin	-	≤10	4,100	NAS	1,600	50
Atlantic white-sided dolphin	-	≤10	4,100	NAS	1,600	50
Common dolphin	-	≤10	4,100	NAS	1,600	50
Risso's dolphin	-	≤10	4,100	NAS	1,600	50
Bottlenose dolphin	-	≤10	4,100	NAS	1,600	50
Long-finned pilot whale	-	≤10	4,100	NAS	1,600	50
High-frequency Cetaceans						
Harbor porpoise	830	110	4,100	900	1,600	50
Phocid Pinnipeds in Water						
Gray seal	370	≤10	4,100	400	1,600	50
Harbor seal	10	≤10	4,100	400	1,600	50
Sea Turtles						
Leatherback sea turtle*	≤10	-	1,427	200	200	100
Loggerhead sea turtle*	≤10	-	1,427	200	200	100
Kemp's ridley sea turtle*	≤10	-	1,427	200	200	100
Green sea turtle*	≤10	-	1,427	200	200	100

* denotes species listed under the Endangered Species Act; SELcum = cumulative sound exposure level; SPL_{pk} = peak sound pressure level;

NAS (Noise Abatement System) means that the zone is small enough that it will be encompassed by the bubble curtain.

[1] Level B harassment zone values are based on the modeled single strike SPL acoustic range isopleths to 160 dB re 1 µPa and 175 dB re µPa for behavioral disturbance of marine mammals and sea turtles respectively.

[2] The Level B harassment zone values shown here are consistent with the values in the LOA and will be used until SFV measurements and analysis are completed. For SFV purposes, the values shown in Table 9 of the *Sound Field Verification Plan* for OSS foundation installation will be used as they reflect the correct (shorter) distances assuming 10 dB of noise attenuation. See the SFV plan for an explanation of the difference in ranges. After SFV is completed, the Level B harassment zone values will be confirmed or revised, as appropriate based on the results.

Table 7: Threshold ranges and mitigation and monitoring zones (including minimum visibility zone(s)) during OSS impact pile driving in Winter (December only).

			Monitoring and mitigation zones (m)			
Species	**Level A Zone (m) (SEL_{cum})**	**Level A Zone (m) (SPL_{pk})**	**Level B Harassment Zone[1, 2]**	**Clearance and Shutdown Zone**	**Minimum Visibility Zone**	**Vessel Separation Distance (m)**
Low-frequency Cetaceans						
Fin whale*	2,680	≤10	4,698	2,700	2,700	500
Minke whale	1,810	≤10	4,698	2,700	2,700	100
Sei whale*	2,050	≤10	4,698	2,700	2,700	500
Humpback whale	3,560	≤10	4,698	2,700	2,700	100
North Atlantic right whale*	2,660	≤10	4,698	See Table 8	2,700	500
Blue whale*	2,680	≤10	4,698	2,700	2,700	100
Mid-frequency Cetaceans						
Sperm whale*	-	≤10	4,698	2,700	2,700	500
Atlantic spotted dolphin	-	≤10	4,698	NAS	2,700	50
Atlantic white-sided dolphin	-	≤10	4,698	NAS	2,700	50
Common dolphin	-	≤10	4,698	NAS	2,700	50
Risso's dolphin	-	≤10	4,698	NAS	2,700	50
Bottlenose dolphin	-	≤10	4,698	NAS	2,700	50
Long-finned pilot whale	-	≤10	4,698	NAS	2,700	50
High-frequency Cetaceans						
Harbor porpoise	1,250	80	4,698	1,300	2,700	50
Phocid Pinnipeds in Water						
Gray seal	370	≤10	4,698	400	2,700	50
Harbor seal	110	≤10	4,698	400	2,700	50
Sea Turtles						
Leatherback sea turtle*	260	-	1,776	200	200	100
Loggerhead sea turtle*	110	-	1,776	200	200	100
Kemp's ridley sea turtle*	230	-	1,776	200	200	100
Green sea turtle*	280	-	1,776	200	200	100

* denotes species listed under the Endangered Species Act; SELcum = cumulative sound exposure level; SPLpk = peak sound pressure level;

NAS (Noise Abatement System) means that the zone is small enough that it will be encompassed by the bubble curtain.

[1] Level B harassment zone values are based on the modeled single strike SPL acoustic range isopleths to 160 dB re 1 µPa and 175 dB re µPa for behavioral disturbance of marine mammals and sea turtles respectively.

[2] The Level B harassment zone values shown here are consistent with the values in the LOA and will be used until SFV measurements and analysis are completed. For SFV purposes, the values shown in Table 9 of the *Sound Field Verification Plan* for OSS foundation installation will be used as they reflect the correct (shorter) distances assuming 10 dB of noise attenuation. See the SFV plan for an explanation of the difference in ranges. After SFV is completed, the Level B harassment zone values will be confirmed or revised, as appropriate based on the results.

Table 8. Relevant NARW Zones[1] during Impact Piling (May through December).

Season	Minimum Visibility Zone	Visual Clearance Delay and Shutdown (m)	PAM Clearance/Shutdown Zone (km)	PAM Clearance Delay and Shutdown (m)
Summer WTG	2,300	Any Distance	10	At any distance within the PAM Clearance/Shutdown Zone
Winter WTG	4,400			
Summer OSS	1,600			
Winter OSS	2,700			

[1] Revolution Wind may request modification to zones based on results of sound field verification.

3.2 Personnel

Dedicated personnel will be required to carry out protected species monitoring and mitigation efforts onboard Project vessels. These roles are required to be filled by NMFS-approved and BOEM-accepted PSOs and PAM operators. In addition, all project personnel in the field have a responsibility to support environmental compliance and will receive Environmental Awareness Training so that they are aware of the required monitoring, mitigation, and reporting.

3.2.1 Project Personnel Training

In accordance with ITR § 217.275 (a), § 217.275 (g)(1), LOA condition 3(a)(2), and all COP Approval Conditions under sections 5.8, Revolution Wind will ensure that all construction supervisors and crews, PSO and PAM teams, vessel operators and all relevant staff are trained prior to the start of all in-water activities. The Revolution Wind Environmental Awareness Training will include offshore roles/responsibilities, communication procedures, summary of relevant permit conditions, protected species awareness and identification, mitigation and monitoring, safety and operational procedures, vessel strike avoidance measures, marine trash and debris awareness training, and reporting procedures. All project personnel will complete two separate sessions potentially occurring over the course of two days held with the PSO provider and Project compliance representative(s) prior to the start of in-water activities. Additionally, project briefings will be conducted by Revolution Wind prior to construction and at each crew change to ensure that personnel have the most current project-specific information and are aware of any changes that have occurred throughout the duration of the Project. This training will be repeated and reported to NMFS OPR for new personnel who join the work during the Project.

Additionally, an online training course provided and required by Revolution Wind's PSO and PAM contractor for all vessel personnel prior to the start of in-water activities including training on how to use the required monitoring equipment (e.g., thermal cameras) specific to each PSO/PAM operator role. Similar equipment training will be reviewed and repeated during the required in-person training provided by the PSO and PAM contractors during vessel mobilization.

Marine trash and debris awareness training is required of all Revolution Wind offshore personnel engaged in offshore activities pursuant to the approved COP and must be completed annually. The training process will include the following elements:

1. Viewing a marine trash and debris training video or slide show;
2. Receiving an explanation from management personnel that emphasizes their commitment to the requirements;
3. Attendance measures (initial and annual).

Orsted is planning to conduct Rehearsal of Concept (ROC) drills with their construction, PSO, and PAM contractors well in advance of construction start. The ROC drills comprise a coalition of senior PSOs, PAM operators, PSO/PAM program managers, pile driving operational leads/managers, and Revolution Wind project leadership. Collaborative monitoring and mitigation drills for all stages of pile driving (including pre- and post-), with emphasis on compliance conditions, decision matrices, communication channels, etc., will take place.

As per LOA condition 3(a)(2), a description of the training program will be provided to NMFS at least 60 days prior to the initial training before in-water activities begin. In accordance with ITR § 217.275 (g)(1); prior to initiation of any on-water Project activities, Revolution Wind will demonstrate in a report submitted to NMFS-OPR at (itp.esch@noaa.gov and pr.itp.monitoringreports@noaa.gov) that all required training for Revolution Wind personnel (including the construction, survey, vessel crews, vessel captains, visual PSOs, and PAM operators) has been completed. To facilitate this, a training log for all personnel will be maintained and reported to NMFS OPR prior to initiation of project activities. As per BiOp Appendix A, BA Table 3.18, EPM Number MM-4 and ST-4, all training records will be maintained and provided to BOEM and BSEE upon request or as a part of annual reporting requirements.

In addition to Environmental Awareness Training, and in accordance with ITR conditions, additional training will be conducted for project personnel that have specific requirements for the role they will fulfill. All personnel involved with protected species mitigation and monitoring will complete Revolution Wind training modules applicable to their role prior to deployment. The following list summarizes the training modules for personnel directly involved in protected species monitoring:

Trained Lookout (1 hour)

In accordance with ITR § 217.274 (b)(1), the Trained Lookout will receive prior training on protected species detection and identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. The Trained lookout will undergo and complete the training requirements included within the Revolution Wind *Vessel Strike Avoidance Plan*.

Mysticetus Data Entry and Reporting (2 hours)

All PSO/PAM personnel will receive training in the operation of Mysticetus PSO data collection software. Training will include data entry, metadata, Quality Assurance (QA) / Quality Control (QC), reporting, integration with other alternative monitoring technologies (i.e., infrared or thermal cameras), detection sharing and situational awareness map, multi-platform data aggregation, and special features applicable to the project.

PSO and PAM Compliance (2 to 3 hours)

PSO and PAM operator training and qualifications will be met as defined in Revolution Wind COP Condition of Approval 5.8.3 and LOA conditions 4(a). PSO and PAM operator training and qualification include:

The Lessee must use independent, dedicated, qualified PSOs provided by a third party. The PSOs sole Project-related duty must be to observe, collect and report data, and communicate with and instruct relevant vessel crew regarding the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards). PSOs or any PAM operators serving as PSOs must have completed a commercial PSO training program for the Atlantic with an overall examination score of 80 percent or greater. The Lessee must use NMFS-approved PSOs and PAM operators. The Lessee must provide training certificates for individual PSOs to BOEM or BSEE upon request. PSOs and PAM

operators must be approved by NMFS before the start of construction activities. The NMFS-approved PSOs and PAM operators will receive additional Revolution Wind PSO and PAM compliance training that will include detailed permit and operational requirements. Contents will cover clearance zones, clearance monitoring, soft-starts, shutdown zone monitoring, shutdown assessment by Lead Engineer, re-start/clearance protocols, PSO-PAM operations and communications, mitigation decision matrices, data collection and weekly/monthly reporting, incident reporting, and NARW reporting.

PAM Operator Training

In accordance with ITR § 217.275 (a)(11) and LOA condition 4 (a)(11), PAM operators will have completed specialized training for operating PAM systems and must demonstrate familiarity with the PAM system on which they will be working. Revolution Wind PAM operators will complete the Gardline PAM course which includes:

- Basic theory of Underwater Acoustics;
- Visual Representation of Sound;
- Sound in the Sea;
- Marine Mammals, Sound production & Hearing;
- Acoustic Monitoring;
- PAM Hardware;
- Hardware practical session;
- PAM Software;
- Software Practical session;
- Role as a PAM operator.

Whale Vocalization training (1-2 hours)

In accordance with ITR §217.275 (a)(11) and LOA condition 4(a)(11), PAM operators will complete specialized training for operating PAM systems and detecting and identifying Atlantic Ocean marine mammal sounds, in particular: North Atlantic right whale (NARW) sounds, humpback whale sounds, and how to deconflict them from similar NARW sounds, and other co-occurring species' sounds in the area including sperm whales; must be able to distinguish between whether a marine mammal or other species sound is detected, possibly detected, not detected. The course module will cover species-specific characteristics of their calls and how to identify them in spectrograms, including visual examples for each species and call type.

PAM Deployment and Recovery

PAM deployment and recovery training will be a mix of onshore and offshore modules that include:

- Mooring design;
- Mooring assembly;
- Antenna feedback/ introduction to software;
- Software troubleshooting;
- Grappling lines;
- Mooring deployment;
- Mooring recovery;
- Recording mooring deployments;
- Health, Safety and Environment (HSE) of mooring deployment;
- Data download;
- PAM recorder configuration;
- Telemetry configuration and testing.

3.2.2 Field Operations Personnel

The field operations team implementing the Plan comprise the visual PSOs, PAM operators, Revolution Wind personnel, and construction contractors. As per LOA condition 3(a)(3), Revolution

Wind personnel and contractors will use available sources of information on NARW presence in or near the Project Area including daily monitoring of the Right Whale Sighting Advisory System (RWSAS), and monitoring of USCG VHF Channel 16 throughout the day to receive notification of any sightings and/or information associated with any Slow Zones (i.e., Dynamic Management Areas (DMAs) and/or acoustically-triggered slow zones) to provide situational awareness for both vessel operators, PSOs, and PAM operators. These systems will be monitored no less than every 4 hours. The following is a description of the key personnel and their roles within the mitigation and monitoring framework covered under this Plan. Details of measures and communication among personnel are provided in other sections of this document.

Visual PSOs

Revolution Wind will deploy PSOs with appropriate skills and in sufficient numbers to meet all mitigation and monitoring requirements. PSOs will be chosen from the applicant pool of available and interested PSOs who have completed training and been granted NMFS-approval. As stated in §217.275(a)(6) NMFS will approve PSOs as either conditional or unconditional. Unconditionally approved PSOs will have completed training within the last 5 years and attained the necessary experience (i.e., demonstrate experience with monitoring for protected species at clearance and shutdown zone sizes similar to those produced during the respective activity). Conditionally approved PSOs will have completed training in the last 5 years, or as otherwise approved by NMFS on a case-by-case basis, but will not have attained the requisite field experience. A conditionally approved PSO will be paired with an unconditionally approved PSO. Revolution Wind will submit to NMFS the names of PSOs/PAM operators who have been previously approved by NMFS OPR for review and confirmation of their approval to perform specific roles on this Project at least 30 days prior to commencement of pile driving or 15 days prior to when new PSOs/PAM operators are required after activities have commenced.

There are two categories of Visual PSOs who will be deployed on the project, PSO and Lead PSO. PSOs are responsible for the detection, identification, localization, and reporting of all protected species observed during watch. PSOs will provide visual monitoring of all clearance and shutdown zones prior to, during, and after impact pile driving. Outside of the designated watch periods, PSOs will be responsible for general monitoring for situational awareness and vessel strike avoidance. PSOs (individuals and teams) will record marine species data into data collection software, submitting detection information when applicable, and communicating with the Lead PSO. Visual PSOs will remain in contact with the PAM operator on duty regarding any protected species detection that would be approaching or found within the applicable zones through the use of VHF radios, mobile phones using WhatsApp, or the Teams application on a computer. If these three methods of communication fail, PSOs will remain in contact with vessel-based PAM operators using the vessel's radio. All PSO detections will be relayed to the Lead PSO so that those detections are transmitted across the Project. If a protected species enters a clearance or shutdown zone, PSOs will immediately notify the Lead PSO so the appropriate mitigation actions can be implemented.

Lead PSOs carry the same duties as PSOs and also manage the activities associated with the PSO team, PAM team, and SFV field team. The Lead PSO will be unconditionally approved by NMFS and have a minimum of 90 days at-sea experience in a northwestern Atlantic Ocean offshore environment performing the visual role with the conclusion of the most recent relevant experience no more than 18 months previous. Alongside the vessel operator, Lead PSOs will hold onboard briefings prior to the beginning of construction activity. Such briefings will be repeated whenever new relevant personnel join

the pile driving activity before work commencement. Lead PSOs will also attend Project meetings, ensuring all PSO and noise monitoring protocols are followed, and conduct general correspondence with dedicated watches and the Client Representative. The Lead PSO will communicate directly with the Designated Person / Works Manager (DP/WM) and will be responsible for communicating when clearances have been completed and pile driving can commence. Lead PSOs will make decisions regarding visibility and conduct final reviews on all PSO data and reporting. The Lead PSO will be the main point of contact (POC) for the entire mitigation team.

The PSO team may also have a PSO supervisor who may work in the field or shore side that provides additional support to the Lead PSO and PSO team. The PSO supervisor would also facilitate communication between PSOs and other shore-side Project parties. The PSO supervisor would also communicate directly with the DP/WM, as needed.

PAM Operators

There will be Lead and Standard PAM operators, and they function in relatively similar roles as PSOs but instead of visual monitoring they will conduct acoustic monitoring. Standard PAM operators will have at least the minimum training and qualifications required by the agencies. The Lead PAM operator will be unconditionally approved by NMFS and have a minimum of 90 days at sea in a northwestern Atlantic Ocean offshore environment performing an acoustic role, with the conclusion of the most recent relevant experience not more than 18 months previous. A conditionally approved PAM operator will be paired with an unconditionally approved PAM operator. The Lead PAM operator will also be able to troubleshoot the acoustic equipment and assist with making final decisions regarding species identifications, localization and other acoustic monitoring details that will be relayed to the Lead PSO. The Standard PAM operator will be able to access the expertise of the Lead PAM operator as needed.

PAM operators will be located on the installation vessel. All PAM operators will inform the Lead PSO on duty of any animal detections approaching or within relevant clearance zones through the data collection software system (i.e., Mysticetus). In the unlikely circumstance that Mysticetus experiences a temporary disruption, all information will be communicated directly through other communication systems including Teams, WhatsApp, and radio. The Mysticetus temporary disruption will be communicated by the PSO teams to all Project personnel to ensure use of other communication systems is consistent.

Acoustic Reporting Scientist

As part of the SFV team, the Acoustic Reporting Scientist will be responsible for confirming deployment, operation, and retrieval of all SFV equipment and relaying that information to the Lead PSO. The Acoustic Reporting Scientist will also be responsible for immediate retrieval of acoustic data from the SFV recorders and ensuring its safe transmittal to the onshore acoustic analysts.

Acoustic Deployment Support Member

These are experienced field personnel who will assist the PAM and SFV deployment and recovery. These support personnel will not play a direct role in mitigation and monitoring but will assist in the deployment and recovery as well as troubleshooting or maintenance of all deployed acoustic buoys. Support members will be on both the PAM and SFV vessels.

Designated Person / Works Manager

The designated person (DP)/works manager (WM) will be the Revolution Wind and construction contractor representative on site that has the role of oversight across the entire Project and will be the POC for maintaining compliance with all regulations for the Project. The key role for the DP/WM will be to maintain communication with the Lead PSO such that the DP/WM is kept abreast of all clearance activities, detections, and mitigation activities. The DP/WM will initiate the shutdowns requested by the Lead PSO, communicate with the hammer operator, and consult with engineers for pile stability in the case of any mitigation actions that require pile safety analysis.

3.2.3 PSO Standards and Overall Schedule

The following requirements and roles will be implemented for PSO personnel. As described in Section 3.2.1, PSOs and PAM operators will all receive project-specific training.

- All PSOs will be chosen from the applicant pool of available and interested PSOs who have been approved by NMFS-OPR prior to the start of the Project. PSOs will meet the qualifications outlined in ITR § 217.275 (a) and LOA condition 4(a), have completed a NMFS-approved PSO course, and will fulfill the physical/medical requirements, communication skills, and visa requirements.
- For prospective PSOs and PAM operators not previously approved, or for PSOs and PAM operators whose approval is not current, Revolution Wind will submit PSO resumes for NMFS' review and approval at least 60 days prior to commencement of in-water construction activities requiring PSOs and PAM operators.
    - Resume's will include information related to their proposed role (i.e., PSO, Lead PSO, PAM operator, or Lead PAM operator) relevant education, experience, and training, including dates, duration, location and description of prior PSO or PAM operator experience. Resumes will also be accompanied by relevant documentation of successful completion of necessary training.
- Revolution Wind will submit NMFS previously approved PSOs and PAM operators to NMFS OPR for review and confirmation of their approval for specific roles at least 30 days prior to commencement of pile driving activities or 15 days prior to when new PSOs/PAM operators are required after activities have commenced;
- For every shift, three visual PSOs per vessel will maintain active watch. On each vessel, at least one of the PSOs on active watch will be an unconditional (experienced) PSO. There will be one PAM operator monitoring the four acoustic data streams from the PAM buoys on duty actively monitoring for protected species during foundation installation.
- Following established BOEM and NMFS standards, the PSO/PAM team(s) will work in designated shifts during protected species monitoring. For PSOs, shifts will be set up such that no individual will work more than 4 consecutive hours without a 2-hour break, or longer than 12 hours during any 24-hour period. The Project will provide each PSO with one 8-hour break per 24-hour period to sleep. An example rotation is provided in Figure 4. Actual rotations will be vessel-specific, and implemented rotations will be documented with the Project's final PSO report. New or inexperienced PSOs will be paired with an experienced PSO qualified to mentor new PSOs so that the quality of marine mammal observations and data recording is kept consistent.
- PAM monitoring rotations on the installation vessel will comprise a single PAM operator on active duty for 4 hours.

- One Experienced PSO per shift will be designated as the In-Charge PSO on each of the PSO vessels. The In-Charge PSO will be responsible for the rest of the PSO team on the vessel and will lead any communications across Project vessels.
- One of the In-Charge PSOs on the installation vessel will also act as the Lead PSO for the project and fulfill the responsibilities outlined above in Section 3.2.2. The Lead PSO will communicate with each of the PSO vessels and will report directly to onshore project managers. The Lead PSO will be responsible for calling shutdowns or delays to impact pile driving activity and determining if visibility is adequate to commence or resume pile driving following a delay or shutdown. When the Lead PSO is off shift, the other In-Charge PSO on the installation vessel will assume these aspects of the Lead PSO role.
- PSO crew on the installation vessel and secondary PSO vessels will be required to be on 4-week rotations. The crew rotation will be staggered per week for each individual Project vessel. Each vessel is estimated to return to port on approximately 2-week rotations. The subcontractor anticipates staggered crew changes to ensure continuity of crews on board. Crew changes on the installation vessel will be conducted via helicopter transfers between pile installations.

An indicative crew rotation for the installation vessel and additional PSO vessel(s), including shift lengths is shown in Figure 4.

Figure 4. Indicative PSO and PAM Operator schedule onboard the installation vessel.

Day/Night Period	Start Time	End Time	In-Charge PSO (Lead)	In-Charge PSO	PSO	PSO	PSO	PSO	PAM	PAM
Day (based on example civil sunrise of 04:34 local time)	04:00	05:00	Visual		Visual	Visual			PAM	
	05:00	06:00	Visual		Visual	Visual			PAM	
	06:00	07:00	Visual		Visual	Visual			PAM	
	07:00	08:00	Visual		Visual	Visual			PAM	
	08:00	09:00		Visual			Visual	Visual		PAM
	09:00	10:00		Visual			Visual	Visual		PAM
	10:00	11:00		Visual			Visual	Visual		PAM
	11:00	12:00		Visual			Visual	Visual		PAM
	12:00	13:00	Visual		Visual	Visual			PAM	
	13:00	14:00	Visual		Visual	Visual			PAM	
	14:00	15:00	Visual		Visual	Visual			PAM	
	15:00	16:00	Visual		Visual	Visual			PAM	
	16:00	17:00		Visual			Visual	Visual		PAM
	17:00	18:00		Visual			Visual	Visual		PAM
	18:00	19:00	Visual		Visual	Visual			PAM	
	19:00	20:00	Visual		Visual	Visual			PAM	
	20:00	21:00		Visual			Visual	Visual		PAM
Night (based on example civil sunset of 20:54 local time)	21:00	22:00		Visual			Visual	Visual		PAM
	22:00	23:00		Visual			Visual	Visual		PAM
	23:00	00:00		Visual			Visual	Visual		PAM
	00:00	01:00								
	01:00	02:00								
	02:00	03:00								
	03:00	04:00								

3.3 Overall Monitoring Strategy

Visual and acoustic monitoring of the clearance and shutdown zones will be conducted by 3rd party PSOs and PAM operators who will be located on the installation vessel as well as two additional PSO vessels. A team of 6 qualified PSOs and 2 PAM operators will be on the installation vessel so that 3 PSOs and one PAM operator can be on duty during all daylight hours. A team of 6 PSOs will be on board the PSO vessels so that 3 PSOs can be on duty during all daylight hours. The number of PSOs per vessel may be reduced while still providing a sufficient number of PSOs per vessel such that three may be on duty during the required periods and with sufficient breaks as described in the ITR § 217.275 (c)(2). A detailed description of the PAM to be conducted to monitor and mitigate for marine mammals is presented in the separate *Pile Driving Passive Acoustic Monitoring Plan*.

The two dedicated PSO vessels will each travel back and forth along a half-circle path around the installation vessel at or near the minimum visibility distance of 2,300 m (4,400 m in winter[6]) during installation of WTG MPs and 1,600 m (2,700 m in winter) for OSS installation. This will ensure complete coverage of all 360° around the pile being installed. Each vessel will travel at a speed of 7–10 knots during clearance, piling, and post-monitoring. This PSO vessel monitoring pattern allows for the PSOs onboard each vessel to more consistently track protected species sightings within their sector and reduces potential double counting of the same animals being sighted by multiple vessels. When available, other vessels with PSOs and acoustic monitoring personnel will assist with visual monitoring. In these cases, the circle will be split into as many sectors as there are vessels conducting monitoring and each vessel will travel back and forth along the portion of the circular path in its sector at the relevant minimum visibility distance.

PSOs on the installation vessel will use mounted high magnification (25x) binoculars, standard handheld (7x50) reticule binoculars, and the unaided eye to continuously search for protected species within all relevant clearance and shutdown zones. At least two PSOs on the installation vessel will be equipped with Big Eye binoculars (e.g., 25 x 150; 2.7 view angle; individual ocular focus; height control), which will be pedestal mounted on the deck at the best vantage point. The three PSOs stationed on the PSO vessels will each be responsible for monitoring a 120-degree sector of the field of view (FOV) with unaided eye and reticle binoculars (and big eyes periodically) which will provide additional coverage inside the clearance zone towards the installation vessel as well as beyond the clearance zone away from the pile. The efficacy and effectiveness of monitoring methods described in this section will continue to be evaluated during and between seasons to ensure appropriate monitoring methods are used. PSOs will use the described monitoring equipment to confirm the relevant clearance and shutdown zones are clear of marine mammals and not impacted by fog or humidity. If a protected species is sighted during daylight conditions, the on-duty PSOs will radio the detection and location/bearing of the individual to all Project vessels to ensure awareness of the protected species. The individual that sighted the protected species will maintain visual contact with the species until they lose visibility, during which one of the other on-duty PSOs will record the sighting in Mysticetus, while the third on-duty PSO visually covers the remaining

[6] No impact pile driving is planned for the months of December through April; however, installation in December may only occur, upon NMFS approval, in the case of unexpected delays. If Revolution Wind requests NMFS approval for WTG MP installation in December due to unexpected delays, Revolution Wind will provide an amended PDMP that covers winter pile driving, including further detail surrounding the PSO vessel configuration to monitor the 4,400 m clearance/shutdown zone.

120-degree sector of the FOV. Photographs and follow-up notes will be downloaded using Mysticetus once visual detection has ceased or at the end of day reporting.

If mitigation zones are expanded due to regulatory requirements outlined in Section 3 of the approved *Sound Field Verification Plan* the distance at which the PSO vessels circle or the pattern that they travel around the pile being installed may be adjusted based on the size of the modified zones. This framework of vessel activity is the basis of the monitoring plan; however, positioning of vessels is dynamic based on the measured zone sizes, therefore, a single, static, solution is not provided here as such a solution is impracticable and does not serve the purpose of establishing the best monitoring protocols possible. Rather, in the case of modified zone sizes, all vessel positions and activities would be designed in consultation with field PSOs and the agencies to develop the most comprehensive visual monitoring protocols.

In addition to the dedicated PSO vessels (PSO vessel #1 and PSO vessel #2), PSO vessel #3, and PSO vessel #4 will be used for supporting monitoring operations by deploying PAM and SFV equipment in the field. Two deployment/acoustic specialists and six PSOs (three on watch) will be on each of these vessels for the duration of all pilling. When not actively deploying or retrieving acoustic equipment, these two PSO vessels are expected to be available to conduct visual PSO observations and increase awareness of marine mammals near the pile driving site; however, one of the two PSO vessels may be required for port calls/crew changes or other duties at which time they would not be conducting PSO monitoring. Additionally, if zones are modified based on SFV results and the resulting monitoring plan stipulates additional PSO vessels are necessary to clear the mitigation zones, these additional vessels would be available to become fully dedicated to PSO surveys during clearance, piling, or post-pilling periods and would not be removed for any other duties during those times. All PAM and SFV deployment and associated pre- and post- watches for the Project will be conducted outside of pile driving activities allowing PSOs to fulfill the required duties on the PSO vessel without any deployment interruptions. Other than the four vessels described within this section, no additional vessels will have the capabilities or resources for mitigation and/or deployment requirements. Table 9 provides a summary of equipment and personnel that will be deployed for all piling operations. Figure 5 shows indicative positions of the PSO and PAM vessels relative to the installation vessel as well as relevant monitoring and shutdown zones for summer foundation installation. Based on the acoustic modeling results, relevant monitoring and shutdown zones will be larger during winter foundation installation (not depicted within Figure 5).

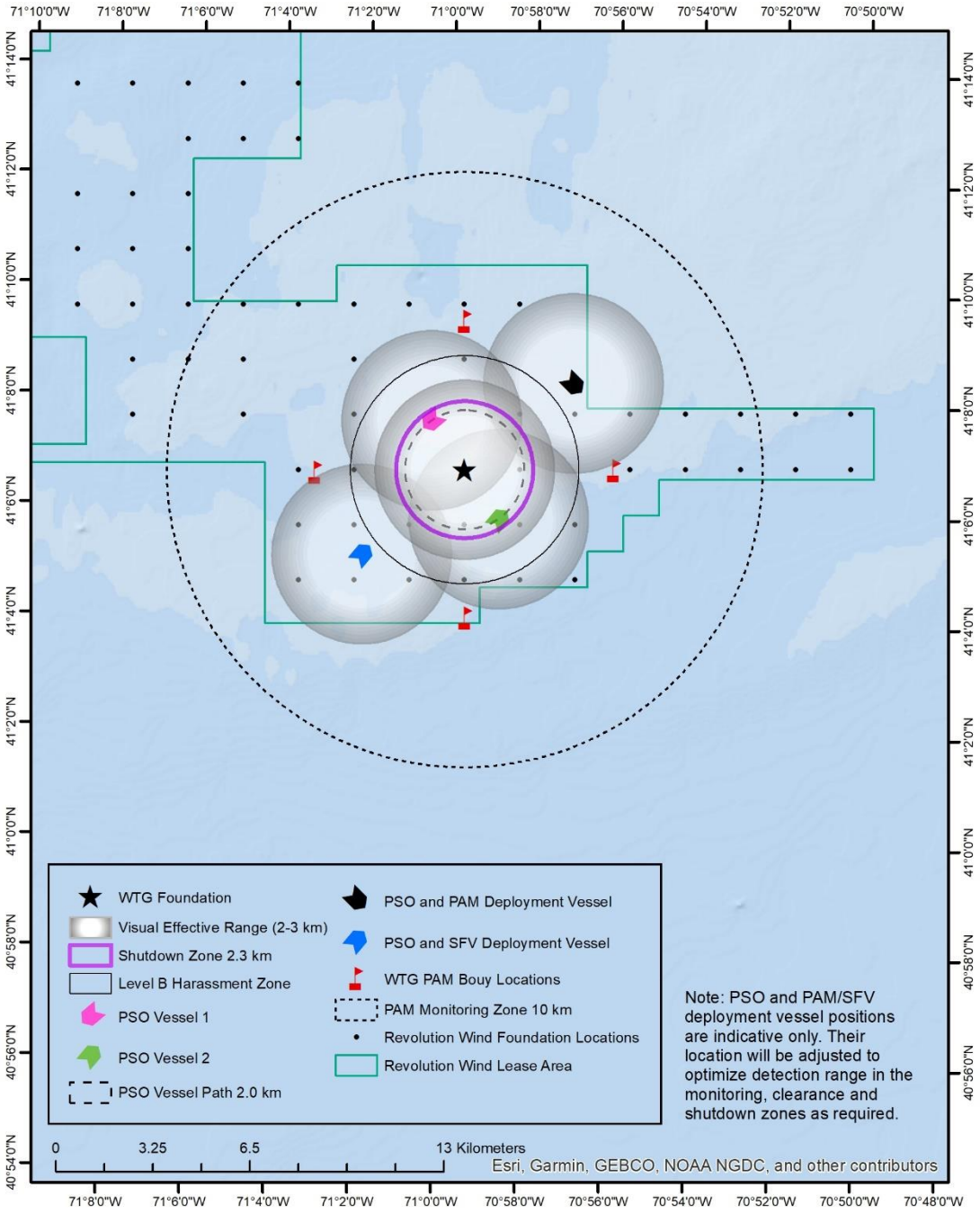


Figure 5. Indicative locations of personnel and equipment during each pile driving event occurring in summer.

Table 9. PSO personnel and equipment on installation and monitoring vessels

Vessel Name		**Installation Vessel**	**PSO Vessel #1**	**PSO Vessel #2**	**PSO Vessel #3**	**PSO Vessel #4**
Vessel Role		**Pile Driving**	**PSO Monitoring**	**PSO Monitoring**	**PSO + PAM Deployment**	**PSO + SFV Deployment**
Personnel						
Visual PSOs		6	6	6	6	6
# PSOs on active watch		3	3	3	3	3
PAM Operators		2	0	0	0	0
# PAM operators on duty[1]		1	0	0	0	0
Acoustic Reporting Scientist		0	0	0	0	1
Deployment/Acoustic support Personnel on Duty		0	0	0	2	2
Equipment	**Model**					
Binoculars (7x – 10x)	Varied	2	2	2	2	2
Binoculars (reticle)	Varied	2	2	2	2	2
Big Eye Binoculars	Fujinon 25 x 150 MT-SX	2	2	2	2	2
Digital cameras[3]	single-lens reflex camera equipped with 300-mm lens	2	2	2	2	2
PSO dedicated VHF Radios	Varied	3	3	3	3	3
Mounted Thermal/IR Camera System	Current Scientific (Cooled – NN 3050; Uncooled – NN 3025	2 (1 – cooled and 1 – uncooled)	1 – uncooled	1 – uncooled	1 – uncooled	1 – uncooled
Night Vision Device (NVDs)	Rongland GNVY-3 Night Vision	1	1	1	1	1
Monitoring station for real-time PAM[2]	Varied	1	0	0	0	0
PAM Buoys	RSA – ORCA- 750-a1	0	0	0	4	0
PAM Hydrophone Mooring	TR-FLOAT	0	0	0	4	0
Mysticetus Data Collection System	Mysticetus	1	1	1	1	1

IR = infrared; PSO = Protected Species observer; VHF=very high frequency.
[1] PAM operator will be stationed on the installation vessel
[2] The selected PAM system will transmit real time data to PAM monitoring stations on the vessels
3 There will be two digital cameras provided on each vessel for use by the three PSOs on duty. Each PSO team will share a single digital camera. This digital camera will be located on the bridge of the vessel to ensure easy accessibility for any PSOs use. A second digital camera will be located on board as a backup (total of two digital cameras).

3.4 Visual Monitoring Distances

Visual monitoring by PSOs will be conducted from the installation vessel and two dedicated PSO vessels. Daytime visual monitoring is defined by the period between nautical twilight rise and set for the region. The PSOs will conduct the visual monitoring from the bridge and bridge-wings located at a height of 6.2 m above the sea level (ASL) on the secondary PSO vessel(s) and at a height of 25.83 m on the installation vessel (Table 10). They will monitor with the unaided eye, 7 x 50 magnification reticle binoculars, and a set of 25x magnification 'Bigeye' binoculars (one on the port and one of the starboard bridgewings, on each vessel). PSO's eye height will be recorded on each vessel and input into the recording template prior to observations so more accurate height can be used during operations.

The longest distance able to be observed by PSOs, which is the distance to the horizon, can be calculated using the following equation: $3.6\sqrt{h}$, where "h" is eye height ASL. To calculate the minimum distance to the horizon observable by a PSOs based on this equation, the minimum eye height of a PSO can be used. Assuming the deck of the vessel is 4.47 m above sea level and the minimum eye height of a PSO is 1.53 m (5 ft), then the minimum eye heigh ASL would be 6 m. Using the equation above, the minimum distance to the horizon visible by PSOs would be approximately 8.8 km (Table 10). The calculated visibility ranges for representative vessels are shown below in Table 10.

While the detection of large whales at or near the calculated visibility ranges (8–10 km) is possible, it is less likely for single individuals or small groups compared to larger groups, especially if larger groups are engaged in certain behaviors such as feeding or social activity. Depending on the environmental conditions and available detection cues of marine mammals, PSOs on a vessel have an effective range of 2–3 km, meaning they can reliably detect individual large whales and/or small groups within that distance. This means that PSOs on the piling vessel could observe the summer minimum visibility distance (~2,300 m) without additional support. However, to increase the probability of detecting whales within and beyond the 2–3 km effective range from the piling vessel, two dedicated PSO vessels will circle the installation vessel as described in section 3.3, providing additional coverage within the minimum visibility zone and effective coverage out to a distance of 4 – 6 km.

PSOs will routinely use available targets of known distances, primarily other project vessels, to quantify the distances at which they can reliably monitor for marine mammals and sea turtles. Each of the two dedicated PSO monitoring vessels will be located 2,300 meters from the BL2 at the edge of the 2.3-kilometer Minimum Visibility Zone. Three-person PSO team teams aboard each monitoring vessel and the BL2 will work collaboratively to monitor the entirety of the Minimum Visibility Zone and adjacent waters beyond this zone. Other project vessels in the area will serve as additional reference points for PSOs to confirm effective monitoring distances and distances to potential sightings. If PSO teams conclude the entirety of the Minimum Visibility Zone cannot be reliably monitored - a determination will be made by the BL2 PSO and informed by targets at known distances in which case pile driving will be delayed or shut down.

Table 10. PSO eye height above sea level in meters (m) for each vessel and the distance to horizon in kilometers (km), assuming average PSO eye height is 1.53 m

	Installation Vessel	PSO Vessel #1	PSO Vesel #2	PSO Vessel #3	PSO Vessel #4
	Pile Driving	PSO Monitoring	PSO Monitoring	PSO + PAM Deployment	PSO + SFV Deployment
Average PSO eye height	1.53	1.53	1.53	1.53	1.53
Eye Height Above Sea Level (unaided eye, 7-10 x magnification binoculars, 25 x magnification binoculars)	25.83	6	5.65	5.78	7.63
Therman cameras	27.3	8.3	8.7	8.33	10.31
Visible distance to horizon (km)	18.3	8.8	8.6	8.7	9.9

Using the below formula, and currently known obstructions aboard vessels, we have estimated the available FOV as a percentage of a full 360° FOV, for each item of visual monitoring equipment on the installation vessel (Table 11) and other PSO vessels (Table 12).

(1) ((360° − °obscured) / 360°) x 100% = Available FOV (%)

Table 11. Available FOV by each PSO and/or visual monitoring equipment on the installation vessel.

	PSO (handheld binoculars)	25 x magnification binoculars – port	25 x magnification binoculars – starboard	NN3025 Thermal Cameras – Helideck	NN3050 Thermal Cameras – Boom-rest
Installation Vessel	79.17%	62.50%	49.44%	50.00%	37.50%

Note: Fields of view takes into account vessel-based obstructions at the anticipated position of equipment use. However, through collective monitoring across the piling and PSO vessels, the full 100% FOV will be achieved.

Table 12. Available FOV by each PSO and/or visual monitoring equipment location on the PSO vessels.

	PSO Vessel #1	*PSO Vessel #2*	*PSO Vessel #3*	*PSO Vessel #4*
PSO (handheld binoculars)	75%	75%	66.67%	79.17%
25 x magnification binoculars	59.72%	65.28%	62.50%	74.44%
NN3025 Thermal Camera	70.83%	50.56%	66.67%	76.39%

Note: Fields of view takes into account vessel-based obstructions at the anticipated position of equipment use. However, through collective monitoring across the piling and PSO vessels, the full 100% FOV will be achieved.

3.5 Mitigation and Monitoring Measures

The monitoring and mitigation protocols that will be followed during daylight conditions are indicated below.

3.5.1 General Measures

1) A minimum of three PSOs on each PSO vessel will simultaneously monitor the relevant clearance/shutdown zones using standard handheld binoculars (7x), high magnification (25x) binoculars, and the unaided eye to search continuously for protected species.
2) PSOs stationed on the dedicated PSO vessel(s) will ensure the outer portion of the clearance/shutdown zones are visually monitored.
3) PSOs on all vessels will immediately communicate sightings within or near the clearance/shutdown zones to PSOs aboard the installation vessel so that appropriate mitigation measures can be implemented.
    a) PSOs and PAM operators will record all detections of marine mammals and sea turtles from periods of active watch, regardless of distance from the pile site or pile driving activity status.
    b) All PSO and PAM detection data will be shared across PSO teams in real time to inform situational awareness and assessment of potential mitigation.

3.5.2 Clearance Protocols

1) Visual and acoustic monitoring will begin at least 60 minutes prior to the start of pile driving activity.
2) PSOs will visually clear (i.e., confirm no observations of marine mammals) the entire minimum visibility zone (as shown in Table 4 through Table 8) for a full 30 minutes immediately prior to commencing foundation installation activities.
3) In recognition of brief periods of reduced visibility, the Lead PSO will determine sufficient visibility conditions through communication between Project vessels. The configuration of PSOs and vessels will ensure that the area out to the relevant minimum visibility distance is visually monitored during the required monitoring periods; this includes the area comprising the sea turtle clearance/shutdown zone of 200 m (As per BiOp Table 3.12).
4) If PSOs cannot visually monitor the minimum visibility zone prior to impact pile driving, pile driving operations will not commence or will be shutdown if they are currently active.
    a) If the minimum visibility zone cannot be adequately monitored due to reduced visibility during daylight, see section 3.6 for appropriate measures.
5) Monitoring and mitigation during nighttime pile driving will be required as described within the *Nighttime Monitoring Plan for Pile Driving*, if approved.
6) If nighttime pile driving is not approved, pile driving will not be initiated earlier than 1 hour after civil sunrise or 1.5 hours prior to civil sunset. Additionally, pile driving may continue after dark only when the minimum visibility zone for impact pile driving is fully visible and if stopping operations represents a risk to human health, safety, and/or pile stability.
    a) If these circumstances arise, PSOs will utilize alternative technology (i.e., IR and/or Thermal camera) to monitor the clearance and shutdown zones (as shown above in measure 3) as approved by NMFS if impact pile driving continues past civil sunset.
7) The Lead PSO will receive confirmation from the DP/WM that the bubble curtain is fully operational and configured correctly.
8) If a marine mammal or sea turtle is observed within the applicable clearance zone during the clearance period, impact pile driving will be delayed until the animal(s) has voluntarily left the specific clearance zone and has been visually or acoustically confirmed beyond that clearance zone,

or when specific time period has elapsed with no further sightings: 15 minutes for odontocetes (excluding sperm whales) and pinnipeds, and 30 minutes for sperm and baleen whales (including the NARW) and sea turtles.

a) Sea turtles observed within a clearance zone will be allowed to remain in the clearance zone (i.e., must leave on their own volition), and their behavior will be monitored and documented.

b) In cases where these criteria are not met, pile driving may restart only if necessary to maintain pile stability at which time Revolution Wind will use the lowest hammer energy practicable to maintain stability.

9) In the event that any large whale is sighted or acoustically detected at any distance that cannot be confirmed as a non-NARW, it will be treated as if it were a NARW for purposes of mitigation.

a) For NARW/unidentified large whale, any visual observation by PSOs at any distance or acoustic detection within the PAM clearance/shutdown zone for NARWs (10 km) will trigger a delay to the commencement of pile driving. The clearance zone will only be declared clear if no NARW visual detections at any distance or acoustic detections within the PAM clearance/shutdown zone for NARWs have occurred during the 60-minute clearance zone monitoring period of which 30 consecutive minutes will be determined to be clear of marine mammals directly prior to commencing these activities.

10) If a marine mammal vocalization is detected on multiple PAM buoys during pile driving and the detection is able to be localized, the appropriate mitigation will be called for:

a) Immediate shutdown and/or delay to pile driving commencement for any confirmed NARW/unidentified large whale localized at any distance within the 10 km PAM clearance/shutdown zone for NARW.

b) Immediate shutdown and/or delay to pile driving commencement for any confirmed non-NARW large whale localized within the 2,300 m [4,400 m in December] clearance/shutdown zone.

c) Continued pile driving if the vocalization is localized within the NAS perimeter and identified to be a delphinid species.

d) Continued pile driving if a NARW/unidentified large whale is localized **outside** the 10 km NARW PAM clearance/shutdown zone (accounting for +/- error, assuming position closest to the pile once error is considered) or if an identified non-NARW call is localized **outside** the 2,300 m (4,400 m in winter) non-NARW large whale clearance/shutdown zone.

11) If a marine mammal is detected on a single PAM buoy and therefore unable to be localized, immediate delay/shutdown of piling will be called for until the animal is able to be localized.

12) If impact pile driving is delayed due to the presence of a NARW/unidentified large whale, impact pile driving will not begin until the NARW/unidentified large whale has neither been visually or acoustically detected for 30 minutes.

3.5.3 Soft-start Protocols

1) Soft start of pile driving will not begin until the clearance zone has been determined free of marine mammals, as determined by the Lead PSO, by the visual PSOs and PAM operators.

2) Soft start is required at the start of all pile driving events and at any time following cessation of piling for 30 minutes or longer.

3) The pile driving soft-start will involve 4–6 strikes per minute at 10–20 percent of the maximum hammer energy, for a minimum of 20 minutes.
4) If a marine mammal or sea turtle is observed within or about to enter the applicable clearance zone during the soft start period, impact pile driving will be stopped until the animal has been visually observed exiting the clearance zone or until a specific time period has elapsed with no further sightings: 15 minutes for odontocetes (excluding sperm whales) and pinnipeds, and 30 minutes for sperm and baleen whales (including the NARW) and sea turtles.

3.5.4 Shutdown Protocols

1) If a marine mammal or sea turtle is detected (visually or acoustically) entering or within the applicable shutdown zone after pile driving has begun, the PSO or PAM operator will call for a shutdown of pile driving and the vessel operator will stop pile driving immediately, unless shutdown is not practicable due to imminent risk of injury or loss of life to an individual or risk of damage to a vessel that creates risk of injury or loss of life for individuals, or the DP/WM determines there is risk of pile refusal or instability.
2) The hammer energy selected to drive the pile will be the minimum hammer energy (no greater than the maximum 4,000 kJ hammer energy) necessary to effectively and safely install and achieve the necessary penetration progress. The most efficient driving energy may not be equal to the minimum effective energy needed to drive the pile with correct penetration progress. The difference between most efficient and minimum effective energy may be small; however, a difference would be recordable in the hammer logs. Therefore, if a shutdown is called for and the pile is not stable enough for a shutdown; mitigation will be requested and, if technically feasible, a lower hammer energy (i.e., change from most efficient to minimum effective) or reduced strike rate, if practicable, would be implemented.
    a) If pile driving is not shutdown when a marine mammal has been detected within the applicable shutdown zone, the hammer energy will be reduced to the lowest level practicable and the reason(s) for not shutting down will be document and reported to NMFS-OPR in the applicable monitoring reports (e.g., weekly, monthly) as described below in Section 5.7 and 5.13.
3) Bubble curtain and AdBm compressor sensor monitoring will take place throughout the piling process. If bubble curtain sensors indicate that pressure or flow rates have changed and are not sufficient to maintain the 10 dB attenuation levels, the DP/WM will be notified and a shutdown in piling operations will be implemented, if it is safe to do so (see above). Similarly, the compressor equipped with the AdBm system provides a continuous air flow rate of 5.5 m3/minute at the nozzle outlets on the hose in the bottom frame to ensure the pockets in the AdBm resonator are always sufficiently filled with air. If the sensor indicates that pressure or flow rates have changed and are not sufficient to maintain the 10 dB attenuation levels, the DP/WM will be notified and a shutdown in piling operations will be implemented if safe to do so. Pile driving will not restart until the bubble curtain and/or the AdBm NAS or its compressor(s) are repaired and full functionality verified.
    a) Bubble curtain performance will be monitored by confirming that the compressors are delivering the minimum required air flow rate of 0.5 m3/(min*m) at the compressors outlet. With this minimum air flow rate, the bubble curtain's noise attenuation capability of 10 dB will be achievable. This flow rate will be logged and included within a DBBC daily report.
4) After a shutdown, impact pile driving may restart when:

b) The animal (other than a NARW) has been observed voluntarily departing and outside the relevant clearance zone, or

c) There have been no visual or acoustic detections for 15 minutes for odontocetes (excluding sperm whales) and pinnipeds, and 30 minutes for sperm and baleen whales (including the NARW), and sea turtles.

5) If pile driving is shut down for less than 30 minutes and all visual and acoustic monitoring has been maintained continuously throughout the shut down period, pile driving may begin immediately without clearance watch and soft start procedures.
6) If pile driving is shut down for a period longer than 30 minutes, all clearance and soft start procedures will be followed.
7) Any disagreements between the Lead PSO, PAM operator, and the activity operator regarding delays or shutdowns will only be discussed after the mitigative actions (as described above) have occurred.

3.5.5 Pauses and Silent Periods

1) The visual clearance and shutdown zones will be continuously monitored by PSOs and PAM during any pauses in pile driving.
2) If an animal is sighted within the applicable visual clearance zone or a NARW is detected on any PAM buoy during a pause in piling, activities will be delayed until the animal(s) has moved outside the clearance zone and no animals have been detected within their respective clearance zones for a period of 15 minutes for odontocetes (excluding sperm whales) and pinnipeds and 30 minutes for sperm and baleen whales (including NARW), and sea turtles.

3.5.6 Post-Piling Monitoring

1) PSOs will continue to monitor using visual and acoustic protocols throughout the pile installation and for a minimum of 30 minutes after piling has been completed.

3.6 Reduced Visibility Monitoring Plan

Pile driving will not be initiated at any time when the minimum visibility zone is not fully visible (e.g., due to darkness, rain, fog etc.) and therefore, all foundation pile driving is planned to occur during daytime periods. As per ITR 217.274(c)(3) and LOA condition 3(c)(i), initiation of pile driving will occur no earlier than one hour after civil sunrise and no later than 1.5 hours before civil sunset. This Reduced Visibility Monitoring Plan is not intended to be used when the minimum visibility zone cannot be collectively cleared by PSOs for at least 30 minutes immediately prior to piling (e.g., at night). As per COP condition 5.10.2, if daylight is insufficient, the Lead PSO will call for a delay in pile driving until the relevant minimum visibility distance can be monitored in all directions.

This Reduced Visibility Monitoring Plan will be used to monitor the relevant shutdown zone(s) in cases where piling has begun during suitable daytime visual conditions, soft start has been completed, but then visibility conditions become reduced to less than the minimum visibility distance and stopping operations represents a risk to human health, safety, and/or pile stability. Under such circumstances, all visual monitoring protocols described in Section 3.5 and PAM monitoring as described in the PAM Plan will be implemented with the additional utilization of alternative monitoring technology (e.g., infrared cameras [IR]) to effectively and reliably monitor for marine mammals and sea turtles (described in the following paragraphs). A map showing the large whale (non-NARW) shutdown zone as well as the PSO

vessel path and visual monitoring coverage at a representative WTG location in summer is shown in Figure 6. The shutdown zone distance for an OSS MP foundation installation in the summer is 1.6 km (Table 6). Therefore, the same approach depicted in Figure 6 for WTG foundations will be used for OSS MP foundation installation during periods of reduced visibility. Recording of marine mammal sightings and notifications to other PSOs during reduced visibility conditions will occur in the same manner as described for daytime periods in Section 3.9. Any detections within or near the shutdown zone will be communicated directly to the on-duty PSOs on the piling vessel (through radio, mobile phone via Whatsapp, computer, or other immediate communication method) so that any necessary mitigation actions can be implemented in a timely manner.

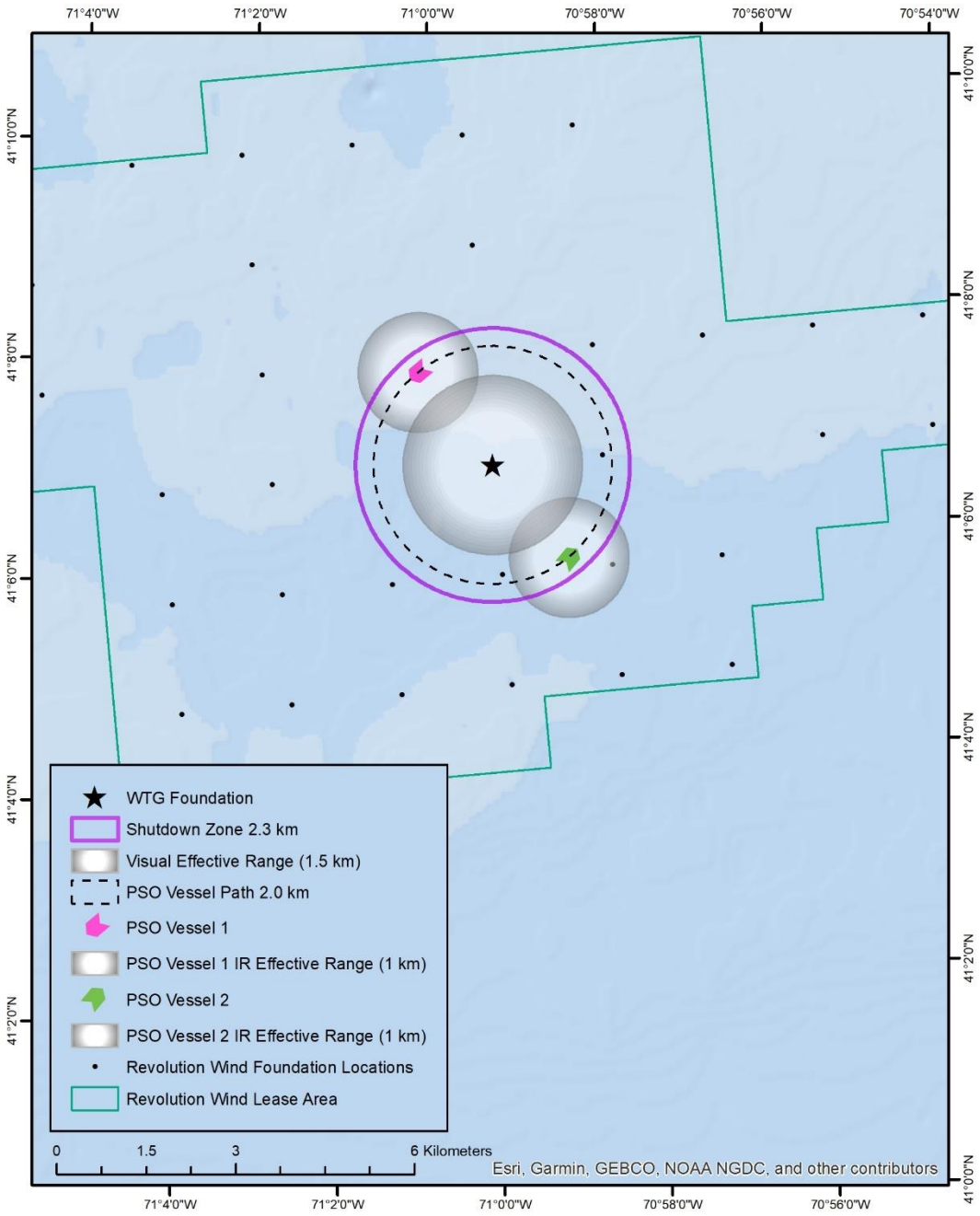


Figure 6. Map showing the shutdown zone at a representative WTG foundation location in summer, including the PSO vessel path and visual effective ranges.

During daylight pile driving operations, there will be a minimum of one vessel-mounted thermal camera on every vessel, supplied by Current Corporation. Two cameras will be outfitted on the installation vessel, a Current NN3050 cooled system, with 100% redundancy and a Current NN3025 uncooled system. All other PSO vessels will have a single Current NN3025 uncooled mounted system. The technical specifications of the cameras are provided in Table 13. Additional estimates on the available FOV as a percentage of a full 360° FOV for the IR cameras on the installation vessel and other PSO vessels are provided in Table 11 and Table 12 respectively. Both types of cameras were tested in the field

during two separate trials in 2022. The field study results from ThayerMayhan (2023) present effective ranges for two camera systems included in shoreside testing where cameras were mounted 11 m above sea level (ASL) and for offshore testing from a vessel where the three IR cameras were mounted 13-14 m ASL. The results of these tests showed the thermal IR cameras to be capable of effective detection of large whale blows out to distances of 1–2 km at night in good visibility conditions (little to no fog, Beaufort Sea state less than 4) (ThayerMahan 2023). Based on comments received from agencies regarding the results in ThayerMahan (2023), the effectiveness of the IR systems were accepted to be 1 km for uncooled cameras and 1.5 km for cooled cameras. The two dedicated PSO vessels will each travel back and forth along a half-circle path around the installation vessel at a distance of 2 km from the WTG foundation (as shown in Figure 6). This will ensure complete coverage of all 360° around the pile being installed. The cooled camera system located on the installation vessel will be able to detect out to 1.5 km towards the 2.3 km minimum visibility zone, while the uncooled camera system located on the PSO monitoring vessels will be able to detect 1 km both towards the WTG foundation being installed and outwards towards the 2.3 km minimum visibility zone. Therefore, through the combined use of the cooled and uncooled camera system located on the installation and PSO monitoring vessels respectively, effective monitoring of the entire minimum visibility zone for summer piling installation (2.3 km) will be achieved. Therefore, Revolution Wind expects coverage beyond the indicated 180° coverage for each of the two cameras given the overlap between the two IR cameras on the installation vessel as well as the NN3025 onboard the PSO monitoring vessels. As described in section 3.3, no impact pile driving is planned for the month of December through April, however, installation in December may only occur upon NMFS approval, in the case of unexpected delays. If Revolution Wind requests NMFS approval for WTG MP installation in December due to unexpected delays, Revolution Wind will provide an amended PDMP that covers winter pile driving, including further detail surrounding the PSO vessel configuration to monitor the 4,400 m clearance/shutdown zone. Thermal IR cameras are not expected to be as effective in detecting whale blows at the same distances during moderate to dense fog or in high sea states. Therefore, the first priority during periods of moderate to dense fog or in high sea states will be to implement a shutdown of pile driving activities. However, in rare cases where pile driving must continue during reduced visibility conditions the Lead PSO on duty will determine whether or not the amount of fog or elevated sea states is affecting their ability to detect whale blows using the IR cameras. Should this determination be made, the Lead PSO will then decide which method (unaided eye or IR) provides the most effective observations under the current conditions and PSOs will use that method during continued periods of observation. The most effective monitoring method will continue to be evaluated as visibility conditions change.

Table 13. Specifications of the Current Corporation, Inc. thermal cameras.

Key factors	NN3025	NN3050 (Bokalift 2 only)
Type of sensor	LWIR Uncooled Thermal Imager	Cooled Mid Wave Infrared (MWIR), 3-5µm
Sensor Resolution	1920x 1080 HD	640x512 pixels, 30fps
Wavelength	8-14µm	3-5µm
Optics Field of View (FOV)	25° (wide) to 6° (narrow)	28° (wide) to 2° (narrow)
Zoom	30x optical zoom	30x optical zoom
360° visual scan	Yes	Yes
Testing standard	(Military standard) MIL-STD 810 & MIL-STD-461	(Military standard) MIL-STD 810 & MIL-STD-461
Stabilization	3 axis gyro stabilization² c./w. enhanced video stabilization	3 axis gyro stabilization² c./w. enhanced video stabilization

Each PSO vessel will have a minimum of one NN3025 vessel mounted thermal camera, which will be monitored by a PSO if piling activity occurs during daylight periods of reduced visibility. The NN3025 thermal camera will be mounted at approximately 14 m ASL on PSO vessels. The installation vessel will have two thermal cameras installed. One on the base of the helideck (NN3025) and one on the Boom-rest platform overlooking the pile installation (NN3050). The cooled camera installed on the boom rest will be installed on the piling side of the vessel, with the least number of obstructions covering the largest FOV with higher specification. Both thermal cameras will be mounted at a height of approximately 27 m. The helideck mounted camera will cover the area over the bow of the vessel and will be used primarily for vessel strike avoidance whenever the vessel is in transit, while the cooled camera on the Boom-rest will be the primary camera used to cover piling operations.

The standard monitoring procedure for the cameras on the installation vessel will be for the cooled camera to be monitored by one PSO while the other two PSOs continue monitoring from the bridge wings. One of the bridge wing PSOs will use NVDs (or the unaided eye, as appropriate based on the amount of vessel lighting present) to monitor primarily for sea turtles since they are less likely to be detected by the IR camera while the other PSO will monitor using the unaided eye. Given the mounted position and expected use of the uncooled camera (vessel strike avoidance), it was determined that the PSO's FOV on the bridge wings resulted in more effective monitoring during piling operations than the FOV afforded by the uncooled camera. However, when the Lead PSO determines that the bridge wing observers are no longer effective, one bridge wing PSO will move to the uncooled thermal camera while the other continues to monitor for sea turtles using whichever monitoring method is determined to be the most effective under the current conditions.

The standard monitoring procedure for the uncooled camera on the PSO monitoring vessels will be for two PSOs to monitor from the bridge wings, one of which will use NVDs (or the unaided eye, as appropriate based on the amount of vessel lighting present) to monitor primarily for sea turtles and the other will monitor using the unaided eye. The third PSO will monitor the uncooled IR camera. If the Lead PSO determines that the bridge wing observers are no longer effective due to reduced visibility conditions, one PSO will continue monitoring for sea turtles using whichever monitoring method they determine to be most effective under the current conditions, while the other PSO assists in monitoring and/or data entry for the PSO monitoring the uncooled camera system.

While using a combination of one cooled (NN3050) and one uncooled (NN3025) IR camera on the installation vessel and a single uncooled IR camera on the PSO monitoring vessels, the PSO monitoring each camera will manually control the pan rate such that it moves steadily back and forth across the 180° sector at a slow enough rate to avoid blurring the image. As described above, Revolution Wind expects coverage beyond the indicated 180° for each of the two cameras given the overlap between the two IR cameras as well as the NN3025 onboard the PSO monitoring vessels. This overlap will provide coverage of the 2.3 km clearance zone as described above. Additionally, the three PSOs stationed on the PSO vessels will each be responsible for monitoring a 120-degree sector of the FOV with unaided eye and reticle binoculars (and big eyes periodically) which will provide additional coverage inside the clearance zone towards the installation vessel as well as beyond the clearance zone away from the pile.

The pan rate of the IR cameras (both NN3025 and NN305) is designed at 30f panning speed to avoid motion blur (Table 13). The FOV for the NN2025 25° (wide) to 6° (narrow) and 63° to 2.3° for the NN3050 thermal camera (Table 13). The NN3025 uncooled camera will have a sensor resolution of 1920x 1080 HD while the NN3050 cooled camera will have a sensor resolution of 640x512 pixels (Table 13). Current Corporation IR camera data is collected in combination with H.264 Codec image compression software. This is a low-loss-high-resolution data compression package that supports real-time auto detection of whale blows and manual monitoring of camera imagery by PSOs viewing a large HD monitor. Motion blur will be continually assessed by PSOs throughout periods of monitoring and the pan rate will be adjusted as necessary to maximize coverage based on environmental conditions at that time, location of additional PSO monitoring effort on other vessels, and any ongoing protected species detection events. Additionally, both camera systems (NN3025 and NN3050) include a mechanical stabilizing mechanism (Gyro stabilization) which increases the reliability of the footage in offshore conditions when movement is inevitable (helping to reduce motion blur).

If a potential detection is made the PSO will stop panning and, if possible, zoom in on the potential detection to improve detection and classification of the object. If the object is determined to be a protected species, the ranging tool in the camera display will be used to determine the distance to the animal(s) and whether they are inside or outside of the relevant mitigation zone. The PSO will then follow the same data recording and sighting communications protocols for daytime monitoring described in sections 3.8 and 3.9. If the object is determined not to be a protected species, then the PSO will return the camera to the systematic panning method previously described. The planned IR cameras do not include automated detection software for highlighting potential objects of interest to PSOs so they will continuously monitor the video feed from their camera while on duty, except for brief periods of time required to record effort and sighting data. If a PAM localization is made, PSOs conducting IR monitoring will use *Mysticetus* to determine in which sector the protected species may be located. The PSO responsible for monitoring that sector will focus their monitoring in the area indicated by the PAM localization. As the vessel continues the circular path around the installation site and the sector where the PAM localization was made the PSO will pass responsibility for monitoring in the area of the PAM localization to the next PSO responsible for that area.

For each detection made, Revolution Wind will document the range to target, FOV, mounting height, environmental conditions including BSS, and degree of fog/humidity/inclement weather. Revolution Wind will use all available data to summarize the distances of detections made using the IR cameras and, to the extent feasible based on the available sample size, will produce a detection function. The summary and analysis will be provided to NMFS within the annual report.

3.7 Nighttime Monitoring Plan for Pile Driving

In accordance with a NMFS-approved *Nighttime Monitoring Plan for Pile Driving*, Revolution Wind may initiate impact pile driving later than 1.5 hours prior to civil sunset through 1 hour after civil sunrise between June 1 to October 31, annually. As per BiOp T&C 10(d), the *Nighttime Monitoring Plan for Pile Driving*, submitted to NMFS, reliably demonstrates the efficacy of the nighttime monitoring equipment at detecting marine mammals and sea turtles in the relevant clearance and shutdown zones under all various conditions anticipated during construction including varying weather conditions, sea states, and in the consideration of the use of artificial lighting. As per COP condition 5.4.9, the *Nighttime Monitoring Plan for Pile Driving* will include a full description of the proposed technology, monitoring methodology, and data demonstrating that marine mammals and sea turtles can reliably and effectively be detected within the clearance and shutdown zones for MPs before, during, and after impact pile driving at night. Further details regarding the measures to be implemented during pile driving intentionally initiated during periods of darkness can be found in the *Nighttime Monitoring Plan for Pile Driving* submitted to the agencies in January 2024.

3.8 Data Collection

3.8.1 Visual PSOs

3.8.1.1 Monitoring Effort, Sightings, and Operations

For all visual monitoring efforts and protected species sightings, the following information will be collected by PSOs. A sequential identification number (ID) unique to each vessel will be assigned to each new marine mammal sighting with multiple sightings of the same animal or group given the same ID. The following information will be collected for each sighting as soon as possible:

- Date and time the monitored activity begins or ends;
- Construction activities occurring during each observation period;
- Watch status (i.e., sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
- PSO who sighted the animal (last, first) and number of PSOs on watch;
- Date and Time of start and end of sighting (YYYY-MM-DD, hh:mm:ss (UTC)) and duration of observation;
- Weather parameters (e.g., wind speed (knots), wind direction, percent loud cover, visibility (km), precipitation, glare);
- Water conditions (Beaufort Sea state, tidal state including swell height (m), swell height (meters), water depth (m))
- Identification of the animal(s) with degree of certainty (i.e., genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species;
- Pace of the animal(s);
- Estimated number of animals (minimum/maximum/high/low/best);
- Estimated number of animals by cohort (e.g., adults, yearlings, juveniles, calves, group composition);
- Description (i.e., as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);

- Whether or not there was a corresponding PAM detection
- Description of behavior (e.g., such as feeding or traveling), including an assessment of behavioral responses thought to have resulted from the activity (e.g., no response or changes in behavioral state such as ceasing feeding, changing direction, or breaching). If bow-riding, record duration;
- Animal's closest distance (reticle distance in meters) from the pile being driven and estimated time spent (time entering and leaving (UTC HH:MM) and seconds duration) within the potential injury zone, or behavioral harassment zone, and/or shutdown zone (specify radius in m) as well as closest distance from observation vessel if different (reticle distance in meters) and times when these closest approaches occurred (UTC HH:MM);
- Distance (meters) and bearing (relative to ship heading or "clock face") to each animal observed and the animal's direction of travel (relative to vessel as well as initial and final heading in degrees);
- Construction activity at time of sighting (i.e., impact pile driving), use of any NAS, and specific phase of activity (e.g., soft start, active pile driving, etc.). If observed during soft start, record first, closest and last distance as well as behavior at final detection;
- Description of any mitigation-related actions implemented, or mitigation-relation actions called for but not implemented, in response to the sighting (e.g., delay, shutdown, etc.) and time and location of the action;
- Location of observer (latitude and longitude in decimal degrees) and compass heading of vessel (degrees);
- Animal occurrence within Level A harassment or Level B harassment zones;
- Other human activity in the area;
- Other applicable information as required in the ITR.

3.8.1.2 NARW Observations (visual and acoustic)

If a NARW is observed at any time, the following information will be recorded (in addition to the information described in section 3.8.1.1) and the sighting will be reported immediately as described in Section 5.4:

- Time (UTC, EST), date (MM/DD/YYY), and location (latitude/longitude in decimal degrees, coordinate system used) of the observation;
- number of whales;
- animal description/certainty of observation (provide photos/video if taken);
- Lease Area/project name;
- PSO/personnel name who made the observation;
- PSO provider company (if applicable); and;
- Reporter's contact information;
- Confirmation the sighting was reported to the respective hotline;
- The vessel/platform from which the sighting was made;
- Activity the vessel/platform was engaged in at time of sighting;
- Project construction and/or survey activity at the time of sighting;
- Distance from vessel/platform to sighting at time of detection;
- Closest point of approach of whale to vessel/platform;
- Vessel speed; and,
- Any mitigation actions taken in response to the sighting.

3.8.1.3 Large Whale Detection during Vessel Transit

If an observation of a large whale occurs during vessel transit, Revolution Wind will collect and report the time, date, and location of the sighting through the WhaleAlert app as described in Section 5.3.

3.8.1.4 Injured or Dead Protected Species

In the event that personnel involved in the Project discover a stranded, entangled, injured, or dead protected species, Revolution Wind will collect the following data and report the sighting as described in Section 5.5:

- Contact (name, phone number, etc.);
- Time, date, and location (latitude/longitude in decimal degrees) of the first discovery (updated location information if known and applicable);
- Species identification (if known) or description of the animal(s) involved;
- Condition of the animal(s) (including carcass condition if the animal is dead);
- Observed behavior of the animal(s), if alive;
- If available, photographs or video footage of the animal(s); and,
- General circumstances under which the animal was discovered.

In the event that a protected species is injured or killed as a result of Project activities, Revolution Wind will collect the following information and report the even as described in Section 5.5:

- Time, date, and location (latitude/longitude in decimal degrees) of the incident;
- Species identification (if known) or description of the animal(s) involved;
- Vessel size and motor configuration (inboard, outboard, jet propulsion);
- Vessel's speed leading up to and during the incident;
- Vessel's course/heading and what operations were being conducted (if applicable);
- Status of all sound sources in use (if applicable);
- Description of avoidance measures/requirements that were in place at the time of the incident and what additional measures were taken, if any, to avoid the incident;
- Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the incident;
- Estimate size and length of the animal that was injured or killed;
- Description of the behavior of the animal immediately preceding and following the strike;
- Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and,
- To the extent practicable, photographs or video footage of the animal(s).

3.8.1.5 Data Collection Software

Mysticetus software will be used by all PSO and PAM Operators aboard Project vessels to collect and share operational, monitoring effort, and species detection data. In addition to the data summarized above, the following project information will be captured in Mysticetus:

- Project Name;
- Lease number;
- State coastal zones;
- PSO contractors;
- Vessel Names;

- Reporting dates (YYYY-MM-DD);
- Visual monitoring equipment used (e.g., bionics, magnification, IR cameras etc.);
- Distance finding method used;
- PSO names (Last, First) and training;
- Observation height above sea surface (m).

The following operational information will also be captured in Mysticetus:

- Date (YYYY-MM-DD);
- Hammer type used (make and model);
- Greatest hammer power used for each pile (kJ);
- Pile identified and pile number for the day (e.g., pile 2 and 3 for the day);
- Pile diameters (m);
- Pile length (m);
- Pile locations (latitude and longitude);
- Number of vessel transits;
- Types of vessels used;
- Vessel routes used.

The following monitoring effort information will also be captured in Mysticetus:

- Date (YYYY-MM-DD);
- Noise source (ON = Hammer on; OFF = Hammer off);
- PSO name(s) (Last, first);
- If visual, how many PSOs on watch at one time;
- Time pre-clearance visual monitoring began and ended (UTC, HH:MM);
- Duration of pre-clearance PAM and visual monitoring (MM:SS);
- Time power-up/ramp-up began and reached full power or ended (UTC, HH:MM);
- Duration of power-up/ramp-up (MM:SS);
- Time pile driving began (hammer on) and ended (hammer off) (UTC, HH:MM);
- Duration of hammer activity (MM:SS).

3.9 PSO Communication Plan

Communications are of upmost importance when conducting multi-vessel operations and monitoring. As such, Revolution Wind will ensure communication channels between the PSOs, the DP/WM, and vessel masters on all applicable vessels are established and maintained prior to and during all vessel movements and pile driving events. Communication and decision tree flowcharts are provided

below for specific protected species observations from any project vessels (

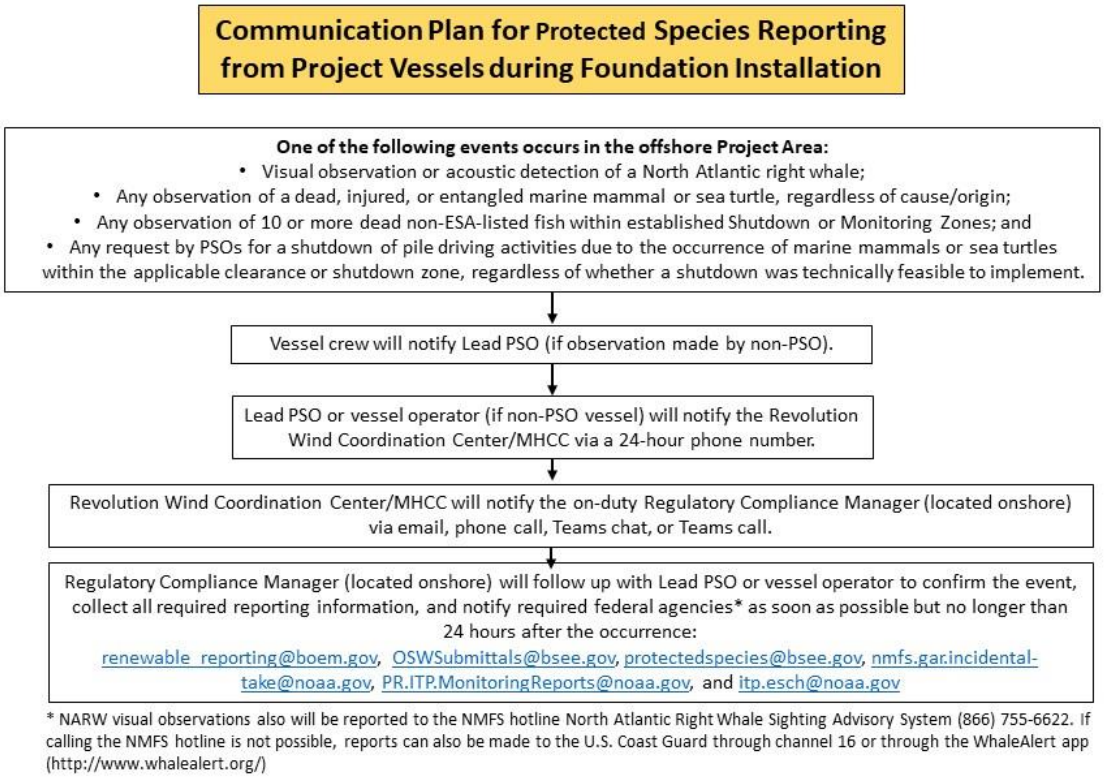


Figure 7), pile driving clearance (Figure 8), and during pile driving (Figure 9).

In-charge PSOs will communicate with the Lead PSO who will act as the main point of contact for the DP/WM, who will be situated on the Bridge of the installation vessel. The Lead PSO will be on the same vessel with the DP/WM and will have direct contact with the DP/WP throughout the piling process. All project personnel (e.g., PSOs, vessel captains, DP/WM) will have radios and will use a dedicated channel outside the standard marine communications channels. As back up, PSOs will use vessel radios, instant messaging, Teams App, and/or cell phones. Additionally, all detections will be reported on Mysticetus and all PSO and non-PSO vessel with displays will receive the location of each detection. All PSO alerts, including visual and acoustic detections, will be transmitted via the radio channel for situational awareness and preparation for any mitigation activities.

For detections that trigger mitigation actions, only the Lead PSO will recommend to the DP/WM what mitigation action should be taken. The DP/WM will be responsible for deciding if a shutdown or delay in operations is safe and technically feasible. All PSOs/PAM Operators will communicate directly with their individual in-charge PSOs who will relay to the Lead PSO for discussion with the DP/WM, with the exception of requesting a delay or shutdown of operations, which goes directly to the Lead PSO and subsequently to the DP/WM. The DP/WM will verbally confirm and authorize the shutdown or delay and the Lead PSO will record the interaction.

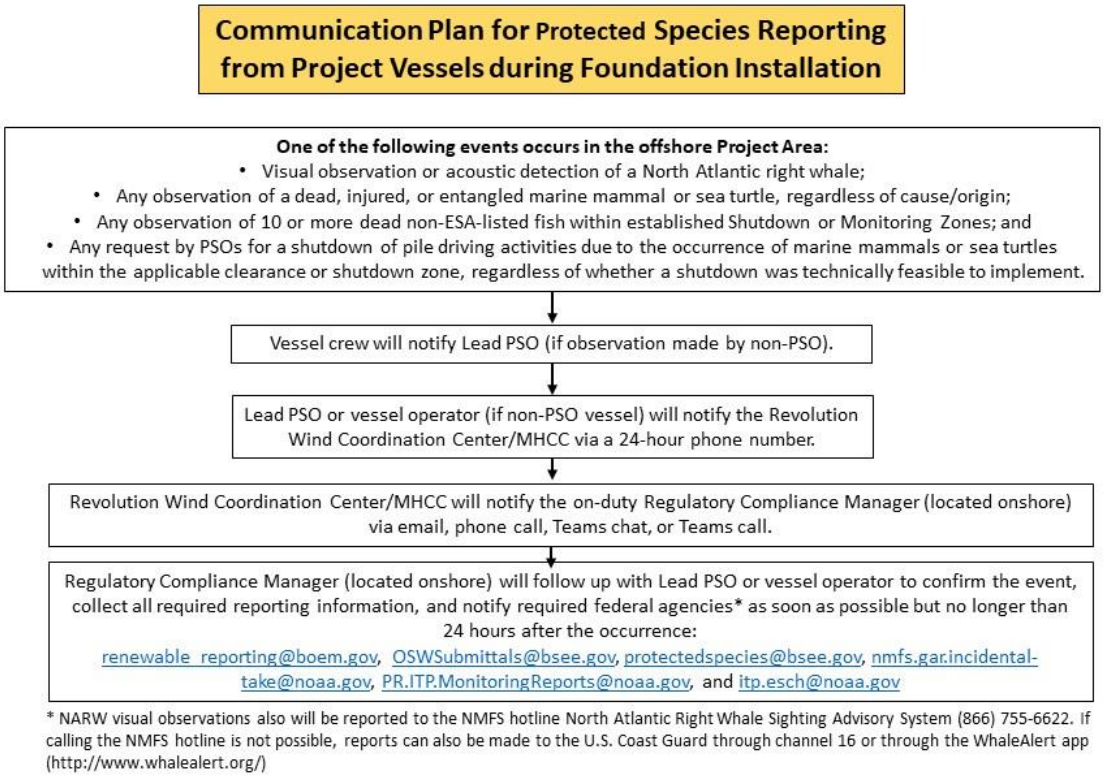


Figure 7. Communication flowchart for detection of certain protected species and mitigation events from Project vessels.

In the event that a shutdown is called for, the DP/WM will consult the Boskalis Offshore Construction Manager who must evaluate the penetration depth of the pile in relation to the known soil data and the pile's hammer/progress logs to determine pile stability and shutdown/reduction feasibility. If a mitigation action requested by the Lead PSO is not implemented due to safety or other allowable circumstances or a reduction in hammer energy is implemented, the general information will be relayed from the DP/WM to the Lead PSO who will note the information in their report. A separate report will be produced by the DP/WM and offshore construction staff detailing the reasoning behind the inability to shutdown.

In the event that a reduced hammer energy is called for, the DP/WM will consult the Boskalis Offshore Construction Manager who must evaluate the penetration depth of the pile in relation to the known soil data and the pile's hammer/progress logs to determine pile stability and shutdown/reduction feasibility. If a mitigation action requested by the Lead PSO is not implemented due to safety or other allowable circumstances or a reduction in hammer energy is implemented, the general information will be relayed from the DP/WM to the Lead PSO who will note the information in their report. A separate report will be produced by the DP/WM and offshore construction staff detailing the reasoning behind the inability to reduce hammer energy.

Each PSO vessel will be outfitted with Starlink broadband internet with dedicated networks for the PSOs/PAM operators and acoustic reporters to provide reports efficiently. Additionally, each vessel will be provided a dedicated PSO laptop with access to a shared mailbox and Microsoft Teams channel. The PSOs and PAM operators will also be provided a VHF radio and mobile phone for onshore and offshore connections should the internet go down. All sightings and mitigation data will be input into Mysticetus by dedicated watch, PSOs and PAM Operators on all Project vessels. The PAM buoys will be on their own network to a monitoring station and will use the Rajant system[7] to communicate with the base station; therefore, they will not be reliant on any offshore internet availability.

[7] The Rajant system has a tested range out to 8 km; therefore, the system will not have any issues maintaining a stable connection out to the Project's 5 km distance from shore.

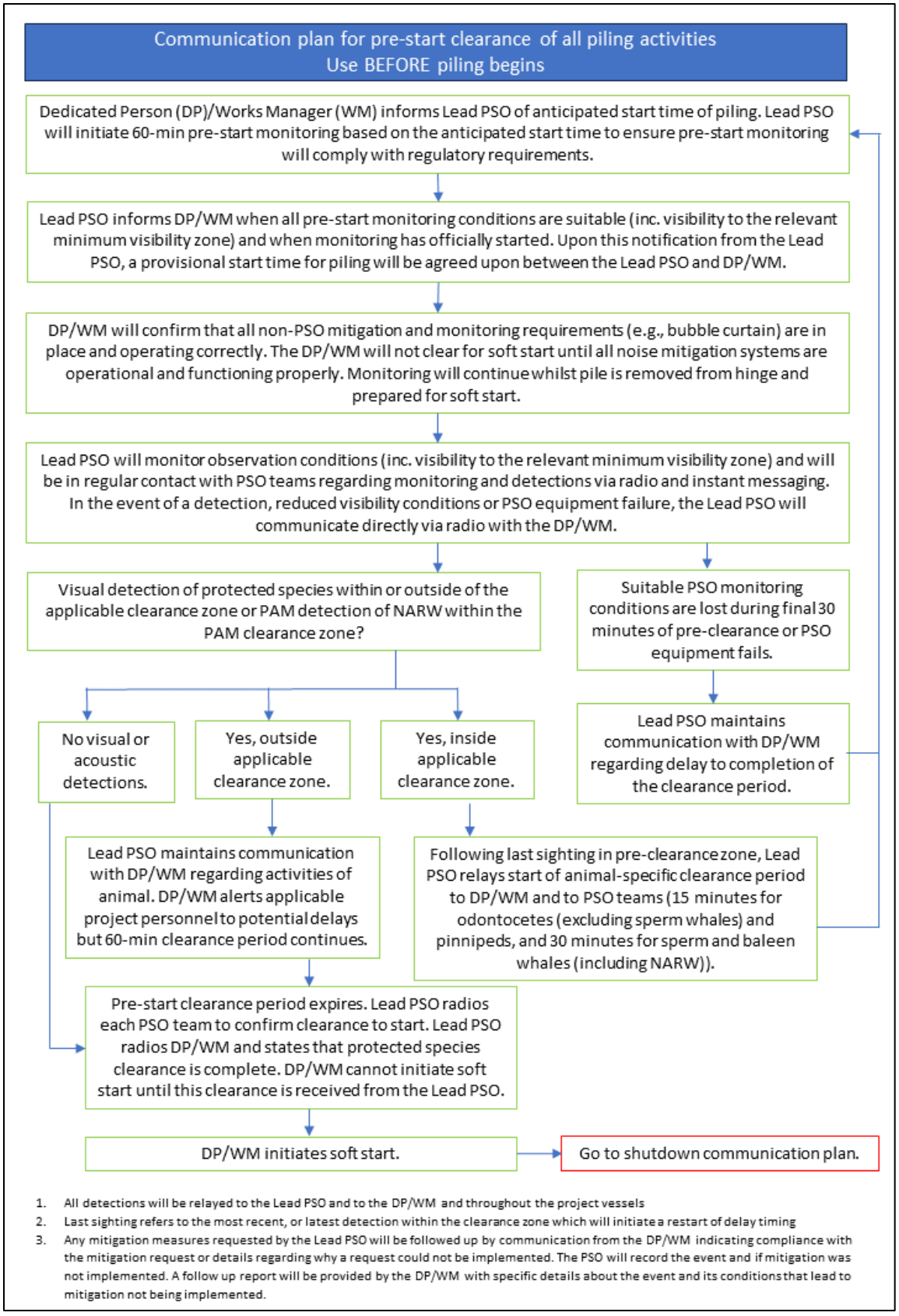
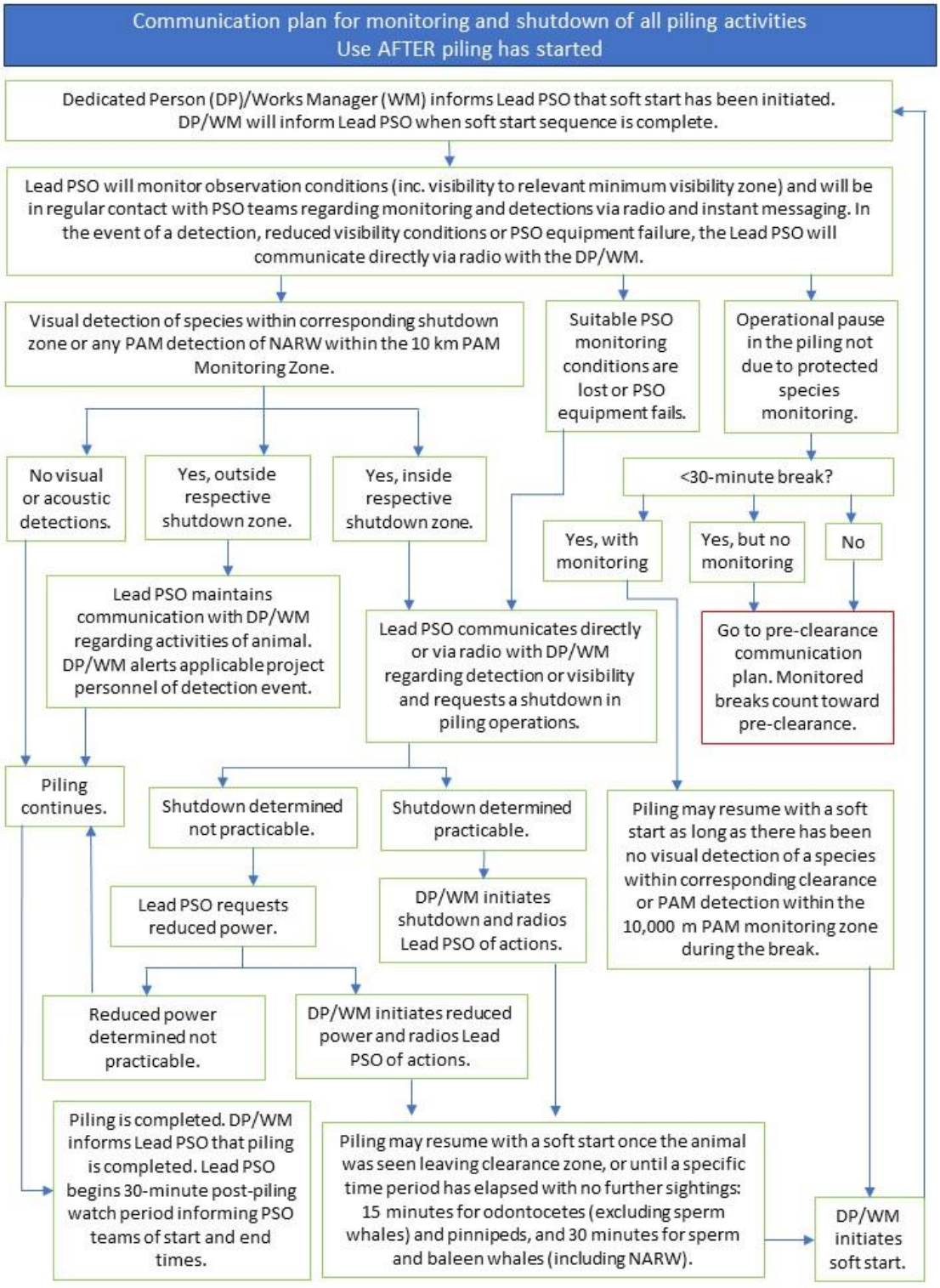


Figure 8. Clearance communication flowchart and decision tree.



1. All detections will be relayed to the Lead PSO and to the DP/WM and throughout the project vessels
2. Any mitigation measures requested by the Lead PSO will be followed up by communication from the DP/WM indicating compliance with the mitigation request or details regarding why a request could not be implemented. The PSO will record the event if mitigation was not implemented. A follow up report will be provided by the DP/WM with specific details about the event and its conditions that lead to mitigation not being implemented.

Figure 9. Communication flowchart and decision tree during pile driving

4 Noise Abatement System (NAS)

As per LOA condition 3(c)(8), Revolution Wind will deploy at least two fully functional, uncompromised NAS that reduce noise levels to the modeled harassment isopleths, assuming 10 dB attenuation during all impact pile driving activities. A DBBC and AdBm, together will be employed during each piling event. The hoses will be flushed out prior to informing the BL2 that the DBBC are operational. Once the MP has been upended and placed on the seabed, the AdBm "curtain" is suspended under water around the MP and remains in place throughout the entire piling event.

The DBBC consists of 2 big bubble curtains (BBCs) comprising nozzle hoses with lengths of:

- BBC 1: 377 m (Inner ring) set at 57 m from the pile, and
- BBC 2: 628 m (Outer ring) set at 103 m from the pile.

The inner and outer BBCs will be deployed as a set on every installation location by the NHDV per MP location and will be supplied with compressed air to maintain a 2-layer bubble curtain around the MP. The DBBC will be pre-installed before MP installation and during piling, the DBBC will be pressurized from the vessel at a level designed to reduce, to the maximum extent practicable, hammering noise that propagates through the water column. The Free Air Delivery (FAD) supplied on the DBBC during pilling operations is greater than 0.5 m^3/(min x m). Therefore, the total air supplied to the DBBC would be greater than 510 m^3/min.

Seven compressors on board the noise mitigation vessel will be used to pressurize the combined DBBC. There will be two spare compressors on board the NAS vessel. There will also be two separate compressors, one operational and one back up, on board the installation vessel that will be used to "fill" the AdBm NAS component. The AdBm system is equipped with an electric compressor that will be installed on the deck of the BL2 which will have the air supply controlled by the depth of the AdBm system bottom frame. From the bottom frame, the air will travel vertically through the AdBm system to fill up the cups of the resonators. The air in the resonators will then compress during the descent of the AdBm system to the operational depth due to increased hydrostatic pressure. A big bubble curtain is often described as 'far-field NAS' in the context of offshore impact pile driving and not necessarily from a strict acoustic propagation standpoint. The reason is it is placed at a distance from the source (foundation) that is often considered 'far field' in acoustics terminology. As stated in https://www.itap.de/media/experience_report_underwater_era-report.pdf page 30: 'The boundary between near and far field for underwater noise (hydro sound) is not exactly defined, but depends on the wavelength λ. In airborne sound, a value of ≥ 2λ is assumed. For underwater noise, values of up to ≥ 5λ can be found.' The AdBm (Helmholtz resonator) will be the near-field portion of the NAS and given that this device is typically deployed within 10 m of the pile, may be considered a near-field system, although, as noted in the far field discussion, it not an exact definition. In accordance with ITR § 217.274 (c)(8)(v), construction contractors will train personnel to collect relevant data regarding the operation or maintenance of the deployed NAS (e.g., proper balancing of airflow to the bubble curtain ring, deployment accuracy of hose nozzles, maintenance record, etc.). Such data will be recorded by the Chief engineer on board the NAS deployment vessel. The Chief Engineer for the NAS will provide the works manager with verbal confirmation that the NAS is correctly operational so that the PSOs can begin watch. The reported data will be submitted to the works manager and the Lead PSO. The NAS report will be included in the daily construction report and will be included in the daily PSO reports. A full description

of the NAS deployment, including equipment configurations that ensure connection to the seafloor, is provided in the Far Field Noise Mitigation Manual (Appendix A).

In accordance with ITR § 217.274 (c)(8)(v), the construction contractor will use a highly experienced NAS contractor with personnel who have deployed and managed NAS(s) on similar projects; all personnel from the NAS contractor will receive Revolution Wind Environmental Awareness Training as required. The construction contractor will submit an inspection/performance report for approval by Revolution Wind within 72 hours following an initial performance test conducted shortly after the NAS is fully operational and has been operating for at least 10 minutes; and any corrections to the NAS to meet the performance standards will occur prior to pile driving. The initial performance test will be performed once, at the start of the offshore campaign at field. Subsequently, prior to each DBBC deployment at the foundation location, the DBBC spread will be inspected. The bubble curtain sensors will indicate if there are any problems with the bubble curtain deployment. Revolution Wind will provide NMFS-OPR with a bubble curtain performance test and maintenance report to review within 72 hours after each pile using a bubble curtain is installed. Additionally, a full maintenance check (e.g., manually clearing holes) will occur prior to each pile being installed. Any corrections to the bubble ring(s) to meet the performance standards as described in ITR § 217.274 (c)(8)(ii) through (v) and LOA condition 3(c)(8)(vi) will occur prior to impact pile driving of MPs. Any repairs or alterations will be included in the daily report and sent to NMFS-OPR, NMFS GARFO – PRD, BOEM and BSEE as described in Section 5.10. Prior to DBBC operations at each location a number of quality checks will be performed to verify operational performance. This includes installation positions, air supply and pressure checks, and flushing out hoses. Additional details surrounding steps taken to ensure the DBBCs are operating at peak efficiency for each use are provided in Appendix A.

If any of the SFV measurements indicate distances to the isopleths corresponding to potential auditory injury and/or behavioral harassment thresholds are greater than the distances predicted by the modeling assuming 10 dB attenuation, Revolution Wind will notify NMFS GARFO Protected Resources Division (NMFS GARFO – PRD), NMFS Office of Protected Resources (OPR), Bureau of Ocean and Energy Management (BOEM), and Bureau of Safety and Environmental Enforcement (BSEE) through TIMSWeb and at protectedspecies@bsee.gov via email. In this same email, Revolution Wind will communicate and confirm the noise mitigation adjustments that will be employed for installation of the next pile prior to beginning installation to ensure future piles do not exceed modeled distances to thresholds (assuming 10 dB attenuation). Additional measures may include improving the efficacy of the implemented noise attenuation technology through inspection and amendment of the DBBC layout, inspection of the nozzle hose and redrilling if needed, adjustment/increase of the air supply to the DBBC/ adjustment of air supply to the AdBm “filling small curtain” and/or modifying the piling schedule to reduce the sound source.

5 Reporting

Revolution Wind will use a standardized reporting system during the effective period of the Letter of Authorization (LOA). All data will be recorded using industry-standard software that is installed on field laptops and/or tablets (see Section 3.8). All reporting will comply with COP approval, ITR, and BiOp conditions. Revolution Wind has the responsibility to meet all permit conditions. Contractor responsibilities are contractual commitments to Revolution Wind that will allow compliance with permit

conditions. Measures related to specific reporting circumstances are outlined in the following sub-sections below.

5.1 Training

5.1.1 Revolution Wind Responsibilities

- Prior to initiation of foundation installation, Revolution Wind will demonstrate in a report submitted to NMFS-OPR (its.esch@noaa.gov) that all required training for Revolution Wind personnel (including vessel crew, vessel captains, PSOs, and PAM operators) has been completed ((ITR § 217.275 (g)(1) and LOA condition 4(g)(1)).

5.1.2 Contractor Responsibilities

- The contractor will provide documentation of all personal training conducted by the contractor within 24 hours of training completion (Excel, word, or PDF format).
- Training certificates for the PSO and PAM personnel will be provided at least 90 days prior to the start of foundation installation activity.
- Contractors will provide copies of PSO training documents to NMFS-OPR upon request.

5.2 Vessel Strike Reporting

Required reporting protocols surrounding vessel strike can be found within the stand-alone *Vessel Strike Avoidance Plan* submitted to NMFS-OPR for review on September 27, 2023.

5.3 Large Whale during Vessel Transit Reporting

If a large whale is observed during vessel transit, the following reporting actions will be taken as described in LOA condition 4(g)(13)(iii).

5.3.1 Revolution Wind Responsibilities

If a large whale is observed during vessel transit, the following actions will be taken:

- Revolution Wind will report the time, date, and location of the sighting through the WhaleAlert app (www.whalealert.gorg/) within 24 hours.

5.4 North Atlantic Right Whale Reporting

If a NARW is visually or acoustically detected by the PSOs or PAM operator on watch, the following reporting actions will be taken as described within in ITR § 217.275, LOA condition (I)(13)(i through ii), and BiOp terms and condition 8(b).

5.4.1 Revolution Wind Responsibilities

If a NARW is observed with no visible injuries or entanglement or is acoustically detected at any time by PSOs, PAM operators or project personnel, the observation will be reported immediately (if not feasible, as soon as possible) and no longer than 24 hours after the initial sighting or acoustic detection. The visual sighting report will include the information described in Section 3.8.1.1. Reporting protocols will include the following steps:

- Download and complete the Real-Time North Atlantic Right Whale Reporting Template spreadsheet (https://www.fisheries.noaa.gov/resource/document/template-datasheet-real-time-

north-atlantic-right-whale-acoustic-and-visual) for both visual sightings and acoustic detections. Save the spreadsheet as a .csv file and email it to NMFS NEFSC-PSD (ne.rw.survey@noaa.gov), NMFS GARFO-PRD (nmfs.gar.incidental-take@noaa.gov), and NMFS OPR (PR.ITPMonitoringReports@noaa.gov), BOEM (at renewable_reporting@BOEM.gov), BSEE (Submittal requirements to BSEE will follow reporting requirements under JOINT NTL 2023 -N01 Appendix B).

- If unable to report a sighting through the spreadsheet within 24 hours, call the relevant regional Hotline (Greater Atlantic Region [Maine through Virginia] Hotline (866-755-6622); Southeast Hotline (877-WHALE-HELP), RWSAS. PAM detections are not reported to the Hotline.
- If unable to report via the template or the Regional NMFS Hotline,, reports can be made through the WhaleAlert App (http://www.whalealert.org/). If this is not possible, reports can be made to the USCG through channel 16. The report to the USCG will include the same information as would be reported to the Hotline and described in section 3.8.1.2. PAM detections are not reported to WhaleAlert or the U.S.C.G.
- Revolution Wind will submit a summary report to NMFS-OPR (PR.ITP.MonitoringReports@noaa.gov) and NMFS-GARFO (nmfs.gar.incidental-take@noaa.gov), and NMFS Northeast Fisheries Science Center (NEFSC) (ne.rw.survey@noaa.gov) within 24 hours including the data collection details described in Section 3.8.1.2.

5.4.2 Contractor Responsibilities

- The Lead PSO will be notified of any visual or acoustic NARW detection(s);
  - Lead PSO will directly contact and notify the Revolution Wind WM (located on the same vessel as the Lead PSO) of the detection. As back up, the Lead PSO will contact the Revolution Wind WM using a vessel radio, instant messaging, and/or a cell phone.
- The sighting information will be recorded as described in Section 3.8.1.1 as well as the following information recorded in Mysticetus:
  - Date, time (in ISO8601 units)
  - location in decimal degrees;
  - recording platform; and,
  - all required data prompted by Mysticetus (as shown in Section 3.8.1.5).
- The contractor will complete monthly NARW reporting using the NMFS Excel template (https://www.ncei.noaa.gov/products/passive-acoustic-data and https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates
  - Monthly detection and reporting data for NARW on the NMFS NARW PAM reporting system website will be submitted to Revolution Wind on the 12th of each month to allow review and submittal by Revolution Wind by the 15th of each month (as required per ITR § 217.275 (g)(5)).

5.5 Injured or Dead Protected Species Reporting

5.5.1 Revolution Wind Responsibilities

- In the event that personnel involved in the Project discover a stranded, entangled, injured, or dead protected species (including a sea turtle or sturgeon), the sighting will be reported immediately to the NMFS SAS hotline (marine mammals and sea turtles only) (866-755-6622), or an alternative electronic reporting system as approved by the NMFS stranding program, as well as the U.S. Coast Guard. Staff responding to the hotline call will provide any instructions for handling or disposing of any injured or dead animals, which may include coordination of transport to shore, particularly for injured sea turtles.
    - Revolution Wind will report the incident to NMFS-OPR (PR.ITP.MonitoringReports@noaa.gov) and, if in the Greater Atlantic Region, to NMFS GARFO Protected Resource Division (NMFS GARFO – PRD) (by phone (marine mammals and sea turtles only) and email (marine mammals, sea turtle, and listed fish) (nmfs.gar.incidental-take@noaa.gov) as soon as feasible.
        - The report will include the information described in in ITR § 217.275 (g)(13)(v), LOA condition 4(g)(13)(v),BiOp T&C 8(d), and Section 3.8.1.4 of this plan.
    - BOEM (renewable_reporting@boem.gov), and BSEE (via TIMSWeb and notification email to (protectedspecies@bsee.gov)).
- If a protected species (including a sea turtle or sturgeon) is injured or killed as a result of Project activities, the vessel captain or PSO on board will immediately report the incident to NMFS-OPR and GARFO, no later than within 24 hours.
    - The report will include the information described in ITR § 217.275 (g)(13)(vi) and Section 3.8.1.4 of this plan.
    - Activity operations will cease until NMFS-OPR is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate before continuing operations.

5.5.2 Contractor responsibilities

- The Lead PSO will be notified of any injured or dead protected species;
    - Lead PSO will directly contact and notify the Revolution Wind WM (located on the same vessel) of the detection. As back up, the Lead PSO will contact the Revolution Wind WM using a vessel radio, instant messaging, and/or a cell phone.
- Contractor will submit a report (within a word document) with the information/details described in ITR § 217.275 (g)(13)(vi) and Section 3.8.1.4.

5.6 Shutdown Reporting

5.6.1 Revolution Wind Responsibilities

- Within 24 hours of detection resulting in a shutdown of piling activity, Revolution Wind will report to BOEM (renewable_reporting@boem.gov) and BSEE (Submittal requirements to BSEE will follow reporting requirements under JOINT NTL 2023-N01 Appendix B) the sighting of any marine mammal or sea turtle in the relevant shutdown zone.

- Within 48 hours of any ESA-listed species observed within the identified shutdown zone during active pile driving, Revolution Wind will report to NMFS GARFO – PRD (nmfs.gar.incidental-take@noaa.gov) and BSEE (protectedspecies@bsee.gov). The report will include the following:
    - During of pile driving prior to the detection of the animal(s);
    - Location of PSOs and any factors that impaired visibility or detection ability;
    - Time of first and last detection of the animal(s);
    - Distance of animal at first detection;
    - Closest point of approach of animal to pile;
    - Behavioral observations of the animal(s);
    - Time the PSO called for shutdown;
    - Hammer log (number of strikes, hammer energy);
    - Time the pile driving began and stopped;
    - Any measures implemented (e.g., reduced hammer energy) prior to shutdown;
    - If shutdown was determined not to be feasible, the report will include an explanation for that determination and measures that were implemented.

5.6.2 Contractor Responsibilities

- Within 12 hours of a detection resulting in a shutdown the contractor will provide the raw data collected in the field and daily report forms including:
    - Date;
    - Time (in ISO8601);
    - Species (in standard species code);
    - Pile identification number;
    - Latitude and longitude in decimal degrees;
    - Time and distance (m) of the animal when sighted;
    - Time when the shutdown or power-down occurred;
    - Behavior of the animal;
    - Direction of travel in degrees;
    - Time the animal left the shutdown zone;
    - Time the piling restarted or powered back up;
    - Any photographs.
- Data will be recorded using Excel/Mysticetus (as shown in Section3.8.1.5):/.FFT & .WAV files when protected species is acoustically detected.

5.7 Shutdown Refusal Reporting

5.7.1 Revolution Wind Responsibilities

- Revolution Wind will report any decision not to shut down pile-driving due to pile refusal to BOEM (renewable_reporting@boem.gov) and NMFS-OPR (PR.ITP.MonitoringReports@noaa.gov) within 24 hours of the decision
    - Report will include an explanation of the safety risk presented by pile refusal and the animals potentially impacted.

5.7.2 Contractor Responsibilities

- Contractors will collect hammer/piling logs, summary of PSO-engineer conversations, engineering report (if applicable), and a debrief of events; and,
- All data will be collected in Word and copies of piling logs as needed.

5.8 Detected or Impacted Dead Non-ESA Listed Fish

5.8.1 Revolution Wind Responsibilities

- An occurrence of at least 10 dead non-ESA-listed fish within any visual clearance or shutdown zone will be reported to BOEM (renewable_reporting@boem.gov) and BSEE (protectedspecies@bsee.gov) as soon as practicable (taking into account crew and vessel safety), but no later than 24 hours after the sighting. BOEM and BSEE will notify NMFS GARFO – PRD via NMFS.GAR.HESDoffshorewind@noaa.gov. Revolution Wind will confirm the relevant point of contact prior to reporting and confirm the reporting was received.

5.8.2 Contractor Responsibilities

- The contractor will provide Revolution Wind, a non-ESA listed fish impact report, within 12 hours of the occurrence. The report will identify the occurrence of 10 or more dead non-ESA listed fish species within any shutdown zone or anywhere within the areas being monitored by PSOs. All data will be recorded using Mysticetus (as shown in 3.8.1.5).
- The report will include:
    - Time of occurrence (in ISO8601 units);
    - Details surrounding the occurrence;
    - Phase of pile driving and monitoring;
    - Species or guild to the best estimate;
    - Condition and number of fish observed.

5.9 Take Threshold Reporting

5.9.1 Revolution Wind Responsibilities

- If the Project estimates that it has reached 80% of the allowable number of takes under the LOA for a given species, Revolution Wind will alert NMFS-OPR (PR.ITP.MonitoringReports@noaa.gov), BSEE (Submittal requirements to BSEE will follow reporting requirements under JOINT NTL 2023 -N01 Appendix B), and BOEM (renewable_reporting@boem.gov).

5.10 Bubble Curtain Reporting

5.10.1 Revolution Wind Responsibilities

- Construction contractors will submit a NAS inspection/performance report for approval by Revolution Wind, which Revolution Wind will then report to NMFF-OPR (PR.ITP.MonitoringReports@noaa.gov) and NMFS GARFO – PRD (nmfs.gar.incidental-take@noaa.gov) within 72 hours following the performance test, which will occur to the first pile installation as well as any additional piles for which SFV is conducted as described within the SFV Plan. This report will be submitted as soon as it is available, but no later than when the interim SFV report is submitted for the respective pile.
    - Any modifications to attenuation device to meet the performance standards will occur before impact pile driving occurs and maintenance or modifications completed will be included in the report.

5.10.2 Contractor Responsibilities

- The contractor will provide the results of a performance test within 48 hours following the test. All data will be recorded using Word and any additional necessary data files;
    - Any modifications to the attenuation device to meet the performance standards will occur before impact pile driving occurs and maintenance or modifications completed will be included in the report.
- NAS contractor will be required to provide this report.

5.11 Sound Field Verification Reporting

5.11.1 Revolution Wind Responsibilities

- Initial results of the SFV measurements for the first three MPs will be submitted to USACE (cenae-r-@usace.army.mil); NMFS-OPR (PR.ITP.MonitoringReports@noaa.gov), NMFS GARFO – PRD (nmfs.gar.incidental-take@noaa.gov), and BOEM (renewable_reporting@boem.gov), as soon as they are available and prior to a subsequent foundation installation, but not later than 48 hours after each completed foundation installation.
- The final results of SFV measurements from each foundation installation will be submitted to BOEM (renewable_reporting@boem.gov), NMFS-OPR (PR.ITP.MonitoringReports@noaa.gov) and NMFS GARFO – PRD (nmfs.gar.incidental-take@noaa.gov) as soon as possible, but no later than 90 days following completion of impact pile driving of the three or more MPs for which SFV was carried out as per BiOp T&C (e)(iii) and ITR ITR § 217.275 (g)(9).
    - Revolution Wind will use results from each interim report to develop a final report.
- See the NMFS-approved *Sound Field Verification Plan* Section 4.1 for interim and Section 4.3 for final reporting content requirements.

5.11.2 Contractor Responsibilities

- All raw data will be archived and provided to Revolution Wind and agencies at the time of final reporting;

- Submission to the National Centers for Environmental Information (NCEI) will be made as appropriate.

5.12 Weekly Reports

5.12.1 Revolution Wind Responsibilities

- Revolution Wind will compile and provide weekly PSO and PAM reports during foundation installation to NMFS-OPR (PR.ITP.monitoringreports@noaa.gov and itp.esch@noaa.gov) and NMFS GARFO – PRD (nmfs.gar.incidental-take@noaa.gov) as described in ITR § 217.275 (g)(4), BiOp T&C 6 (e), and LOA condition 4(g)(4), NMFS . Weekly reports will also be provided to BOEM (renewable_reporting@boem.gov) and BSEE (Submittal requirements to BSEE will follow reporting requirements under JOINT NTL 2023 -N01 Appendix B).
- Weekly reports will be due on Wednesday for activities occurring the previous week (Sunday – Saturday, local time)
- Once all foundation installation is completed, weekly reporting is no longer required.

5.12.2 Contractor Responsibilities

- Contractors will compile and submit weekly PSO and PAM reports to Revolution Wind documenting the information described in ITR § 217.275 (g)(4) and BiOp T&C 6 (e);
- Weekly reports are due on Wednesday for the previous week (Sunday – Saturday);
- Weekly reports will include:
    - Pile ID;
    - Type of pile;
    - Pile diameter;
    - Start and finish time of each pile driving event;
    - Hammer log (number of strikes, max hammer energy, duration of piling);
    - Any changes to NAS and/or hammer schedule;
    - The start and stop of associated observation periods by PSOs;
    - Details on the deployment of PSOs;
    - Vessel operations (including vessel name, port departures, number of vessels, type of vessel(s), and route
    - Record of all detections of marine mammals (acoustic and visual) as described in3.8.1.1;
    - Sightings during pile driving activities (clearance, active pile driving, post-pile driving);
    - Any mitigation actions (or if mitigation actions could not be taken, why that was the case);
    - Details on the NAS(s) used and their performance;
    - Any equipment shutdowns or takes that may have occurred; and,
    - Identify which turbines become operational and when (a map will be provided).
- All reports will be compiled using Mysticetus (as shown in3.8.1.5), Excel, and Word.

5.13 Monthly Reports

5.13.1 Revolution Wind Responsibilities

- Revolution Wind will compile and submit monthly reports to NMFS-OPR during foundation installation on the 15th of the month for the previous month via PR.ITP.monitoringreports@noaa.gov and itp.esch@noaa.gov. Monthly reports will also be provided to BOEM (renewable_reporting@boem.gov), BSEE (Submittal requirements to BSEE will follow reporting requirements under JOINT NTL 2023 -N01 Appendix B), and NMFS GARFO – PRD (nmfs.gar.incidental-take@noaa.gov)
    - Reports will be compiled using contract or weekly data to develop monthly reports for the agencies.
- The monthly report will include information described in described in ITR § 217.275 (g)(5) and BiOp T&C 8(g).
- Revolution Wind will also contribute all recorded sea turtle sightings, as reported, to an agency-approved centralized database in coordination with the monthly reports.

5.13.2 Contractor Responsibilities

- PSOs will collect data in accordance with standard reporting in standard forms, software tools, or electronic data forms authorized by BOEM for pile driving activity
- As described in ITR § 217.275 (g)(5) and BiOp T&C 8(d), monthly reports will include:
    - Project activities carried out in the previous month including dates and location of any fisheries surveys carried out;
    - Vessel transits (name, number of transits, type of vessel, vessel activity, Mobile Service Identity (MMSI) number, and route (this includes transits from all ports, foreign and domestic));
    - Number of piles installed and pile IDs;
    - All detections of marine mammals, sea turtles, and sturgeon as described in 3.8.1.1;
        - Species ID
        - Time
        - Date
        - Initial detection distance
        - Vessel platform/name
        - Vessel activity
        - Vessel speed
        - Bearing to animal
        - Project activity
        - If any mitigation measures take
    - Any mitigative action taken as a result of those observations; and,
    - Identify which turbines become operational and when (a map will be provided).

- PSOs will collect data in accordance with standard reporting in standard forms, software tools, or electronic data forms authorized by BOEM for pile driving activity;
- PSOs will fill out report forms for each vessel with PSOs aboard. Unfilled cells will be left empty and must not contain "NA". The reports will be compiled using Mysticetus (as shown in3.8.1.5), Excel, and Word.
- A new entry will be created on the Effort form each time a pile segment changes, or weather conditions change, and at least once an hour as a minimum. Contractors will review and revise all forms for completeness and resolve incomplete data fields before submittal.
    - The file name will follow this format: Lease#_ ProjectName_PSOData_YearMonthDay to YearMonthDay.xls.
    - Data fields will be reported in Excel format.
    - Data categories will include Project, Operations, Monitoring Effort, and Detection.
    - PSO data will be generated through software applications or otherwise recorded electronically by PSOs.
- Applications developed to record PSO data are encouraged, as long as the data fields listed below can be recorded and exported into Excel.

5.14 Final Report

5.14.1 Revolution Wind Responsibilities

- Revolution Wind will submit a draft annual report on all visual and acoustic monitoring conducted under the ITR and COP Approval no later than 90 days following the end of a given calendar year as described in ITR § 217.275 (g)(6) and LOA condition 4(g)(6).
- Revolution Wind will provide a final report within 30 days following resolution of NMFS' comments on the draft report. If no comments are received from NMFS within 30 days of NMFS' receipt of the draft report, the report will be considered final.
- All draft and final monitoring reports will be submitted to NMFS-OPR (PR.ITP.MonitoringReports@noaa.gov and itp.esch@noaa.gov), BOEM (renewable_reporting@boem.gov), and BSEE (Submittal requirements to BSEE will follow reporting requirements under JOINT NTL 2023 -N01 Appendix B) and NMFS-GARFO – PRD (nmfs.gar.incidental-take@noaa.gov)

5.14.2 Contractor Responsibilities

- The contractor will provide Revolution Wind a final report (Word format) containing all information in the Orsted Report Template within 30 days of completion of all PSO activities (described in ITR § 217.275 (g)(6)).
- The draft and final report will include:
    - The total number of marine mammals of each species/stock detected and how many were within the designated potential injury and behavioral harassment zone(s) with comparison to authorized take of marine mammals for the associated activity;
        - The number of sea turtles exposed above the 175 dB harassment threshold and the number of marine mammals exposed above the Level A and Level B harassment thresholds will be determined based on the number actually observed

within the relevant distances during pile driving. For comparison, alternative estimates of the number of individuals potentially exposed may be made based on sightings recorded during periods without pile driving and/or by using availability bias corrections available in the literature.

  - Marine mammal detections and behavioral observations before, during, and after each activity;
  - What mitigation measures were implemented (i.e., number of shutdowns or clearance zone delays etc.) or, if no mitigative actions were taken, why not;
  - Operational details;
  - Any PAM systems used;
  - Results, effectiveness, and which NAS(s) were used during relevant activities;
  - Summarized information related to situational reporting;
  - Any other important information relevant to the Project;
- All raw data will be transferred in data packages following the Orsted data submittal folder structure
  - Raw data will be submitted as appropriate to the NCEI.

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Appendix A – Far Field Noise Mitigation

Document Title: Far Field Noise Mitigation Manual – REV01	
Operator:	Ørsted Offshore Wind Power North America LLC
Project Name:	Revolution Wind 01 (REV01)
Scope:	Foundations, OSS
Contract Number:	REV01 – WK00119171
Document Type:	MA - Manual
Ørsted Document Number:	07822480
Ørsted Revision:	B
Originator:	Boskalis Offshore Contracting LLC
Contractor Document Number:	0040135-BOS-OPS-MA-0104-01
Contractor Revision:	01
PO Number:	P0040135
RDS-PP Code:	#REV01=X51VES01&CDC
Spare Parts Number:	N/A
Serial Number:	N/A

Revision Record					
Ørsted Revision	**Reasons for Issue**	**Date**	**Author**	**Checked**	**Accepted**
A	For Construction	30-10-2023	KKOT / ROSW	THNA	BALC
B	For Construction	20-12-2023	KKOT / ROSW	WIEE	BALC

Change Log		
Ørsted Revision	**Location**	**Brief description of change**
A		
B	All	Updated based on Client comments

Far Field Noise Mitigation Manual – REV01

DOCUMENT NUMBER: 0040135-BOS-OPS-MA-0104-01
PROJECT NAME: Ørsted US Projects
PROJECT NUMBER: P0040135

CLIENT NAME: Ørsted Offshore Wind Power North America LLC
CLIENT REFERENCE : 07822480

Rev.	*Stat.*	*Revision date*	*Prepared by*	*Reviewed by*	*Interdisciplinary Check*	*Approved by*
Rev. 00	IFC	20-Dec-2023	Koen van Koten / Ruben van Oorsouw Project Engineer	Ed Wiersema Lead Project Engineer	Jack Spaan Eng. Manager (BU)	Balazs Czech Package Manager
Rev. 01	IFC	20-Dec-2023	Koen van Koten / Ruben van Oorsouw Project Engineer	Ed Wiersema Lead Project Engineer	jack. spaan Digitally signed by jack.spaan DN: cn=jack.spaan, email=jack.spaan@boskalis.com Date: 2023.12.21 07:32:02 +01'00' Eng. Manager (BU)	Balazs Czech Package Manager

koen. van. koten Digitally signed by koen.van.koten DN: cn=koen.van.koten, email=koen.van.koten@boskalis.com Date: 2023.12.20 17:10:43 +01'00'

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DOCUMENT CONTROL

General document data	
Document Title:	Far Field Noise Mitigation Manual – REV01
Document Number:	0040135-BOS-OPS-MA-0104-01
Project Name:	Ørsted US Projects
Project Number:	P0040135
Client Name:	Ørsted Offshore Wind Power North America LLC
Client Reference:	07822480
Client Revision Number:	B
Boskalis Entity:	Boskalis Offshore Contracting LLC

Change log		
Revision	**Section**	**Change**
Rev. 00	All	Issued for Construction Duplicate of 0040135-BOS-OPS-MA-0103-01 Far Field Noise Mitigation Manual – SFW01 with updates to paragraph: - 2.1, 3.2, 3.3, 3.6, 3.7, 3.9, 4.2.2, 6.2, & 6.3 - 3.10 & 6.5 removed - All reference to SFW01 removed and replaced by REV01 - Included SFW - MOC-021 increase in corridor length DBBC vessel Inner- and outer hose radius changed to R 57m and R 103m
Rev. 01	All	Issued for Construction Updated based on Client comments in following paragraphs: - 2.1, 3.3.1, 3.2.2, 3.4.1, 3.5, 4.2.2, 6.2, 6.3, 7.1, 7.2 - 6.5 reinstated

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Project Description

Ørsted Wind Power North America LLC, hereafter referenced as Employer is developing the US wind farm projects South Fork Wind (SFW01) and Revolution Wind (REV01). Together these projects are referred to as the Northeast Program (NEP). The wind farms, located ~30km Southeast of Block Island:

- South Fork Offshore Wind Farm (SFW01)
  The wind farm will cover an area of approximately 69km2 and will consist of 12 turbines and 1 offshore substation (OSS). The water depths in the field location range from 33 to 40m below the Mean Lower Low Water (MLLW).
- Revolution Wind Offshore Wind Farm (REV01)
  The capacity of the wind farm will be around 715MW and will consist of 65 turbines and 2 offshore substations. The water depths in the field location range from 31 to 47m below the Mean Lower Low Water (MLLW).

Contractor scope includes the transport and installation of the Wind Turbine Generators (WTG) foundations and the Offshore Sub Station (OSS). The WTG foundations include monopile, anode cage, external platform and the internal platform. The OSS consists of a monopile foundation, anode cage, J-tube(s), boat landing, MSF and topside. Contractor's installation schedule is split between two campaigns these will run through the summer 2023 and summer 2024.

Figure 1-1 Working area

1.2 Scope of Document

The purpose of this document is to provide the instructions for the NHDV (Nozzle Hose Deployment Vessel) crew for the work to be performed during the Deployment, Operation & Retrieval of the DBBC. This manual describes the marine operations in the field and the step-by-step procedure including contingency procedures. All activities are performed by the NHDV.

The scope of this document comprises the following descriptions, including but not limited to:

- General operations in the field;
- Deployment of DBBC (Double Big Bubble Curtain);
- Operation of DBBC;
- Retrieval of DBBC;
- Contingency procedures.

The operation starts with the NHDV in the field ready enter the field to deploy the DBBC on the installation location and ends with the Retrieval of the DBBC after the HLV has completed the MP installation operations and is re-located to the next installation location.

This manual in relation to the other manuals within the Boskalis Scope of Work is illustrated in Figure 1-2.

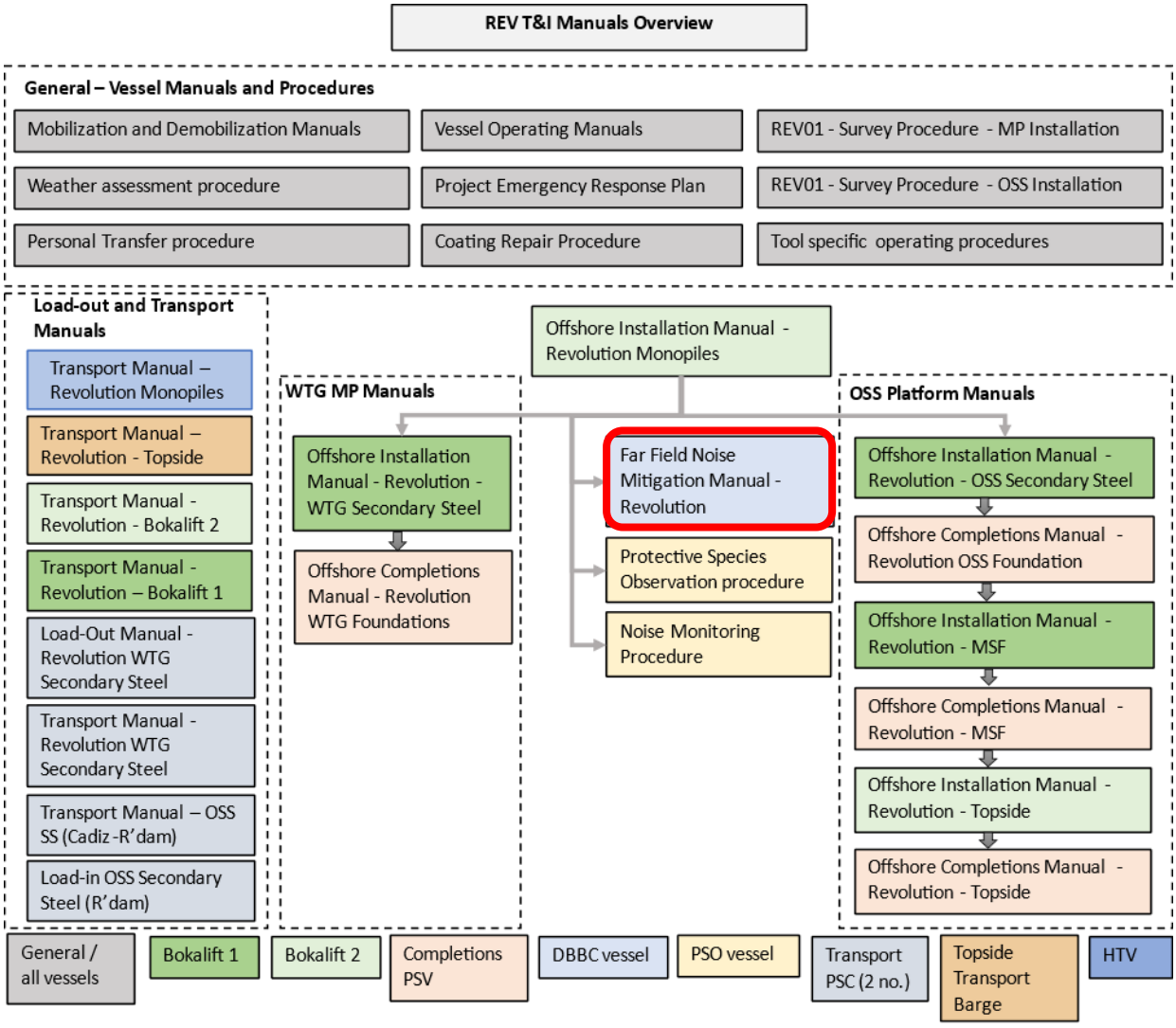
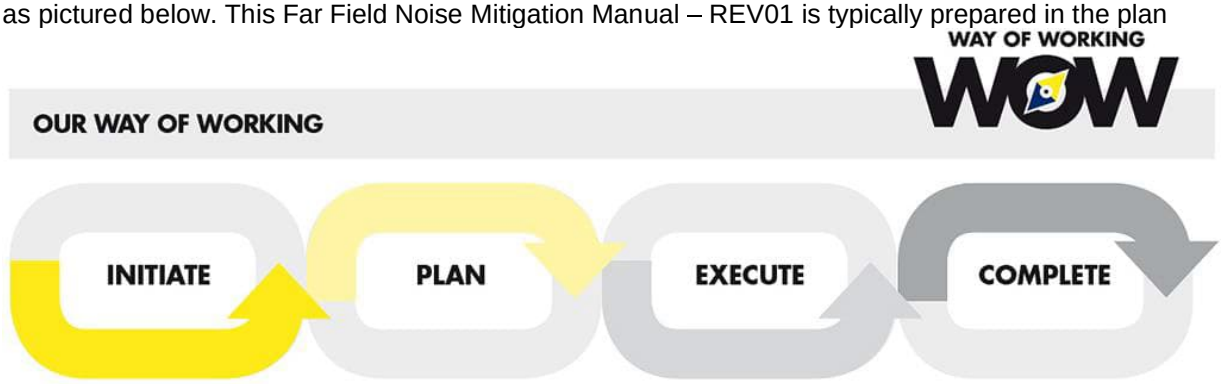


Figure 1-2 Manual overview

This document forms part of the Boskalis Way of Working, the integrated quality management system applicable to all operations in Boskalis. The Boskalis Way of Working is structured around four Phases as pictured below. This Far Field Noise Mitigation Manual – REV01 is typically prepared in the plan



1.3 Purpose of Document

The purpose of this document is to present the scope, method, and procedures by which Contractor will safely perform the Deployment, Operation & Retrieval of the DBBC which as part of the Noise Mitigation Method for the Monopile Installation.

This manual can in no way overrule the decisions made by Captain, Offshore Construction Manager or one of his/her delegates, who is ultimately responsible for the safe execution of this part of the works in compliance with the provisions of the contract and associated specifications. Changes in the procedures will be controlled and documented through Management of Change Plan [15]. The Contractor, Employer, Marine Warranty Surveyor and Project Team will be informed prior to deviations from the procedures in this document

2 REFERENCES, ABBREVIATIONS, DEFINITIONS

2.1 References

No.	Document No.	Document Title
[1]	06914236	H.13.COM - Permitting Conditions
[2]	-	Sound Field Verification Plan

No.	Document No.	Document Title
[3]	DNVGL-ST-N001	Marine Operations and Marine Warranty

No.	Document No.	Document Title
[4]	0040135-BOS-DES-RP-0010-01 Ørsted Doc. No.: 08412809	DP Capability Analysis - BBC Vessel – REV01
[5]	0040135-BOS-OPS-PR-0064-01 Ørsted Doc. No.: 08373084	Weather Assessment Procedure – REV01
[6]	0040135-BOS-OPS-PR-00218-01 Ørsted Doc. No.: 07687590	Protected Species Observation Procedure – REV01
[7]	0040135-BOS-OPS-PR-0040-01 Ørsted Doc. No.: 08024085	Personnel Transfer Procedure – REV01
[8]	0040135-BOS-OPS-PR-0068-01 Ørsted Doc. No.: 08416223	Vessel Importation + Clearance Procedure – US
[9]	0040135-BOS-OPS-PL-0014-01 Ørsted Doc. No.: 08039856	Crew Logistics Plan - REV01
[10]	0040135-BOS-PMT-PL-0014-01 Ørsted Doc. No.: 08391102	Project Management Plan Revolution
[11]	0040135-BOS-OPS-PR-0039-01 Ørsted Doc. No.: 08024084	Noise Monitoring Procedure – REV01
[12]	0040135-BOS-SHE-PL-00164-01Ørsted Doc. No.: 08467648	Project Emergency Response Plan – REV01
[13]	0040135-BOS-PMT-PR-0003-01 Ørsted Doc. No.: 08024082	Basis of Programme – REV01
[14]	0040135-BOS-PMT-PL-0015-01 Ørsted Doc. No.: 08391103	Project Management of Change Plan Revolution
[15]	0040135-BOS-OPS-MA-0093-01 Ørsted Doc. No.: 07883874	Offshore Installation Manual – Revolution Monopiles
[16]	0040135-BOS-OPS-MA-0079-01	Mobilization and Demobilization Manual - BBC Vessel
[17]	0040135-BOS-RIS-PL-0003-01 Ørsted Doc. No.: TBD	Project Risk Management plan – REV01
[18]	BOHL-BL2-OPS 001	BOKALIFT 2 – Operations Manual

No.	Document No.	Document Title
[19]	0040135-BOS-DES-DG-0571-00 Ørsted Doc. No.: 08024139	Binder - Deck Layout of DBBC Vessel - REV01
[20]	0040135-BOS-DES-DG-1111-00 Ørsted Doc. No.: 08291759	Binder - Bubble curtain layout - REV01
[21]	0040135-BOS-ENG-MS-0007-01	Method Statement - Scour Protection Installation

2.2 Abbreviations

Abbreviation	Full meaning
AHT	Anchor Handling Tug
DBBC	Double Big Bubble Curtain
DP	Dynamic Positioning
HLV	Heavy Lift Vessel
FAD	Free Air Delivery
FOU	Foundation
MP	Monopile
MHC	Marine and Helicopter Coordinator
MWS	Marine Warranty Surveyor
NMS	(Far Field) Noise Mitigation System
NHDV	Nozzle Hose Deployment Vessel
OSS	Offshore Sub Station
PtW	Permit to Work
SS	Secondary Steel
VMT	Vessel Management Team
WAD	Work Authorization Document
WOW	Way of Working

2.3 Definitions

Definition	Full meaning
Employer	Ørsted Wind Power North America LLC
Contractor	Boskalis Offshore Contracting LLC
Employer's Design	Drawings of foundation installation items including scour protection.

Definition	Full meaning
Limiting Operational Conditions / Workability Limits	Set of climatic conditions (wind speed, wave height, swell wave height, current speed, temperature etc.) defined for each phase of execution of the works. All works shall be effectively and safely operable in all weather conditions up to and including the limiting operational conditions
Marine Installation	MP, OSS, Topside and SS installation with the HLV. Station keeping and mooring engineering are included.
Lifting	Includes all lifting and rigging engineering
Mobilization Port	Port where the contractor mobilizes the NHDV in preparation of the works.
Offshore Site	Offshore place where the works are to be executed and the installation items incl. scour protection are to be installed
Supply Port	Port at which the contractor takes delivery of the Installation Items from either the Employer or another contractor of the Employer. From the supply port the installation items are transported to either a feeder port or directly to the Offshore Site

3 GENERAL INFORMATION

3.1 High level Scope of Work DBBC Operations

The scope of work covered in this manual:

- General operations in the field;
- NHDV outfitting & preparation;
- Set-up vessel in field;
- NHDV Operations in the field;
- Contingency scenarios.

3.2 DBBC Layout

The DBBC consists of two nozzle hoses with lengths of:

- BBC 1: 358m (Inner ring, R 57m) and
- BBC 2: 647m (Outer ring, R 103m).

The inner and outer BBCs are deployed as a set on every installation location by the NHDV and will be supplied with compressed air to maintain a 2x layer bubble curtain around the Monopile. Details on the dimensions and layout on each location can be found in the DBBC layout drawings, in reference [20].

The Free Air Delivery (FAD) supplied on the DBBC during pilling operations is greater than 0.5 m3/ (min x m) as per Permitting Conditions [1]. Therefore, the total air supplied to the DBBC would be greater than 510m^3/min.

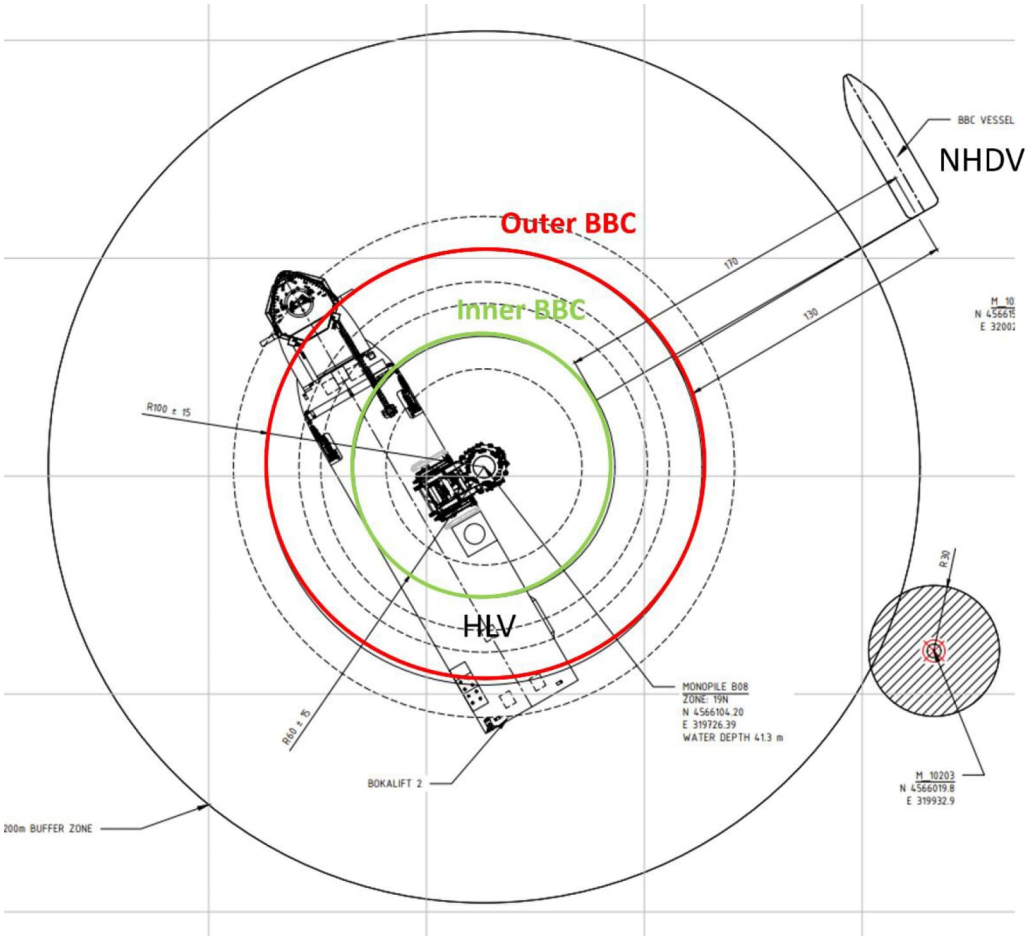


Figure 3-1 Example of typical DBBC layout (NHDV heading indicative only)

3.3 Existing Field Components and Key Locations

3.3.1 Existing Field Components

An overview of the REV01 field is shown below:

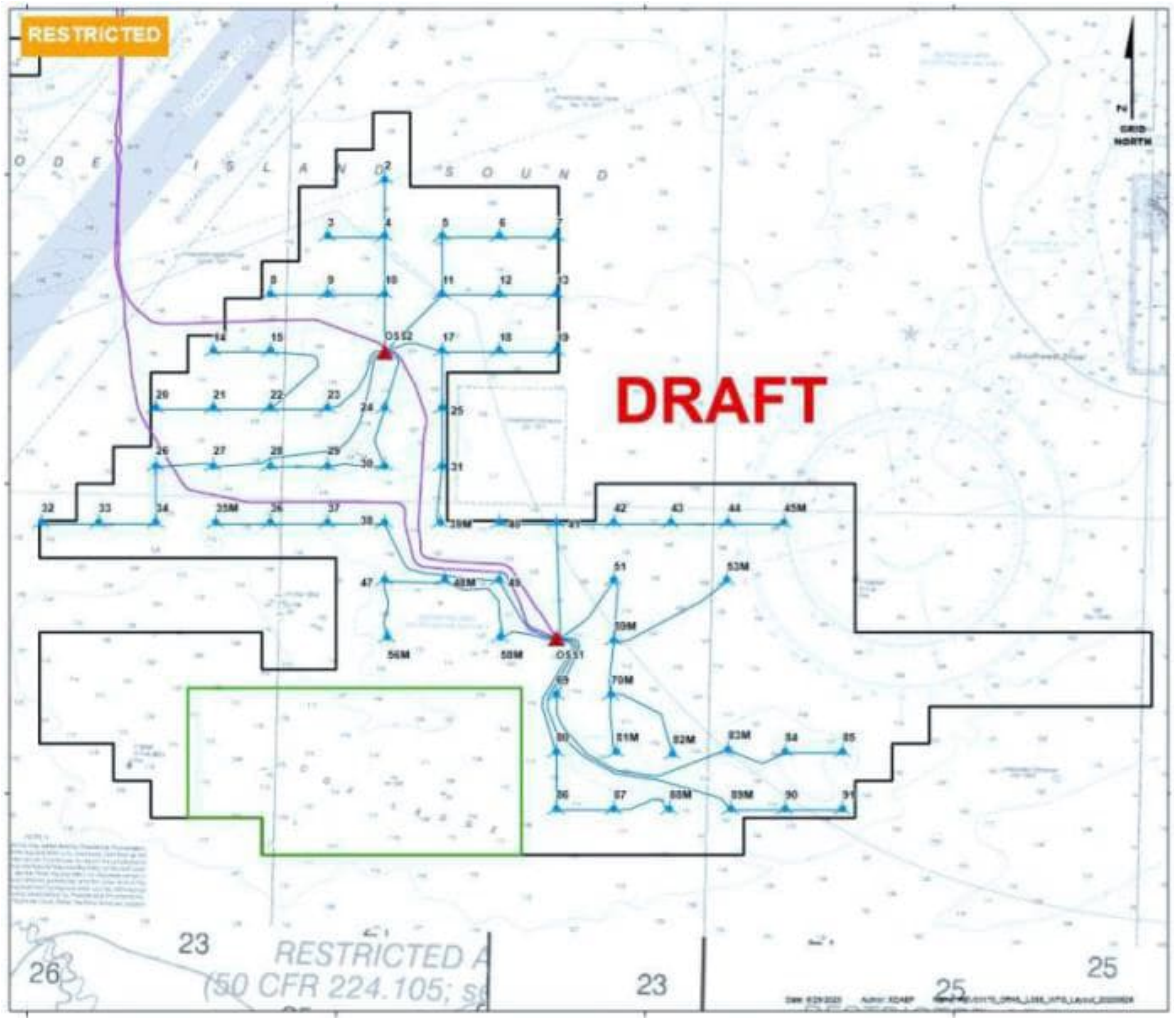


Figure 3-2 Field layout REV01

Below Figure 3-3 shows a map including bathymetry.

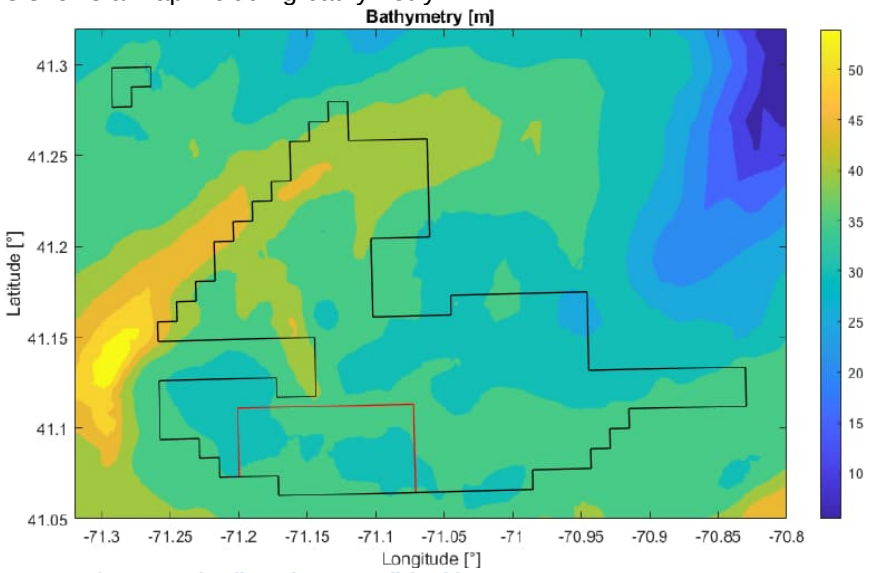


Figure 3-3 Bathymetry of SFW01 (red) and REV01 (black)

The scour protection for REV01 is pre-installed on a certain number of locations. Reference is made to the Method Statement Scour Protection installation [21] The max. outer radius for scour material is below 20m and the inner hose will be installed with a minimal radius of 42m (inner R = 57 – 15m tolerance)Therefore, there are no clashes expected during hose deployment at MP locations. Potential UXOs per MP location can be found in the drawings in [20].

3.4 WTG Foundation

The WTG foundation consists of a monopile and secondary steel (anode cage, external concrete platform, and suspended internal platform). For installation details, such as coordinates, reference is made to [11].

3.4.1 Existing Field Components

Prior MP installation the only existing field components are the pre-installed scour protection layers on a few locations, which have no interference with the nozzle hose deployment activities as per section 3.3.1 Potential UXOs per MP location can be found in the BBC Deployment drawings in reference [20]. In case of uninspected Potential UXOs in vicinity it is allowed to place the DBBC in an ellipse to stay well clear from the object.

3.4.2 WTG Foundation

The WTG foundation consists of a monopile and secondary steel (anode cage, external platform, and internal platform). In Figure 3-4, the foundation is shown without the inclusion of secondary steel, providing a preview of its appearance upon completion of the NHDV operation. Details of the foundation components can be found in below tables.

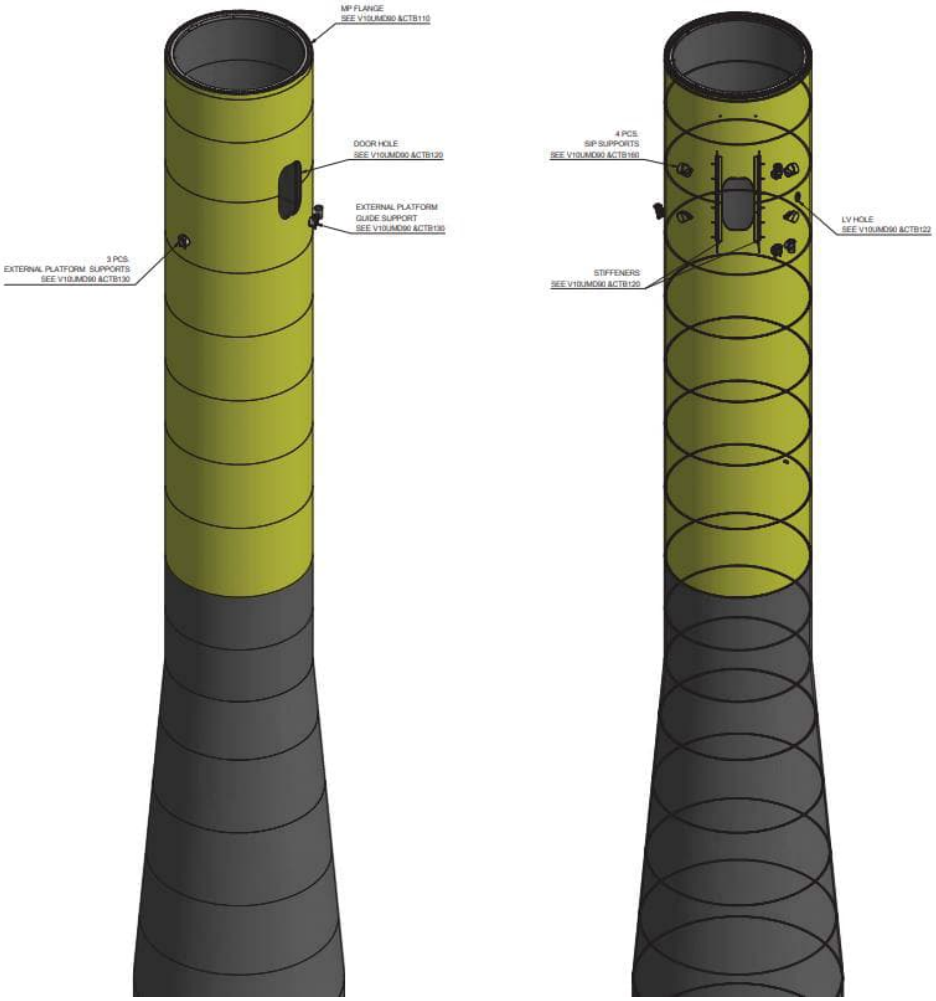


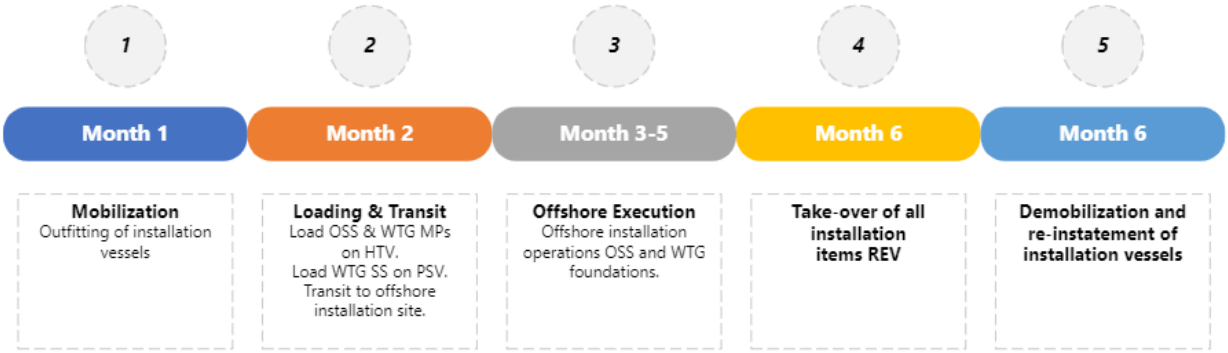
Figure 3-4 Isometric layout of Monopile excluding Secondary Steel

Table 3-1 WTG Monopile diameters	
	Revolution
Top diameter	7.00 [m]
Bottom diameter	9.50-10.00 [m]
Vertical elevation MP flange (top) [1]	27.19 [m]

3.5 Offshore Execution Schedule

Below figure shows an indication of the timeline. The exact timeline is subject to change and for a more detailed schedule, reference is made to the project schedule [13]. Note that subsequent conditions such as weather can increase the duration of the offshore operations.

[1] Relative to MSL.



3.6 Coordinate system and DP Capability

The following coordinate system is applicable:

- The X-axis is defined as positive from the stern to the bow of the vessel;
- The Y-axis is defined as positive from the Center Line to Port Side
- The Z-axis is defined as positive from the Base Line upwards.

The environmental angles of attack with respect to the vessel are shown in Figure 3-5. The DP capability analysis of the NHDV can be found in reference [4].

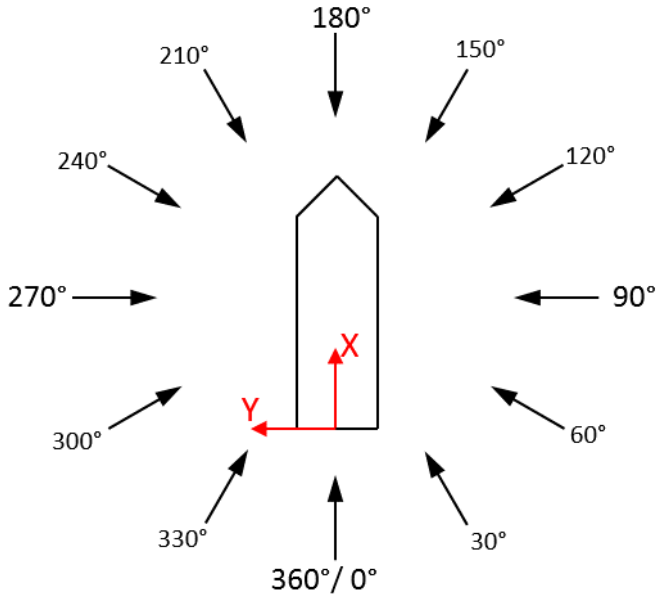


Figure 3-5 Environmental forces direction convention

3.7 DP Capability

A DP capability analysis has been performed and reference is made to reference [5]. This analysis is based on a loaded deck with complete DBBC spread on board at maximum draft as seen in the deck layout, reference is made to Section 6.2.

3.8 Weather Reporting and Monitoring

During the offshore operations, the following will be available for the weather assessment:

- Two (2) independent (bespoke) weather reports (StormGeo; Employer provided, Infoplaza ;Contractor provided);
- Wave data from weather buoy (supplied by Employer);
- Vessel wind sensor;
- Guidance from onshore meterologist consultant.

This information will be available to the Offshore Construction Managers (OCM's), Field Engineers (FE's), and Vessel captains. For more details, reference is made to the Weather Assessment Procedure [5].

3.9 Daily Progress Reporting

Reporting is required daily for the period midnight to midnight (at worksite's local time). A web based DPR filing and approval system will be used, which will contain the following information as a minimum:

- Date of report and report number;
- Current vessel operation and position;
- Current and forecasted weather;
- Personnel Movements (quantity);
- Active Marine Spreads;
- Consumables;
- Mechanical Breakdowns;
- HSE Statistics;
- Breakdown of activities past 24 hours;
- Waiting on weather (time).
- As installed data of DBBC;
- Planned activities for next 24 hours.

Output of the DPR system is a signed .pdf file that will be distributed on a daily basis.

3.10 Organization and Communication

All communication shall follow the guidelines as identified in the Vessel's Operations Manual, as referenced in [18]. The organizational chart during offshore construction can be seen in Figure 3-6 (HLV) and Figure 3-7 (NHDV).

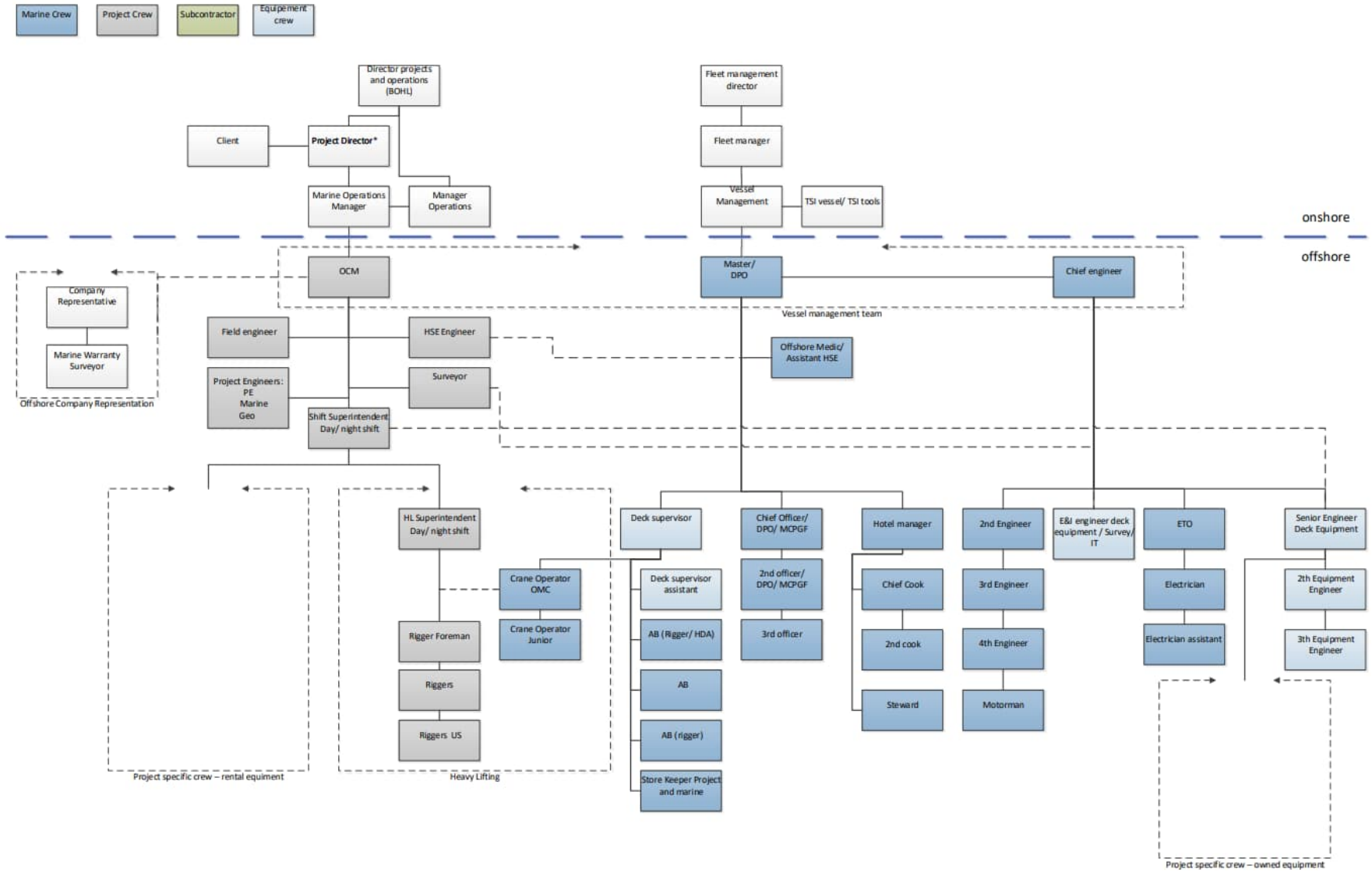


Figure 3-6 Organization chart of Offshore Operations HLV

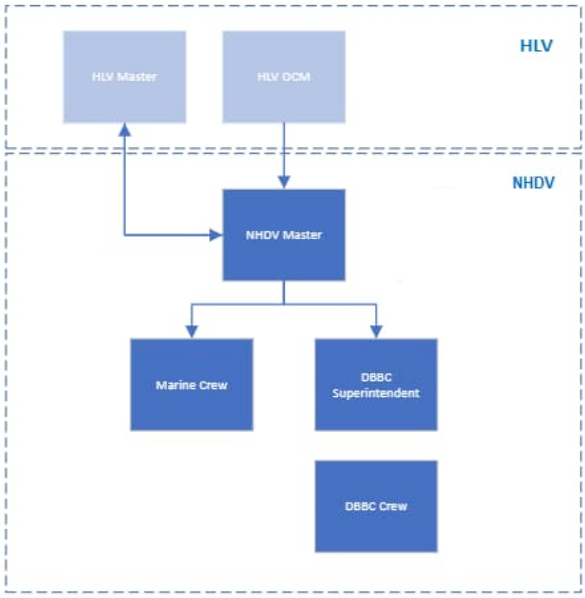


Figure 3-7 Organization chart on board of the Nozzle Hose Deployment Vessel (NHDV)

For the communication between the NHDV Bridge and NHDV DBBC Superintendent on deck UFH/VHF radios will be used. A dedicated UHF/VHF channel including backup channel must be agreed prior any operation.

3.11 Project Management Plan

All activities shall adhere to the processes, procedures and Boskalis' Way of Working (WOW) as stipulated in the Project Management Plan; reference is made to [10].

4 OPERATIONS IN THE FIELD

4.1 General

Operations and SIMOPS in the field are controlled by the Client through the Marine & Helicopter Coordination Centre (MHCC). Contractor will request authorization to work in the field daily.

Supporting processes for the field operations are listed here:

- Equipment and Material Logistics Procedure – US [1];
- Vessel Importation + Clearance Procedure – US [8];
- Crew Logistics Plan - REV01 [9];

4.2 Role and Responsibilities

Reference is made to:

- BL2 Operations Manual [18]

There are two (2) roles that require further definition:

- Marine operations Manager;
- Offshore Construction Manager BL2.

4.2.1 Marine Operations Manager

The Marine Operations Manager is overall responsible for the marine spread. In close consultation with the OCM's he directs field operations including (but not limited to) material logistics, crew movements, port calls, bunkering, provisions, mobilization, demobilization, vessel clearance, permits etc. This role is based onshore.

4.2.2 Offshore Construction Manager BL2

In addition to the job description in BL2 Operations Manual [18], the Offshore Construction Manager (OCM) BL2 is responsible for the efficient daily operations of the BL2 and the following vessels, when positioned inside the Revolution Offshore Wind farm.

- HMT Vessels / MP transport vessels
- NHDV Vessel
- PAM Vessel
- SFV Vessel
- PSO Vessels
- HMT Vessel / OSS Topside transport vessel
- Bokalift 1, see below.

OCM BL2 is responsible for the efficient daily operations of the BL2 and the following vessels, when positioned inside the Revolution Offshore Wind farm.

- SS Transport PSV1, and SS Transport PSV2

OCMs will work closely with the Bokalift Captains and the bridge teams to guide the supporting fleet accordingly. This role is based offshore.

On the NHDV the Captain is in charge of the vessel & marine crew and the OCM onboard is steering project crew on deck and is in close contact with OCM BL2 on sequencing and moving in. During hose deployment the NHDV captain is in close (radio) contact with deployment supervisor on deck for accurate hose positioning.

4.3 Intra ship communications

All intra ship project alignment communications shall be done through internet phone link. All near field instructions and operations shall be communicated through VHF radio channel #8 and #10.

4.4 Personnel Transfer

The transfer of Project or Marine crew from and to the NHDV will be done either in Base Port (Port of Providence) or offshore. Reference is made to the Personnel Transfer Procedure [7].

4.5 Permit to Work (PtW)

All vessels will use their own Permit to Work (PtW) system as per their Vessel Management System unless stated otherwise.

On board the BL2 the permit to work system is according to the BL2 Operations Manual, reference is made to [18].

4.6 Marine Mammal Observation

For the marine mammal observation procedure reference is made to the employer's Protected Species Mitigation Measures Plan section on Permitting conditions document [1] and to the contractor's Protected Species Observation Procedure [6].

4.7 Noise Monitoring

For Noise Monitoring, reference is made to the employer's Sound Field Verification Plan [2] and to contractors to the Noise Monitoring Procedure [11].

5 MARINE & HELICOPTER COORDINATION CENTRE (MHCC)

Client has an established MHCC set up for this project. Including a software system for applying for Work Authorization Document (WAD).

5.1 Marine Helicopter Coordinator

The Marine and Helicopter Coordinator (MHC) is the person responsible for the overall Offshore Site [field]. The MHC is employed by the Client.

5.2 Daily Planning Meetings

The Contractor must attend Daily Planning Meetings throughout the execution phase of the project. This will be the forum whereby any access conflicts and activity scheduling will be discussed and agreed between all relevant parties. The Daily Planning Meetings will be chaired by the MHC.

The Contractor must submit their planning for the next 24, 48 and 72 hours, 2 hours prior to the Daily Planning Meeting. In case of conflicts, work will be prioritized in best interest of the project.

5.3 Field Entry Requirements

NHDV to enter the field as per vessel field entry checklist. DP functional test will be performed as per vessel standard protocol at arrival at the field. Permission to enter the field is granted by the MHCC.

The Bokalift 2 OCM and/or Captain are responsible for applying the applicable permits for the vessel to operate in the REV01 lease area. Planned SIMOPS need to be risk assessed (reference [17]). If required, priorities can be determined based on the risk assessment.

5.3.1 Field entry checklist

All vessels to perform the field entry checklist as per their Vessel Management System [VMS].

5.3.2 Training, Next of Kin and ID cards

Prior to being allowed to work in the field, personnel have to complete and upload the following documentation:

- All training in line with the Training Matrix;
- Next of Kin [NOK] forms.
- Photograph.

Personnel receive their own personal ID card prior to Offshore Site access.

Contractor plans to use ‘crew management software’ to automatically connect and complete this compliance check for the offshore personnel.

5.3.3 Work Authorization

The vessels are only allowed to start work in the field with a Work Authorization Document [WAD].

The Marine Operations Manager [or his delegate] is responsible for applying for the applicable WAD for the vessel to operate in the REV01 lease area. This Work Authorization Request is done via a software system provided by Client.

6 VESSEL PREPARATION AND EQUIPMENT

6.1 General

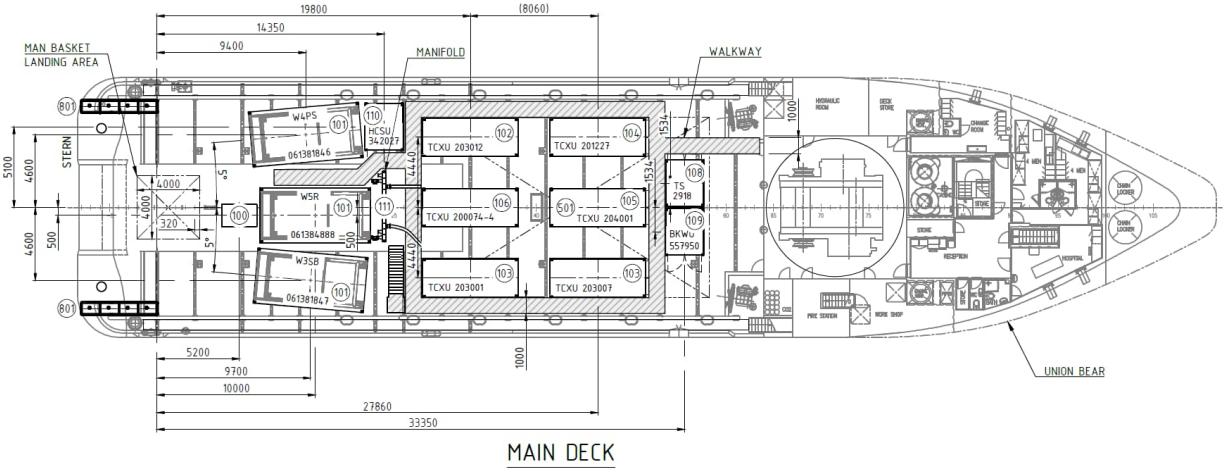
The NHDV (Nozzle Hose Deployment Vessel) is a multi-purpose DP-2 offshore Anchor Handling Tug Supply vessel, fitted with a stern roller open aft deck which allows for hose deployment & retrieval of the nozzle hoses from the aft. The vessel is fitted with the BBC-Equipment for deployment, operation and retrieval of the DBBC. A detailed description of the equipment can be seen in section 6.3.
Vessel Specifications for the NHDV and the HLV can be seen in below Table 6-1 and Table 6-2.

Table 6-1 Nozzle Hose Deployment Vessel (NHDV) particulars		
Name	Bear	
Length	73.50 [m]	
Beam	16.40 [m]	
Depth	8.00 [m]	
Speed	10 [kn]	
Owner	Boskalis	

Table 6-2 Monopile Installation Heavy Lift Vessel (HLV) particulars		
Name	Bokalift 2	
Length	231 [m]	
Beam	49 [m]	
Depth	17.8 [m]	
Speed	10 [kn]	
Owner	Boskalis	

6.2 Deck Layout and vessel preparation

The latest version of the Deck layout of the NHDV Bear vessel can be found in reference [19]. There are two separate deck lay-outs for the NHDV Bear vessel: 1) for transatlantic voyage and 2) for operations in the field. The difference between the two is that during the transatlantic voyage there are two extra winches on the aft of the vessel. They will be removed for the operations in the field. This is different from the SFW campaign as this improvement comes from the LL session. This setup allows for more working area for hose handling on deck for safety and installation speed improvement. Further explanation on remaining hose deployment is explained in section 7.1. In Figure 6-1 the deck layout for the in-field operations is shown.



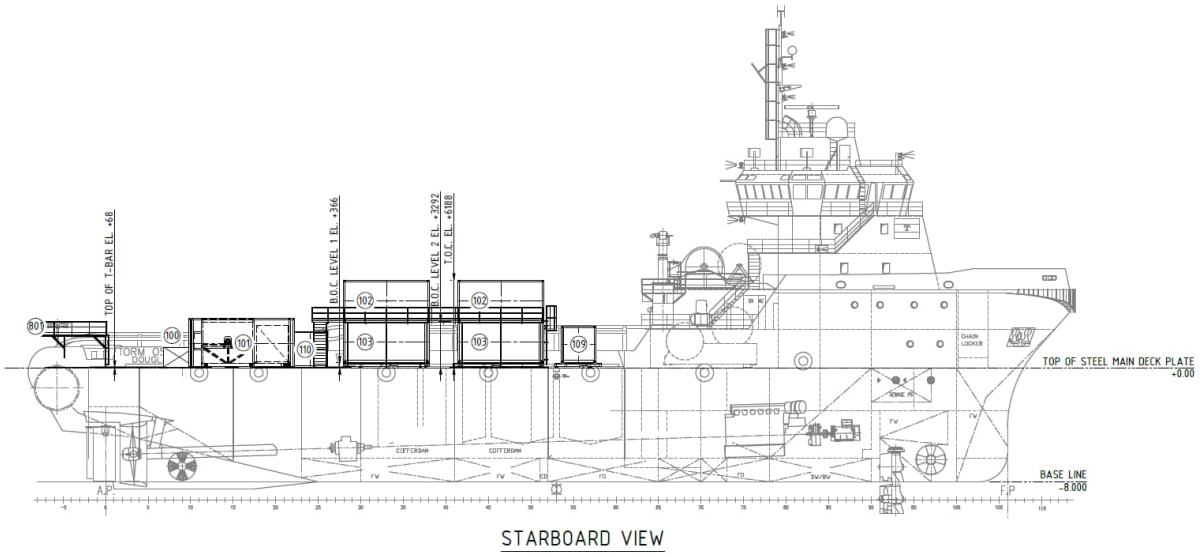


Figure 6-1 Deck-layout of the NHDV Bear

6.3 Key Equipment

For the Revolution development, key mission equipment has been identified and procured. The following sections provide a brief description on the equipment and their utilization. All key equipment shall be made ready for use prior to the commencement of the MP installation campaign according to the individual operation manuals and procedures. Inspections and function tests of individual key mission equipment and assembled spread are part of the preparations before sending the equipment to mobilization port.

The main DBBC spread consists of:

Table 6-3 Nozzle Hose Deployment Vessel (NHDV) particulars

1	Air compressors	Air-Compressors type ST3100 with a sufficient combined operational Free Air Delivery (FAD) 0.5 m3/(min x m) as per Permitting Conditions [1]. Spare air compressor(s) are placed on board to keep the DBBC functional in the instance of compressor failure. Technical information and specifications for the compressors can be found in Appendix C.
2	Nozzle hoses	DBBC Nozzle hoses fitted with a ballast chain. The hoses are drilled for the site conditions of the project to allow for uniformly distribution of air around the DBBC. Technical information and specifications can be found in Appendix A. Spare parts are available on board to carry out repair on the hose. Small damages (cuts, twists etc.) can be repaired with clips. For blockage of the Nozzles, a redrilling and flushing procedure is to be followed. Reference is made to contingency procedures in Section 9.
3	Nozzle hose deployment winches	Nozzle hose deployment Winches fitted in offshore frames. Technical information and specifications can be found in Attachment B. The winch consists of two parts. The hydraulic power pack and the winch with hoses. To have redundancy on board the vessel is equipped with three (3) complete sets of winches. In case there is a failure on one hydraulic power pack it can be interconnected between the winches. In case two hydraulic power packs fail two winches can operate with only one hydraulic power pack at 70% of the total speed. A 3th winch is permanently installed and ready to operate as contingency. For the remote control there are spare batteries available. In case of a general failure the system can be operated manually. Reference is made to contingency procedures in Section 9.
4	Seasentry	The Seasentry bundles the supplied air from the compressors (7 active 2 spare) and filters the air. From the Seasentry the air will be supplied to a manifold. Technical information and specifications can be found in Attachment D.
5	Manifold	The manifold bundles the two 6” lines coming from the Seasentry and distributes the air into the four 4” lines going to the DBBC. Additionally, it has two three-way-valves that can be used to bleed-valves or to flush the nozzle hoses.
6	Spare Parts	All spare parts related to the equipment are identified in the spare parts list, reference is made to Attachment E
7	Buoy recovery Winch	Small 12T pulling winch for buoy & hose end retrieval. Reference to appendix 0
8	Fuel tank	A 20.000ltr. fuel tank is used to store and circulate the fuel for all nine (9) compressors.
9	Fuel line	From the vessel tank a fuel line is laid to the middle of the NHDV. A pistol fuel dispenser can be used to fill up the HPU fuel tanks and a quick connect system is used to fill up the 20.000ltr. fuel tank.

6.4 Mobilization of NHDV at the base port

Base port for the outfitting and mobilization of the NHDV will be in the Rotterdam area (NL). Activities include as a minimum:

- Removal of the vessel spare towing winch on B-deck and placement and hook-up of additional accommodation units.
- Preparation of the Main Deck on the NHDV. Deck frames are installed on main deck prior to DBBC equipment mobilization.
- Loading Nozzle Hose Winches, Compressors, Generators Air supply-hose reels, Spare parts container
- Sea fastening of equipment on custom built deck frame
- All connections between the DBBC equipment are fitted after every piece of the DBBC spread is in the final position on deck.
- Compressors and Air Manifolds are pressurized until maximum bar and all connections are checked for leaks and test run of all winches to check for hydraulic leaks and proper functioning.

The detailed process for the mobilization of the NHDV can be found in the vessel's mobilization manual in reference [16].

6.5 Site Testing of DBBC deployment and operation

Contractor must submit an inspection/performance report for approval to Employer, Contractor must submit an inspection and performance report to the Employer within 12 hours following the performance test. Any modifications to attenuation device to meet the performance standards must occur before impact driving occurs and maintenance or modifications completed must be included in the report. Procedure of the agreed test proposal can be found in Attachment 0

7 DBBC OFFSHORE OPERATIONAL SEQUENCE

7.1 General

The far field Noise Mitigation System (NMS) consists of a Double Big Bubble Curtain and is pre-laid at the Foundation Installation location to allow the HLV to operate without interruption of laying or retrieval of the BBC hose. The BBC hoses shall be laid in a round shape at the installation location. If the lay route is blocked by something, an oval shape can be used. For details of the hose layout per location, reference is made to the Bubble curtain layout drawings for REV [20]

To allow an uninterrupted installation campaign the BBC hoses will "leapfrog" from location to location. This means that once the 1st installation location is prepared with the BBC hoses, this location will be marked and abandoned by the NHDV Vessel. On the 2nd installation location, the BBC hose will be deployed where, in parallel, the HLV will position on the 1st installation location.
Once the latter has been completed and the BBC hose is successfully deployed on the 2nd location, the NHDV will return to the first location and (re)connect to and operate the BBC hose.

Upon completion of the installation at the 1st location and repositioning of the HLV to the 2nd location the NHDV Vessel will retrieve the BBC hoses and deploy this set on the 3th Foundation Installation Location. This cycle will be applied until all foundations have been installed and all BBC hoses are retrieved on board the NHDV.

The DBBCs will be deployed around the future Foundation Locations, whereby the track serves as a guideline for the NHDV Vessel (actual position of the NHDV may deviate from this track). With the Tug Management System (TMS) the surface position of the stern roller is recorded. The HLV working position will be over the DBBC.

The DBBC will consist out of 2no Big Bubble Curtains. The inner hose track (BBC1) has a nominal hose length of 358 m. The outer hose track (BBC2) has a nominal hose length of 647 m. The BBC hoses will be sequentially deployed by the NHDV. The base case is to lay first the inner and second the outer. This order is selected to avoid entanglement in the alley.

The BBC hoses will be rigged in accordance with below guidelines.

Hoses: The ends of each of BBC ring are connected to a primary buoy, the buoy is equipped with light and radar reflector and connected through an 8m long 14mm fiber rope to the secondary buoy as shown in below figure.

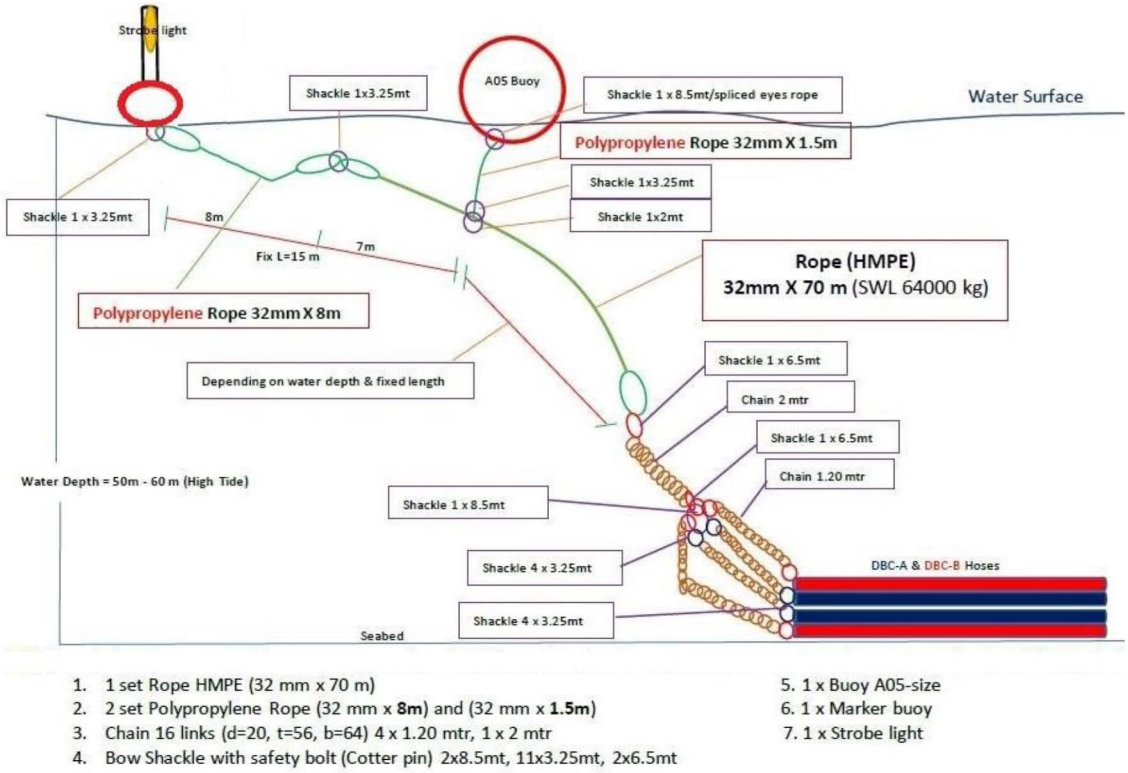


Figure 7-1 DBBC retrieval buoys.

To retrieve the buoys and hose ends during the different DBBC phases a small pulling winch is used situated on the aft deck in front of the large middle spare winch for nozzle hoses.
During operations on the stern work deck with unprotected stern roller, staff shall be connected to the dedicated safety work line.

The following (repetitive) outline sequence will be followed.

Table 7.1 Outline DBBC Double Bubble Curtain deployment sequence

Item	TASK	Responsible
1.	Deploy DBBC on 1st foundation installation location, prior to arrival of HLV. Including function test	DBBC Superintendent
2.	Deploy DBBC on 2nd foundation installation location, prior to arrival of HLV.	DBBC Superintendent
3.	NHDV to return to 1st foundation installation location.	NHDV Captain
4.	Upon successful positioning of HLV, NHDV to approach to standby position. Pick-up BBC hoses	NHDV Captain
5.	NHDV to perform noise mitigation activities	NHDV Captain
6.	NHDV to move out of HLV DP positioning area	NHDV Captain
7.	Upon relocation of HLV, NHDV to retrieve DBBC from 1st foundation installation location.	DBBC Superintendent
8.	NHDV to sail to 3rd foundation installation location	NHDV Captain
9.	NHDV to deploy DBBC on 3rd foundation installation location.	DBBC Superintendent

Table 7.1 Outline DBBC Double Bubble Curtain deployment sequence		
Item	**TASK**	**Responsible**
10.	NHDV to sail to 2nd foundation installation location and upon successful DP positioning of HLV approach to standby position.	NHDV Captain
11.	Repeat steps 5 - 10 for all following foundation installation location.	NHDV Captain / DBBC Superintendent

7.2 DBBC Deployment

The DBBC inner and outer layout are installed in a plotted track in the vessel's survey system. The aft of the vessel is the center point of hose deployment therefore it will be used as tracking point. Once the equipment is installed a function test will be executed and the outcome recorded.

The start and end of each nozzle hose (inner & outer) are marked with buoys. The position of the nozzle hose shall be recorded during deployment by the NHDV positioning system with reference point the aft of the vessel.

The following steps will be taken for the deployment of the DBBC.

Table 7.2 DBBC Deployment Activity list		
#	**Task**	**Responsible person**
1	Perform communication check, additional required checks according to project specific offshore installation guidelines, confirm mobilization is accepted and Toolbox talk for upcoming works has been held	NHDV Captain
2	DP function test to be executed according to NHDV DP checklist.	NHDV Captain
3	Manoeuvre vessel towards 500m Zone	NHDV Captain
4	Before entering 500m Zone: Set vessel in DP-2 Auto position	NHDV Captain
5	Entering 500m Zone	NHDV Captain
6	Start hydraulics for winch and compressors for minimum pressure on hose	DBBC Superintendent
7	Deck to report towards the Captain readiness for operation	DBBC Superintendent
8	DBBC Superintendent to instruct DBBC operators about start of deployment. During deployment of hoses the holes will be checked and (re)drilled where needed for sufficient airflow.	DBBC Superintendent
9	Weighted end of hose with the connected surface buoy to be brought into water, keep track of length paid out	DBBC Superintendent
10	Pay out hose, until hose has landed on the seabed	DBBC Superintendent
11	Move vessel ahead slightly whilst paying out, ensure sufficient slack is on the seabed. Departure angle to be 5~10deg from vertical. Hose angle to be continuously monitored by the DBBC Superintendent and communicated to the bridge.	DBBC Superintendent
12	Constant communication between Captain and DBBC SI during deploying of DBBC, bridge to confirm DBBC SI about required AC's, as they follow provided track	DBBC Superintendent

Table 7.2 DBBC Deployment Activity list		
#	**Task**	**Responsible person**
13	After 100m of hose is laid on the seabed, a stronger catenary can be created allowing departure angle to be increased until 25~30deg from vertical	DBBC Superintendent
14	If the circle is closed this is to be communicated from the bridge towards the deck. Speed to be reduced. DBBC Superintendent has visual over the vessel aft deck and communicates to Captain.	DBBC Superintendent
15	Manoeuvre close to the DBBC retrieval buoy	NHDV Captain
16	NOTE: Maintain sufficient distance between DBBC vessel and buoy in blow off, to avoid surface buoy with rope to be caught in thrusters of DBBC vessel.	NHDV Captain / DBBC Superintendent
17	The buoy will be caught with a hand grapnel; from predefined position, to minimize chance of entanglement	DBBC Superintendent
18	Buoy to be lifted on board and disconnected	DBBC Superintendent
19	Connect connecting wire to winch	DBBC Superintendent
20	First end of hose to be lifted on deck with winch, second end still connected to winch	DBBC Superintendent
21	Both ends to be connected to a surface buoy	DBBC Superintendent
22	Both ends of BBC 1 to be deployed with no pressure	DBBC Superintendent
23	Repeat task #6 - #22 for BBC 2	DBBC Superintendent
24	Wait until HLV in the field	DBBC Superintendent
25	Buoys to be lifted on board and disconnected	DBBC Superintendent
26	BBC hose to be connected to the supply coupling	DBBC Superintendent
27	Supply valve to be opened. Function test of DBBC air flow is executed. Uninterrupted flow confirmed.	DBBC Superintendent
28	Vessel Heading within the environment to be adjusted to minimum thrust	NHDV Captain
29	Provide notice to HLV confirming the DBBC has been successfully deployed within the positioning limits. Operational readiness to be reported towards installation vessel.	NHDV Captain

7.3 DBBC Operation

The following steps will be taken during pilling operations and when the DBBC is at operational pressure.

Table 7.3 DBBC Operation Activity list		
#	**Task**	**Responsible person**
1	Full pressure test to be executed.	DBBC Superintendent
2	Positioning of the NHDV, start air supply, flushing of BBCs, standby pressure, operational pressure. RPM and associated air supply (from compressor technical specifications) during pilling operations for each compressor will be documented.	DBBC Superintendent
3	After piling operations are finished, stop air supply, retrieve wire, air supply hoses, and disconnect the air supply hoses from feeder hoses.	DBBC Superintendent

Table 7.3 DBBC Operation Activity list		
4	If piling works are interrupted for less than 30mins the NHDV sets pressure to standby pressure to avoid ingress of foreign material in the DBBC hose. When the works on HLV are interrupted this will be communicated to the NHDV as per **Table 8-1**.	DBBC Superintendent
5	In case of interruption longer than 30mins NHDV ends BBC operation to start again when operations continue. When the works on HLV are interrupted this will be communicated to the NHDV as per **Table 8-1**.	NHDV Captain

7.4 DBBC Retrieval

After the end of pilling operations, the NHDV will wait for the HLV to finalize installation works on the location. Once HLV confirms that location is clear the NHDV can approach to start works for retrieval of the DBBC.
The following steps will be taken for the retrieval of the DBBC.

Table 7.4 DBBC Retrieval Activity list		
#	**Task**	**Responsible person**
1	Receive information that piling operations is completed	NHDV Captain
2	Toolbox-talk held with all involved persons	DBBC Superintendent
3	Reduce the air pressure from the compressors for economic operation	Deck Coordinator
4	Confirm that HLV is clear from location and NHDV can access for recovery of DBBC.	NHDV Captain
5	When confirmed DBBC can be recovered start hydraulics and prepare all systems for recovery	DBBC Superintendent
6	Captain to inform deck and installation vessel that recovery operation starts	NHDV Captain
7	Close supply valve for double side injection	DBBC Superintendent
8	DBBC hose will be slowly lowered to the seabed	DBBC Superintendent
9	Buoy will be lowered to the water	DBBC Superintendent
10	Vessel to move away from buoy	DBBC Superintendent
11	Based on weather situation vessel either to be turned or hose to be recovered going sternways	NHDV Captain
12	After being on the opposite track the vessel will be manoeuvred along this track and hose per hose will be recovered	NHDV Captain
14	Once cycle is completed the buoy will be brought on deck and secured / switch off compressors	DBBC Superintendent
15	Bridge will inform installation vessel that operation is completed	NHDV Captain
16	Vessel will leave from location and relocate to continue with pre-laying activities on a next location (as per communicated sequence).	NHDV Captain
17	Once the cycle is completed the Compressors will be re-fuelled for the next cycle. DBBC superintendent to request permit from the Captain for refuelling operations on deck.	DBBC Superintendent

8 VESSEL COMMUNICATION PLAN

In the process of DBBC operations in relation to MP Installation cycle (as described in Section 7), communication between HLV and NHDV is decisive on the next step(s) of the operation. The Offshore Construction Manager (OCM) of the HLV or his delegate will the responsible to communicate the operations planning and direct the vessels in the field. The NHDV plan will be directed from the HLV plan and follow any changes on the installation sequence that may occur. The minimum notifications between HLV and NHDV prior, during and post pilling on each location can be seen in Table 8-1 HLV / NHDV Communication plan on each installation location below. Reference is also made in MP Offshore Installation Manual [15].

Table 8-1 HLV / NHDV Communication plan on each installation location

	Communication	Vessel	Radio	Vessel	Communication
1		HLV	←	NHDV	Notification to HLV Confirm DBBC deployed on next FOU location
2	Notification to NHDV Prior moving to next FOU location	HLV	→	NHDV	
3	Notification to NHDV 3 hr. before start piling	HLV	→	NHDV	
4		HLV	←	NHDV	Notification to HLV Confirm connection DBBC + Confirm compressor start up
5	Notification to NHDV 1 hr. before start piling	HLV	→	NHDV	
6		HLV	←	NHDV	Notification to HLV DBBC On operational Pressure
7	Final notification to NHDV 15 mins before start piling	HLV	→	NHDV	
8a	Notification to NHDV (If occurs) Piling Interrupted	HLV	→	NHDV	
8b	Notification to NHDV 15 mins before re-start piling	HLV	→	NHDV	
9	Notification to NHDV Piling Finished	HLV	→	NHDV	
10		HLV	←	NHDV	Notification to HLV DBBC Retrieval

9 CONTINGENCIES

9.1 General

In the event of a deviation from the approved procedures due to an equipment malfunction or due to unforeseen circumstances, the course of action to be followed upon will be agreed between all parties concerned.
This section solutions are given for certain contingencies applicable to the operations.

9.2 Deteriorating Weather

In the event of deteriorating weather conditions, the HLV Captain and Superintendent shall agree their intended course of action and advise the NHDV Captain and DBBC Superintendent.
When deteriorating weather occurs and the NHDV can remain in the field the DBBC spread will wet stored and upon recommencement of operations flushed.
If circumstance so dictate (i.e. storm) the DBBC is to be recovered to the NHDV when reasonably practicable.

9.3 Missing Buoy

In the event of a buoy being lost, the Employer shall be advised immediately.

In case of a missing buoy, other than small plastic buoys, the relevant coast guard authority shall be informed immediately, giving the following details:

- Size, colour and marking of the buoy;
- Time buoy was last sighted;
- Probable speed and direction in which buoy is drifting;
- Action being taken to locate and recover;
- Wind direction, sea and swell and prevailing current.

In view of the potential hazard to shipping, a seabed search to ascertain whether the buoy has sunk, and a vessel search of the area shall be performed.

The results shall be communicated to the relevant coast guard authority by the NHDV Captain.
Retrieval of DBBC equipment due to missing buoy; working class ROV may be used for retrieval of the buoy.

9.4 NHDV Blackout While Maneuvering

During the stay inside the 500m-Zone of the HLV all main engines and generators will be running.

The NHDV is a DP2 class vessel, and as such in cases of black-out the Vessel can rely on its back-up / secondary system. In case the black-out cannot be remedied within a reasonable time frame, the operation must be ceased for subsequent repairs of the NHDV and become fully operational.

If needed the BBC hose to be wet stored (deployed without bringing any tension onto the hose). BBC winch drivers must be ready for emergency abandonment upon NHDV Captains' decision (cutting the hoses).

For the emergency abandonment and before the hoses can be cut, the pressure is to be released from the hoses on the seafloor for safety reasons. For this a manifold with bleeding valves is introduced on deck of the NHDV between the compressors and the hose winches. The bleeding valves can be quickly opened in case of emergency and all 4 feeding lines individually closed with a turning wheel valve. Below picture showing the manifold and working principle.

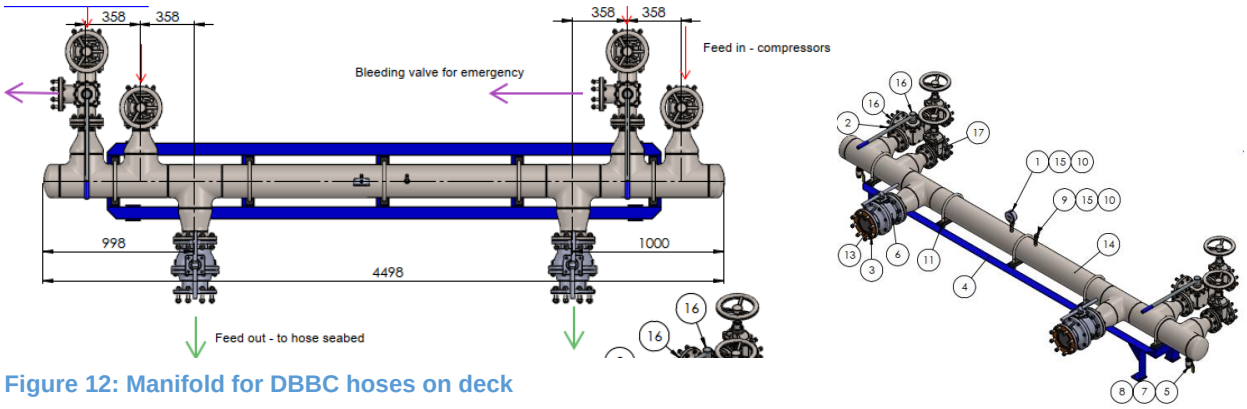


Figure 12: Manifold for DBBC hoses on deck

9.5 Loss of Thruster while maneuvering proximity of the HLV and/or fixed structure

In case of any failure on either thruster the NHDV will be maneuvered away from the HLV and the operation will be ceased for subsequent repairs of the NHDV and become fully operational. If needed the BBC hose to be wet stored (deployed without bringing any tension onto the hose). BBC winch drivers must be ready for emergency abandonment upon NHDV Captains' decision (cutting the hoses).

9.6 Hose/Chain in Propeller

In the case that the hose/chains come into one of the propellers, the propeller is clutched out or stopped and the hoses will be cut off. The NHDV will leave the site with the remaining propeller for subsequent repairs and become fully operational.

9.7 Failure to Hose Winch during Deployment/Recovery

In case of a failure on the winch during deployment or recovery the vessel will be stopped and hold in position. It is possible to interconnect the hydraulic from one hydraulic power pack to another. The speed of the winch will reduce to 70%.

For the remote control there are spare batteries available. In case of a general failure, the system can be operated manually.

9.8 Clogging of hose

If clogging of the hose is observed the nature of the clog is to be found (hose section) and de-clogged. If this is not practical, the clogged hose section is replaced.

9.9 Failure to the DBBC Spread

Trouble shooting is to be carried out ASAP by Contractor. Based on the outcome, e.g., extent of possible damages and repair time, Employer will be informed of the way forward.

9.10 Compressor Failure

Identify cause of failure. Substitute malfunctioning compressor with one of the spare contingency compressors. Spare compressors are connected permanently to the manifolds and can be instantly supply air when needed, so the DBBC operation is uninterrupted.

9.11 Spills on board

In case of spills or (hydraulic) leaks on board the readily available SOPEP kits shall be used to contain and clear the spill.

9.12 Shutdown

In case sensors indicate that pressure or flow rates have are not sufficient; the DBBC superintendent/Captain of NHDV will notify BL2 OCM and a shutdown in piling operations will be implemented if possible/safe. The piling will not recommence until the bubble curtain is repaired and specifications verified. A restart will follow all pre-start clearance protocols.

10 APPENDICES

A. Technical Description Nozzle Hose – Bubble Curtain Nozzle Hose

B. Technical Description - Nozzle Hose Deployment Winch

C. Technical Description – Air Compressor

D. Technical Description – air filtration

E. Technical Description – Spare Parts List

A. TECHNICAL DESCRIPTION NOZZLE HOSE – BUBBLE CURTAIN NOZZLE HOSE

Technical-Description-DBBC Hoses

CONTRACTOR DOC. NR.: 0040135-WEY-ENG-DS-0005-01
PROJECT NAME: **Ørsted US Projects**
PROJECT NUMBER: **P0040135**

SUBC. NAME: **Bernhard Weyres GmbH**
SUBC. DOC. NR.: **220916_Appendix N - Technical-Description-Bubble Curtain**

Rev.	*Stat.*	*Revision date*	*Prepared by*	*Reviewed by*	*Interdisciplinary Check*	*Approved by*
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Revision Number:	A1
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Approved By:		Role:

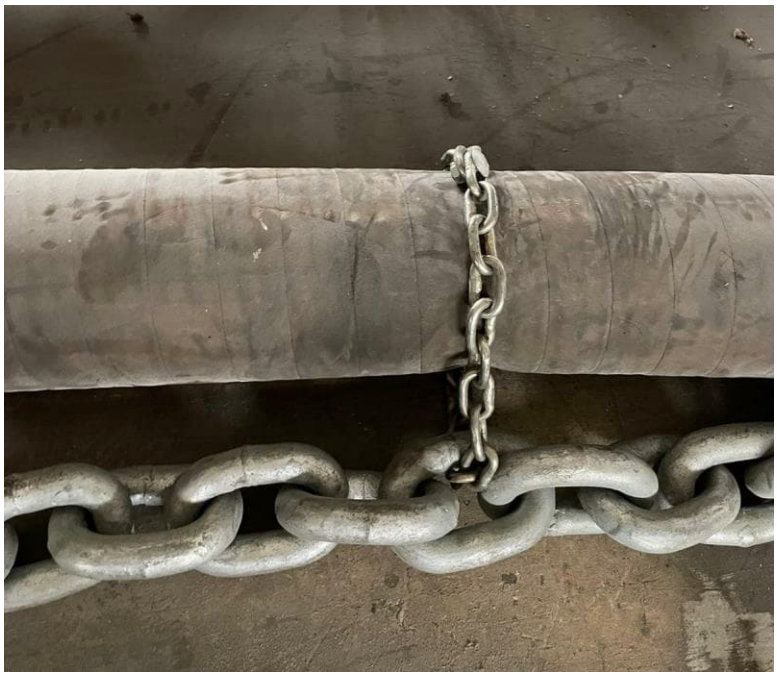
Change Log		
Revision	**Section**	**Change**
Rev. A1	All	Issued for
Rev.		

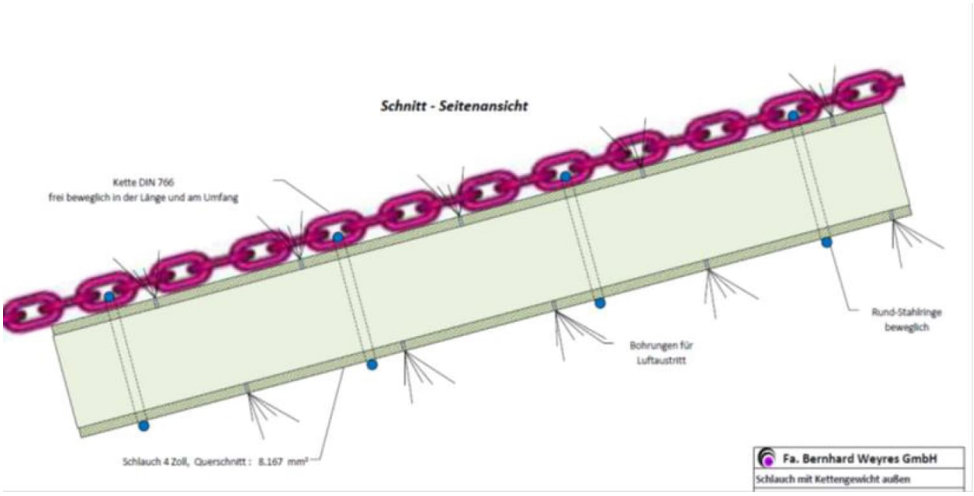
Content

1. BUBBLE CURTAIN

- Tubing - system with external chain.
- Hose length up to 1040 meter per winch possible.

Figure 2: Hose with a fixed chain outside





2. SPECIFICATIONS: HOSE

2.1. New specification: 2022

T-130 AK
COMPRESSED AIR 40 BAR (600 PSI) - STEEL REINFORCED

TUBE : BLACK SBR/NBR - OIL MIST RESISTANT
REINFORCEMENT : HIGH TENSILE STEEL CORDS
COVER : YELLOW SBR - ABRASION AND OZONE RESISTANT - PIN PRICKED
APPLICATION : HIGH PRESSURE COMPRESSED AIR DESIGNED FOR HEAVY DUTY MINE AND QUARRY APPLICATIONS WHERE LONG SERVICE LIFE AND MAXIMUM SAFETY IS REQUIRED.
SAFETY FACTOR : 4:1
TEMPERATURE : -30°C +80°C (-22°F +176°F)
BRAND TEXT : ALFAGOMMA -ITALY- T-130 STEEL AIR
BRAND TYPE : EMBOSSED
APPROVALS :
NOTE :

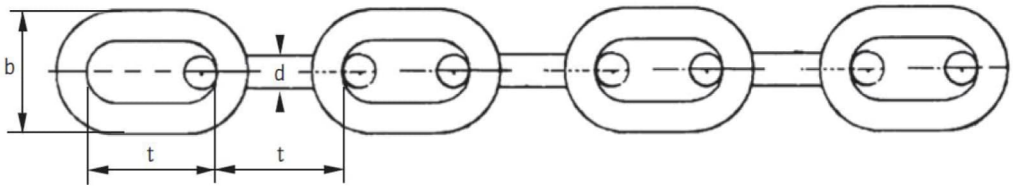
Code	ID mm	ID inch	OD mm	Wall mm	Weight g/m	WP bar	WP psi	Vac. %	BR mm	Available Length m	Stock Length m
130AK019311X03	19	3/4	31	6	810	40	600		95	30,5	30,5
130AK025371X03	25	1"	37	6	1010	40	600		125	30,5	30,5
130AK032441X03	32	1" 1/4	44	6	1240	40	600		160	30,5	
130AK038521X03	38	1" 1/2	52	7	1660	40	600		190	15,25 / 30,5	30,5
130AK051651X03	51	2"	65	7	2350	40	600		255	15,25 / 30,5	30,5
130AK063831X03	63	2" 1/2	83	10	3570	30	450		315	15,25 / 30,5	30,5
130AK076961X03	76	3"	96	10	[illegible]	30	450		380	30,5	30,5
130AK102221X03	102	4"	122	10	[illegible]	30	450		510	15,25 / 30,5	30,5

The total weight for 1m fitted hose length:

for the hoses:	6,15 kg/m now
for the chain:	9,00 kg/m
connections:	0,50 kg/m
	15,65 kg/m fitted hose length

Bending radius min: 510 mm

2.2. Specifications: main chain



Bezeichnung *Type*	Maße mm *Dimensions mm*			Gewicht *Weight*	Belastbarkeit* *Capacity**
	d	t	b	ca./*appr.* kg	kg/max.
DIN 5685, kurzgl.2056	**20**	**56**	**64**	**8Kg/m**	**18000**

Table 1: Main chain

2.3. Connection chains:

Rundstahlkette nach DIN 5685 | C-Glieder (langgliedrig) | gerade | ungeprüft
Langgliedrige Kette für nicht sicherheitsrelevante Arbeitseinsätze, z. B. als Absperrkette oder zur Abhängung von Schildern | lieferbar in 3 verschiedenen Ausführungen (blank, galv. verzinkt oder feuerverzinkt).

Maße (mm) d x t x b2	Oberfläche	Länge je Bund m	Belastbarkeit kg	Gewicht (ca.) kg / 100 m
2 x 22 x 8	feuerverzinkt	30	20	6
2 x 22 x 8	galvanisch verzinkt	30	20	6
2 x 22 x 8	blank	30	20	6
3 x 26 x 12	feuerverzinkt	30	45	14
3 x 26 x 12	galvanisch verzinkt	30	45	14
3 x 26 x 12	blank	30	45	14
4 x 32 x 16	feuerverzinkt	30	80	26
4 x 32 x 16	galvanisch verzinkt	30	80	26
4 x 32 x 16	blank	30	80	26
5 x 35 x 20	feuerverzinkt	30	125	42
5 x 35 x 20	galvanisch verzinkt	30	125	42
5 x 35 x 20	blank	30	125	42

Table 2: Connection chain

B. TECHNICAL DESCRIPTION - NOZZLE HOSE DEPLOYMENT WINCH

Winches and Power Packs

CONTRACTOR DOC. NR.: 0040135-WEY-ENG-DS-0009-01
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PROJECT NUMBER: **P0040135**

SUBC. NAME: **Bernhard Weyres GmbH**
SUBC. DOC. NR.: **220916_Appendix M - Technical-Description-Winch**

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Prepared By:	Karin Kloske	Role: PM Offshore projects
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Approved By:		Role:

Change Log		
Revision	**Section**	**Change**
Rev. A1	All	Issued for
Rev.		

Content

1. WINCH

- 2x Hose reels as per picture above
- Hose reels: Steel drums with side rotary joint for permanent compressed air supply and an axial drive consisting of a hydraulic motor, planetary gears and an internal disc brake
- 1 x Hydraulic power pack stored in 10" container
- Hydraulically operated (in/out and spooling device)
- Operated by remote control. One for 2 winches with manual switch over
- Max. 1.040m/hose per winch
- Hoses fitted with an outside chain for negative buoyancies. 7kg/m in water
- Minimum breaking load for the chain: 18t
- Hoses: Alfagomma T-130AK 40bar steel reinforced, Ø 122mm with a minimum breaking load of 9 metric tons
- Minimum bending radius is 510 mm
- Total weight: (Frame, Drum with hoses and HPU): approx. 29 tons
- Pulling force: approx. 5 tons on first (lowest) layer
- Air supply connector at winch: project specific (see sub. 5.)
- Length: approx. 6.900mm; Height: approx. 3.300mm; Width: approx. 3.400mm with air inlet valve connection (project specific)

1.1 Winch Remote Controls

The remote control comes with a spare battery and a charging station. Changing the battery takes less than a minute (<1m).

All remote controls are equipped with an Emergency Stop at the side. Additionally, there is one emergency stop inside the hydraulic container.

Before the operation start:

- Remote control battery fully charged
- Fully charged spare battery charging slot inside the powerpack

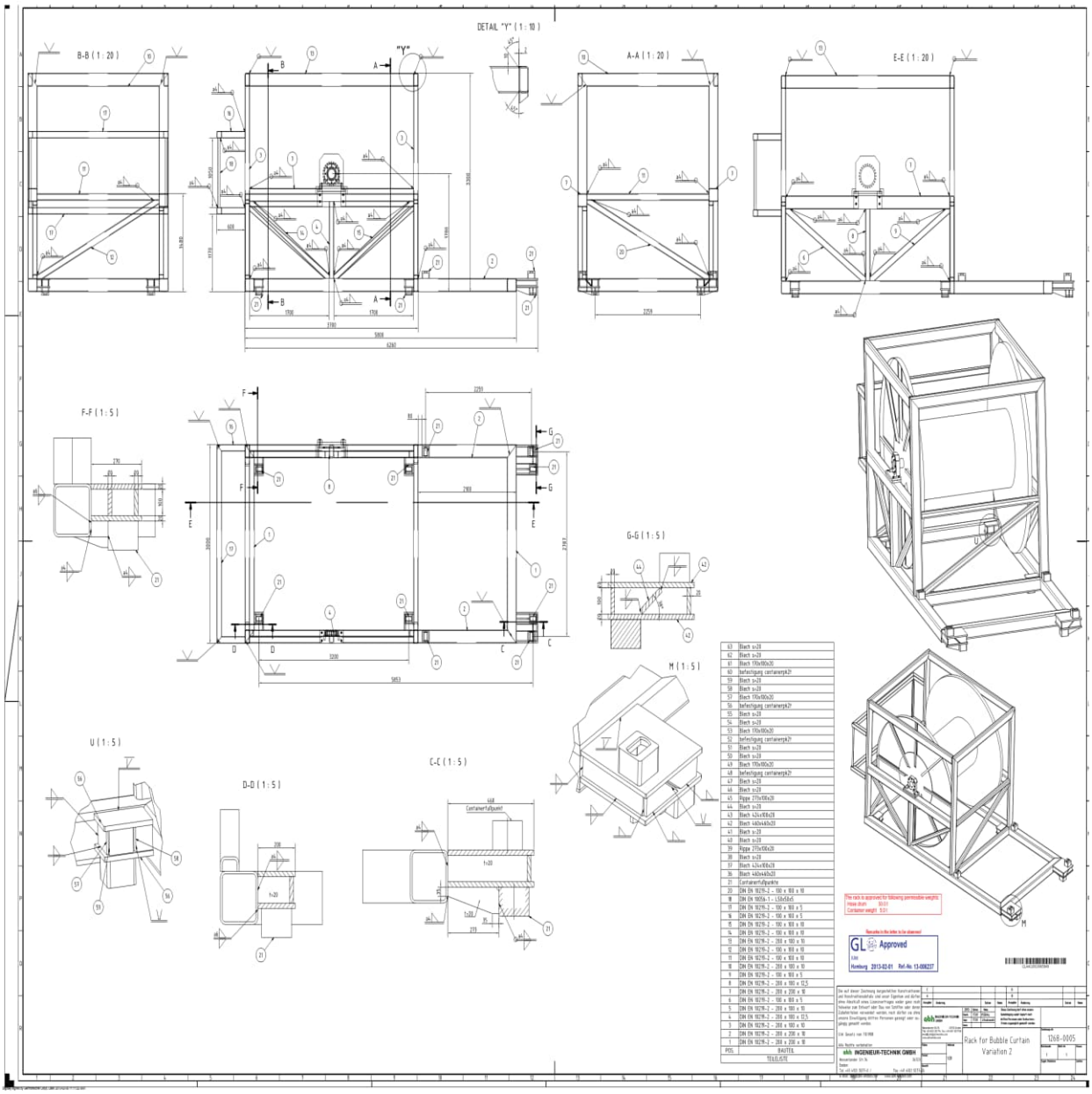
2. HYDRAULIC POWER UNIT

The Hydraulic Power Unit that is used to drive the winch(s) is a container solution (10ft container) that is attached to the frame of the winch. In this/these container(s) are built the following modules:

- diesel engine, Perkins 1200 series
- hydraulic pump connected to diesel engine
- Fuel tank with a capacity of approx. 100 litres
- Hydraulic Oil tank, capacity: approx. 80 litres
- Remote control with a battery charging station
- Spare parts intended for the project (e.g., joints, screws and more)
- 220 Volt supply for lights, battery chargers and plug(s) for the use of the tools (e.g., grinder, drill, etc.)
- Fire extinguisher

Example of hydraulig power unit container

3. DRAWINGS WINCH FRAME



4. SAFETY SYSTEMS

4.1 Fire extinguisher:

6 kg powder, for A, B, C class fires

4.2 HPU unit:

The HPU unit (engine and pump) is controlled by a Perkins BU Power Unit system with permanent monitoring of key engine data. Emergency shutdown when key values are exceeded.
Remote control: Emergency call buttons on the remote control itself and inside the HPU container, immediately accessible from the front door (see image page 4).

C. TECHNICAL DESCRIPTION – AIR COMPRESSOR

Big Bubble Curtain Air Compressor

ST3100

Stage V complaint air compressor designed to support large scale bubble curtain projects. High volume / medium pressure provides optimal FAD for projects even in deep waters (~60metres).

Stackable design allowing clients to optimise available deck space.

For more information on how ScanTech Offshore can add value to your offshore operations, please visit www.scantechoffshore.com or contact our business development team at sales@scantechoffshore.com or call +44 (0) 1493 443300.

Benefits
Stackable Design (Both CSC & DNV 2.7-1 Compliant)
Best In Class Emissions
Unique Patented Cooling Matrix (suitable for placement on vessels with High Sides)

All equipment offered is subject to availability at point of order confirmation.

Technical Information	
Model	ST3100
Delivered Flow @ 12 Bar	3100cfm / 87.5m3/min
Delivered Flow @ 14 Bar	2700cfm / 76.4m3/min
Stackable	Yes
Sound Level	Power (Lwa) >90dBA
Fuel Consumption	200 litre per hour
Fuel Tank Capacity	700 litres (designed for auto refuelling set up)
Compressed Air Outlet	4" Fig 206 'Weco Wing'
Compressor Start Up	Electric Start (Standalone)
Ambient Operating Range	-10°C to + 50°C
Emission Compliance	EU Stage V & US EPA Tier 4 Final
Air Quality	Class Zero (ISO8573-1:2010) when operated via ScanTech SeaSentry™
Weight & Dimensions	
Length	6090mm
Width	2440mm
Height	2896mm
Weight	Gross 16,500kgs
Container Rating	CSC / DNV 2.7-1

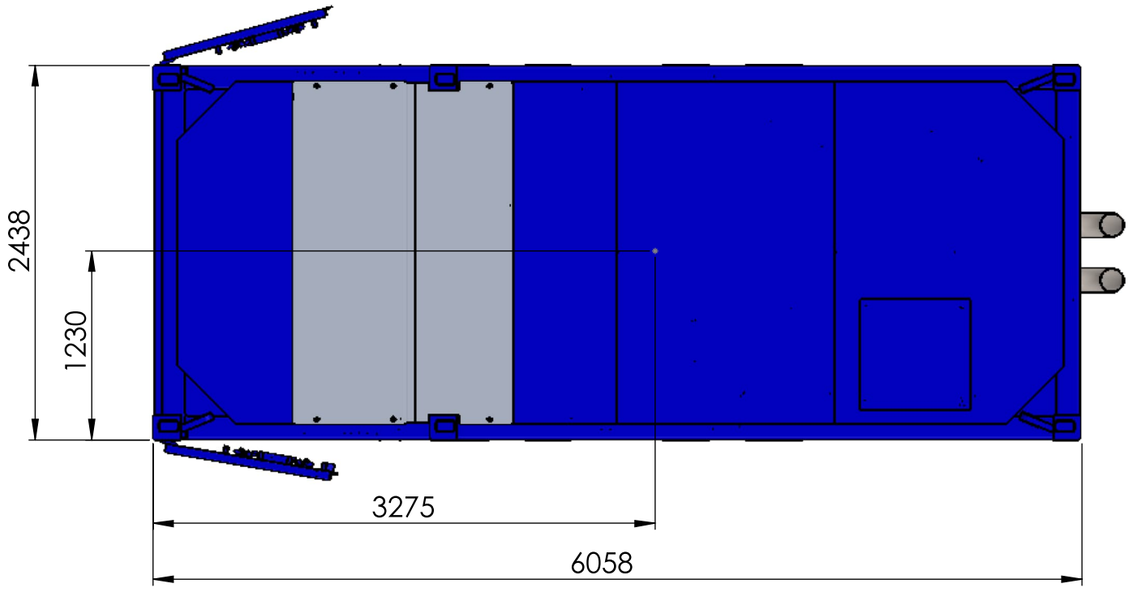
MANAGEMENT SYSTEM CERTIFICATION
DNV·GL
ISO 9001 = ISO 14001
OHSAS 18001

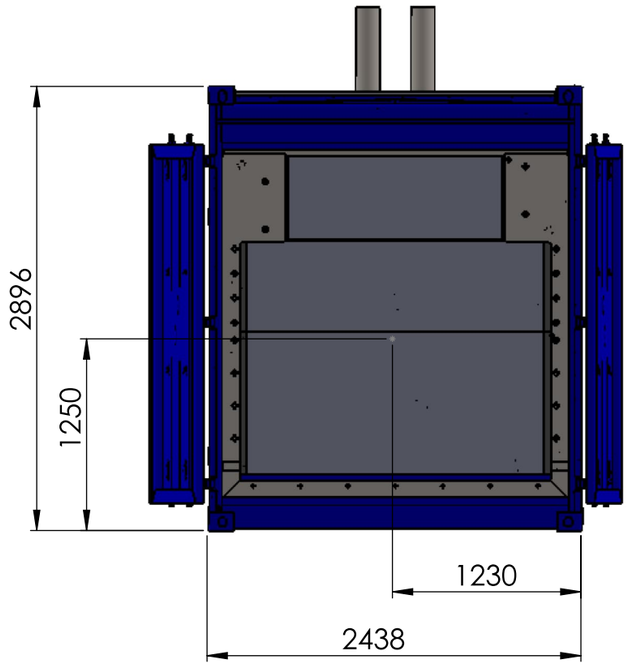
ScanTech Offshore
ScanTech House, Morton Peto Road
Great Yarmouth, NR31 0LT

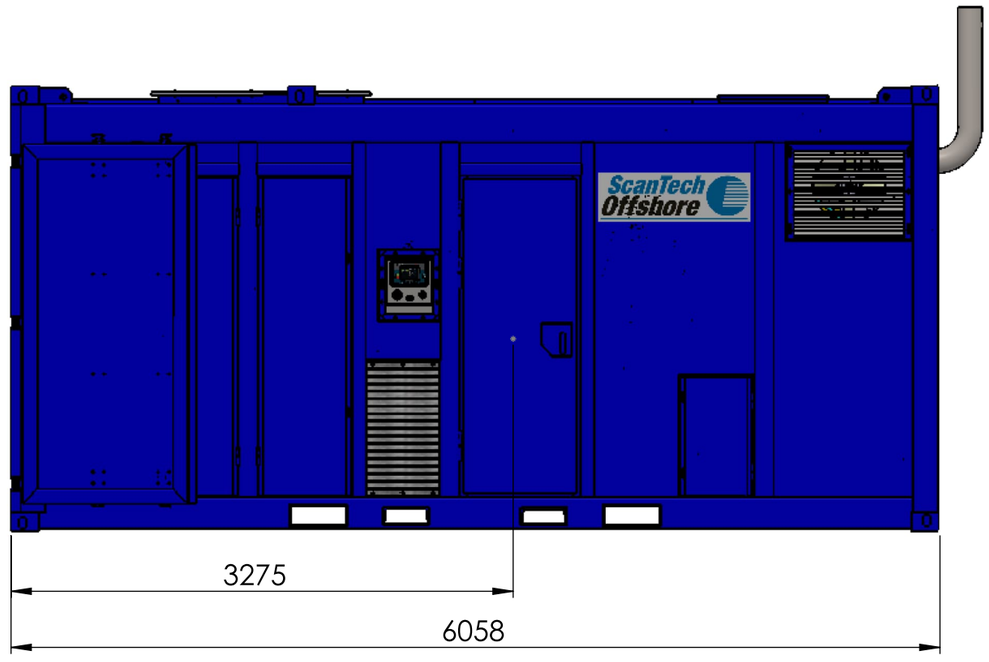
A part of
James Fisher and Sons plc
Marine Services Worldwide

DO NOT SCALE - IF IN DOUBT ASK

Total wet weight with full fuel tank = 17500Kg







REVISION HISTORY

No.	Description	By	Date

Scantech House
Morton Peto Road, Great Yarmouth
Norfolk, NR31 0LT
A member of James Fisher & Sons Plc

Title 3100cfm 175psig air compressor

Scale 1:40

Drawn	Date
Scott Berry	22/02/23
Checked	Date

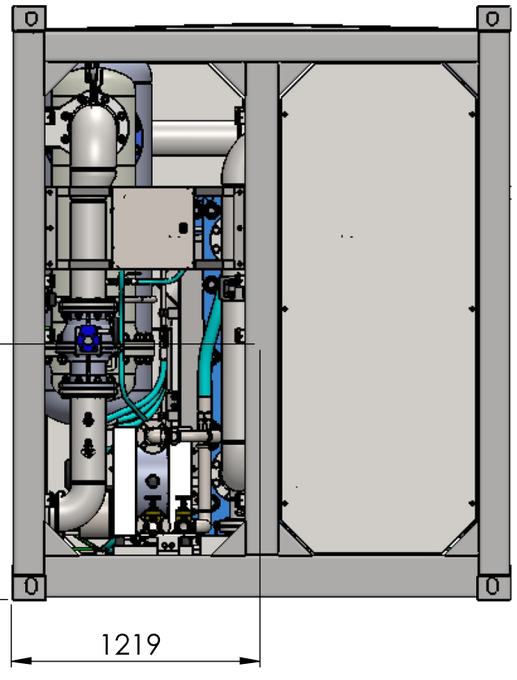
Detail Estimated CoG from 3D CAD data

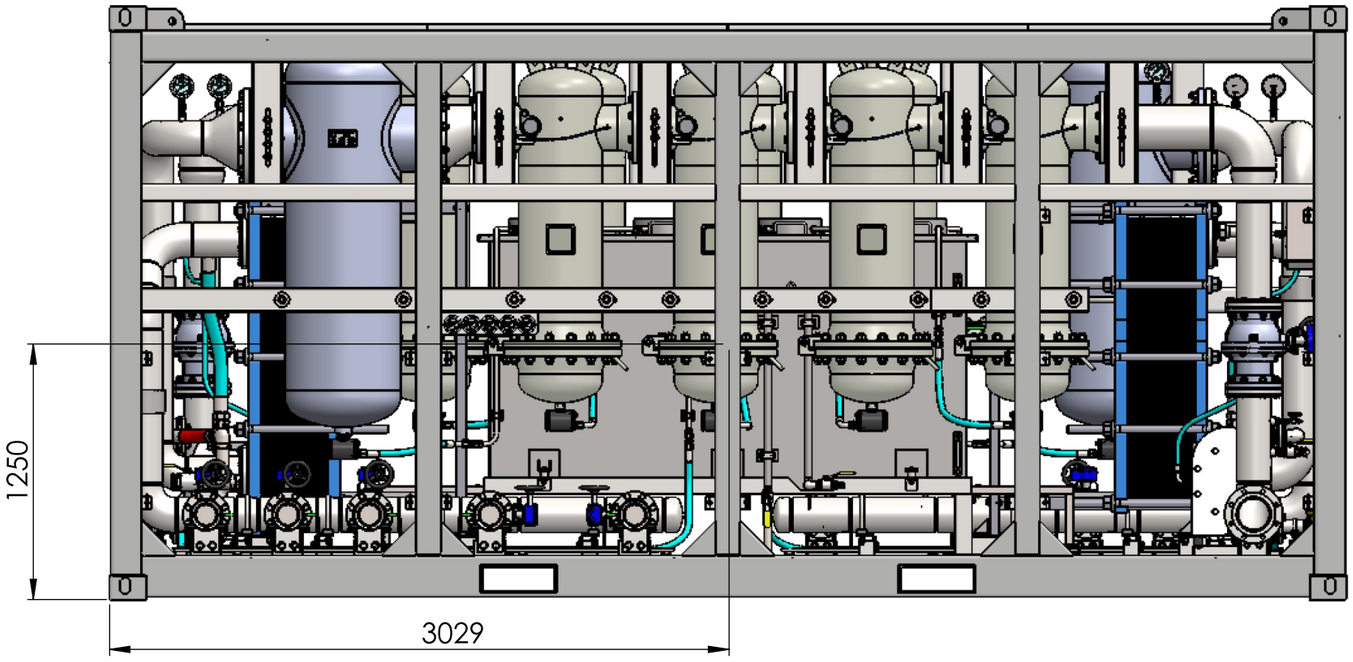
DWG No. 19-0096-001 CoG

D. TECHNICAL DESCRIPTION – AIR FILTRATION

DO NOT SCALE - IF IN DOUBT ASK

Total weight = 15000Kg





REVISION HISTORY

No.	Description	By	Date
0	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

ScanTech Offshore
Scantech House
Morton Peto Road, Great Yarmouth
Norfolk, NR31 0LT
A member of James Fisher & Sons Plc

Title Air Filtration 20' x 8' System

Scale	Drawn	Date
1:30	Scott Berry	25/04/22
	Checked	Date
	-	-

Detail Estimated CoG from 3D CAD data

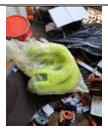
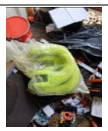
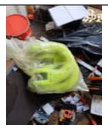
DWG No. RS-AIRFILTER-04744 3

E. TECHNICAL DESCRIPTION – SPARE PARTS LIST

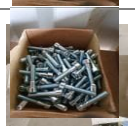
Spare parts -USA Project

Bernhard Weyres
BEKA-Schallschutzsysteme

Stand: 01.12.2022

Nr.	Bezeichnung	Menge		Einsatz	Bemerkungen	check per date	01.12.2022								
1	Oil filter Perkins	3		USA	BBC vessel		open								
2	Fuel filter Perkins	3		USA	BBC vessel		open								
3	Air filter Perkins	3		USA	BBC vessel		open								
4	Hammerlock 8 mm	4		USA	BBC vessel		v								
5	Hammerlock 13 mm	4		USA	BBC vessel		v								
6	Hammerlock 16 mm	2		USA	BBC vessel		v								
7	screws for closing a hose	2500		USA	BBC vessel		open								
8	Bit for unscrewing screws	4		USA	BBC vessel		v								
9	Bit for unscrewing screws from shells	3		USA	BBC vessel		v								
10	Drive pin	8		USA	BBC vessel		v								
11	Socket to impact hammer	4		USA	BBC vessel		v								
12	Pins for the shackles (big)	200		USA	BBC vessel		v								
13	Bushings	500		USA	BBC vessel		v								

Spare Parts _Boskalis USA_Winches_Power Packs

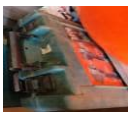
14	M10 x 80 screw	**20**		**USA**	BBC vessel		√									
15	M10 x 40 screw	**300**		**USA**	BBC vessel		√									
16	Nuts M10	**300**		**USA**	BBC vessel		√									
17	Nuts M16	**50**		**USA**	BBC vessel		√									
18	M16 screws	**50**		**USA**	BBC vessel		√									
19	Small grinder discs	**20**		**USA**	BBC vessel		open									
20	Big grinder discs	**20**		**USA**	BBC vessel		√									
21	Manometer (small and big)	**1 + 1**		**USA**	BBC vessel		√									
22	Multi purpose grease	**10**		**USA**	BBC vessel		open 7pcs									
23	Chainblock	**1**		**USA**	BBC vessel		√									
24	Measure tape	**1**		**USA**	BBC vessel		√									
25	Safety harness set	**4**		**USA**	BBC vessel		open									
26	Sling 2 m 3 T	**2**		**USA**	BBC vessel		√									
27	Sling 3 m 2 T	**2**		**USA**	BBC vessel		√									
28	Sling 3 m 5 T	**2**		**USA**	BBC vessel		√									

Spare Parts _Boskalis USA_Winches_Power Packs

29	Sling 2 m 1 T	**1**		**USA**	BBC vessel		√									
30	Sling 1 m 2 T	**1**		**USA**	BBC vessel		√									
31	Cargo strap 5,6 m + racket	**4**		**USA**	BBC vessel		√									
32	Cargo strap 7,5 m	**2**		**USA**	BBC vessel		√									
33	Cargo strap 9,6 m	**1**		**USA**	BBC vessel		√									
34	Cargo strap 8 m	**1**		**USA**	BBC vessel		√									
35	Cargo strap 19,5 m	**1**		**USA**	BBC vessel		√									
36	Lashing ratchet	**4**		**USA**	BBC vessel		√									
37	Spool with wire	**200 pcs a 53 cm**		**USA**	BBC vessel		√									
38	Pipe thread sealant	**2**		**USA**	BBC vessel		√									
39	Contact spray	**1**		**USA**	BBC vessel		√									
40	Electro cleaner	**1**		**USA**	BBC vessel		√									
41	Color spray	**14**		**USA**	BBC vessel		√									
42	Rostloser	**2**		**USA**	BBC vessel		√									
43	WD40	**1**		**USA**	BBC vessel		open									

Spare Parts _Boskalis USA_Winches_Power Packs

44	Grease gun	**1**		**USA**	BBC vessel		v									
45	Life vest clasp	**4**		**USA**	BBC vessel		open									
46	Oring	**1**		**USA**	BBC vessel		v									
47	Seals	**7**		**USA**	BBC vessel		v									
48	Spare cable with socket	**1**		**USA**	BBC vessel		open									
49	Cable tie	**250 pcs**		**USA**	BBC vessel		v									
50	Spare valve handles	**2**		**USA**	BBC vessel		v									
51	Extension cord	**1**		**USA**	BBC vessel		open									
52	Brushes	**3**		**USA**	BBC vessel		v									
53	Securing chain	**11**		**USA**	BBC vessel		v									
54	Oil spillage mats	**1 box**		**USA**	BBC vessel		v									
55	Oil Absorbent	**1**		**USA**	BBC vessel		v									
56	Spare batteries for impact hammer	**6**		**USA**	BBC vessel		v									
57	Pneumatic hose	**1**		**USA**	BBC vessel		v									
58	Hawsack	**1**		**USA**	BBC vessel		v									

59	Big grinder	**1**		**USA**	BBC vessel		√									
60	Small grinder	**1**		**USA**	BBC vessel		√									
61	Impact wrench	**2**		**USA**	BBC vessel		√									
62	Crimper	**2**		**USA**	BBC vessel		√									
63	Cordless screwdriver	**2**		**USA**	BBC vessel		√									
64	Crowbar	**1**		**USA**	BBC vessel		√									
65	Hose fork	**2**		**USA**	BBC vessel		√									
66	Anchor with heaving line	**2**		**USA**	BBC vessel		√									
67	Hose connections	**15**		**USA**	BBC vessel		√									
68	Shells set	**120**		**USA**	BBC vessel		√									
69	Rubber hammer	**2**		**USA**	BBC vessel		√									
70	Hammer 5 kg	**1**		**USA**	BBC vessel		√									
71	Hammer 1 kg	**2**		**USA**	BBC vessel		√									
72	Sprocket	**1**		**USA**	BBC vessel		√									
73	Shackles 4,75 t	**8**		**USA**	BBC vessel		√									

74	Shackles 8,5 t	**2**		**USA**	BBC vessel		v									
75	Shackles 3,25 t	**8**		**USA**	BBC vessel		v									
76	Shackles 2 t	**8**		**USA**	BBC vessel		v									
77	Swivl (small and big)	**2**		**USA**	BBC vessel		v									
78	Rope 30 m	**2**		**USA**	BBC vessel		v									
79	Rope 15 m	**1**		**USA**	BBC vessel		v									
80	Rope 10 m	**1**		**USA**	BBC vessel		v									
81	Rope 45 m	**2**		**USA**	BBC vessel		v									
82	Rope 60 m	**1**		**USA**	BBC vessel		v									
83	Spare torpedo	**3**		**USA**	BBC vessel		v									
84	Spare shere valve	**1**		**USA**	BBC vessel		v									
85	Life vest	**5**		**USA**	BBC vessel		open									
86	Polyprophylene rope	**270 m**		**USA**	BBC vessel		v									
87	Big buoy	**3**		**USA**	BBC vessel		v									
88	Small buoy	**7**		**USA**	BBC vessel		v									

Spare Parts _Boskalis USA_Winches_Power Packs

89	Screwdriver	**10**		**USA**	BBC vessel		√									
90	Ladder	**1**		**USA**	BBC vessel		√									
91	Pincers 70 cm	**2**		**USA**	BBC vessel		√									
92	Cuting Pincers	**1**		**USA**	BBC vessel		√									
93	Tool Box	**1**		**USA**	BBC vessel		√									
94	Electrical Tool Box	**1**		**USA**	BBC vessel		√									
95	Chain Conectors	**40**		**USA**	BBC vessel		√									
96	Hydraulic Oil	**20 L**		**USA**	BBC vessel		√									
97	Engine Oil	**5 L**		**USA**	BBC vessel		√									
98	Coolant	**10 L**		**USA**	BBC vessel		√									
99	Battery 12V	**1**		**USA**	BBC vessel		√									
100	Spare Chain 1 M	**12**		**USA**	BBC vessel		√									
101	Wrench Box	**1**		**USA**	BBC vessel		√									
102	Spanner (32, 17, 13, 27, 13, 24,24)	**1**		**USA**	BBC vessel		√									
103	winch bearing	**1**		**USA**	BBC vessel		√									