

Survey report for vibrocore investigations, 2023

Geological screening for offshore wind farms,
the Danish Energy Agency

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1. Summary

GEUS has carried out fieldwork in 2023 in Danish waters as part of a geological screening for offshore windfarms for the Danish Energy Agency (ENS). The purpose of the survey was to acquire sediment cores with vibrocore equipment widespread in the survey areas for correlation with the seismic data acquired in 2022 and 2023 and verification of the geological interpretations. A secondary purpose was to perform CPT measurements in a dedicated case study area for more detailed correlation between downhole information and seismic data and for a first correlation between large scale geological interpretation and geotechnical parameters. Thus, the acquired data will serve to establish a better basis for developing conceptual geological models and mapping geological units of importance for offshore windfarm development.

The survey, hereafter referred to as the ENS 2023 vibrocore and CPT survey, comprised most of the Danish waters. The activities were carried out using the survey vessel Fortuna Crane and was divided into five survey legs. Mobilization of the vibrocore equipment took place in Esbjerg on August 14 and the investigations started August 15. The survey finished on September 16 at Bornholm.

Leg 1 started August 14 and included 23 vibrocores in the North Sea. Some technical problems with the anchor winches of the vessel were encountered as well as a short period of weather standby and repair in Hvide Sande. Before planned crew change and repair in Esbjerg on August 21, 7 vibrocores were taken as part of another project at Blåvandshuk.

Leg 2 started out August 21 with acquisition of 5 vibrocores on the Blåvandshuk project mentioned above and subsequently 45 vibrocores were taken in the North Sea. Two periods of weather standby were encountered, one offshore and one in Hirtshals also with repair due to continued technical problems with the anchor winches. A planned crew change took place in Hirtshals on August 30.

Leg 3 started August 30 and comprised 73 vibrocores in Kattegat, south of Ærø, southeast of Lolland and Falster and east of Sjælland. Additionally, 4 vibrocores were taken on another project in Langelandsbælt, Fakse Bugt and Kattegat. A short period of rough weather was used for transit from Kattegat to south of Ærø. A planned crew change took place in Grenaa on September 7.

Leg 4 started with mobilization of CPT equipment and repair of anchor winches in Grenaa on September 7 and 8 and included 2 CPT measurements on September 9 and 10, respectively, before demobilization of the equipment and crew change in Grenaa on September 10. Technical problems with the CPT equipment resulted in one damaged CPT cone on September 9 and a broken CPT rod on September 10 resulted in loss of the second and last CPT cone.

Leg 5 started with transit to Bornholm on September 11 and subsequently 24 vibrocores were taken around Bornholm. A short period of rough weather was used for taking 11 vibrocores on another project in a more sheltered area southwest of Rønne before resuming

the ENS survey and finishing on September 16. After the survey, 3 additional vibrocores were taken in Kattegat off Grenaa during another project.

A total of 168 vibrocores and 2 CPT measurements were carried out during the ENS 2023 vibrocore and CPT survey. Details on the vibrocore and CPT positions are provided in the survey log included as Appendix A.

2. Introduction and purpose

GEUS has carried out vibrocoreing and CPT fieldwork for the Danish Energy Agency (Energistyrelsen, ENS) as part of the offshore windfarm geological screening in Danish waters. The survey is hereafter referred to as ENS 2023 vibrocoreing and CPT survey.

The purpose of the offshore windfarm geological screening is to collect geophysical and geological data that improves the knowledge of the shallow geological conditions in Danish waters. In the fall 2022 and spring 2023 a major seismic mapping program was conducted. Thus, the aim of the ENS 2023 vibrocoreing and CPT survey is to support the geological interpretation of the seismic data by providing sediment composition at the borehole positions and in selected locations provide estimates of geotechnical strength parameters.

Prior to the survey activities, GEUS applied for and was granted relevant permissions for the investigations.

3. Overview of survey activities

The ENS 2023 vibrocore and CPT survey was carried out using the survey vessel Fortuna Crane (Figure 3.1) provided by Foga Consult ApS.



Figure 3.1 Survey vessel Fortuna Crane.

Mobilization of vibrocore equipment on board the Fortuna Crane took place in Esbjerg on August 14. The vibrocore survey was initiated on August 15 and was divided into five survey legs. The survey finished on September 16 at Bornholm, where the vessel, personnel and equipment started directly on another project.

In addition, 3 ENS survey vibrocores were carried out off Grenaa during a subsequent project on September 20.

3.1 Vibrocore and CPT

Based on the interpretation of existing seismic data, 168 vibrocore locations were designated and sampled during the survey (Figure 3.2) in 11 different areas, while 2 CPT measurements were performed.

The acquisition of vibrocores included sediment cores from the seabed and down to a maximum depth of 6 m. The CPT measurements included cone push down to a maximum depth of 15 m.

A general overview of the vibrocore and CPT activities appears from Table 1, while further details are included in chapter 5 and the vibrocore and CPT survey logs in Appendix A.

In total, 168 vibrocores and 2 CPT measurements were carried out.

Table 1 Overview of survey areas and vibrocore/CPT locations. Further details are included in chapter 5 and Appendix A.

Area	ID	No. of vibrocores	No. of CPT's
Western North Sea	VN	36	
Southern North Sea	SN	7	
Near-coast Southern North Sea	SN-K	6	
Northern North Sea	NN	11	
Potential gas seep sites, North Sea	SEEP	8	
Læsø North	LN	8	
Læsø-Anholt	LA	20	
Anholt South	AS	26	2
Vejsnæs Flak	VF	9	
Køge Krieger	KK	13	
Bornholm	BO	24	
Total		168	2

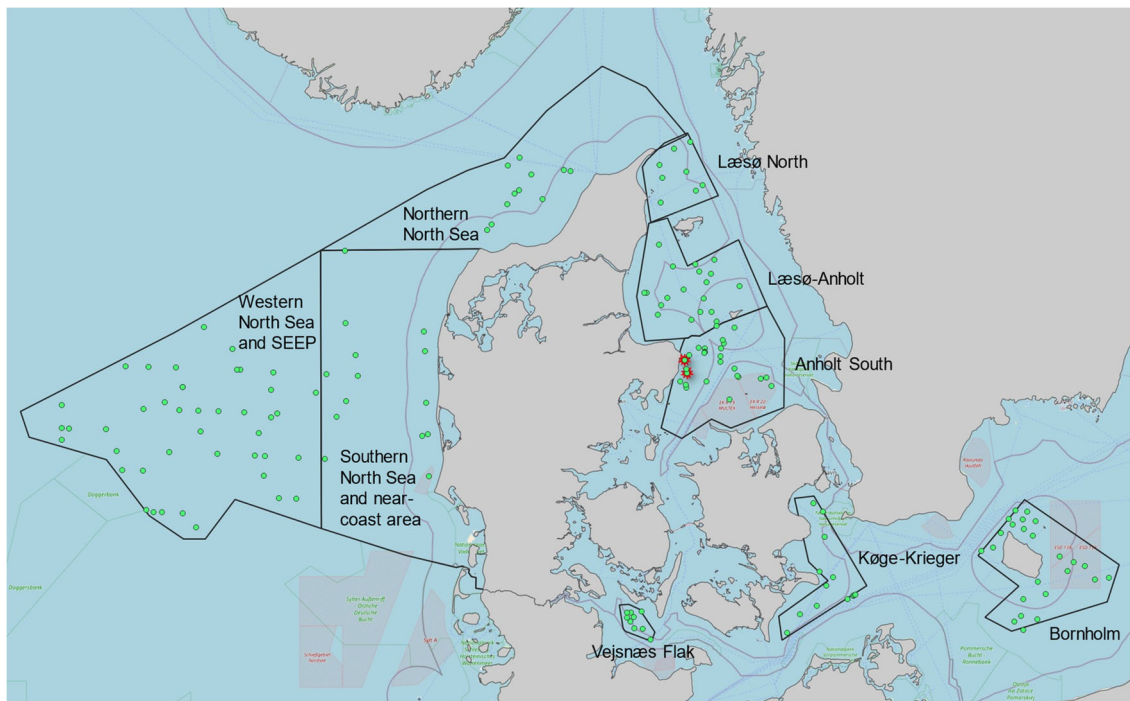


Figure 3.2 Overview map with location of vibrocores (green dots) and CPT's (red stars).

4. Personnel

Apart from the professional ship crew, GEUS had a crew of 9 people manning the ENS 2023 vibrocore and CPT survey, a vibrocore crew of 5 people from Bjerregaard Montage ApS and a CPT crew of 4 people from Geo-Engineering GmbH.

Data acquisition was carried out 24/7 and each survey leg was manned with a GEUS cruise lead, a GEUS surveyor and a vibrocore/CPT team of four people working in two shifts.

The GEUS cruise lead had the overall responsibility for the vibrocore/CPT survey and the drilling and CPT teams operated the vibrocore and CPT instruments, respectively. The GEUS cruise lead and GEUS surveyor planned the vibrocore activities and was responsible for the on-site geological description and quality control of the data.

The following people attended each survey leg:

Leg 1 – Vibrocore: 14/8 - 21/8

The GEUS personnel was:

- Katrine Elnegaard Hansen (Cruise lead/Surveyor)
- Rasmus Ørneköll Stenshøj (Surveyor)

The drilling crew was:

- Andreas Hansen
- Jakob Vind
- Jon Braher
- Ole Camin

Leg 2 – Vibrocore: 21/8 - 30/8

The GEUS personnel was:

- Niels Nørgaard-Pedersen (Cruise lead/Surveyor)
- Sunny Singroha (Surveyor)

The drilling crew was:

- Andreas Hansen
- Jakob Vind
- Jon Braher
- Ole Camin

Leg 3 – Vibrocore: 30/8 - 7/9

The GEUS personnel was:

- Henrik J. Granat (Cruise lead, geologist)
- Lisbeth L. Pedersen (BSc in geoscience)

The drilling crew was:

- Andreas Hansen
- Jakob Vind
- Jon Braher
- Jakob Lynge Hansen

Leg 4 – CPT: 7/9 - 11/9

The GEUS personnel was:

- Thomas Vangkilde-Pedersen (Cruise lead, geologist)
- Nicklas Christensen (geologist)

The CPT crew was:

- Tobias Mörz
- Wolfgang Schunn
- Saskia Stanjura
- Mark Jörg Schachtschneider

Leg 5 – Vibrocoreing: 11/9 – 16/9

The GEUS personnel was:

- Luna Holland Winther (Cruise lead, geologist)
- Lisbeth L. Pedersen (BSc in geoscience)

The drilling crew was:

- Andreas Hansen
- Jakob Vind
- Jon Braher
- Ole Camin

5. Equipment and operation

Before vibrocore or CPT operations, the vessel was anchored at the desired location using typically one forward anchor and one aft anchor. In a few positions, e.g. the CPT locations, three-point mooring was necessary using a third anchor.

In Figure 5.1 below, is shown the ship's navigation panel used when anchoring together with a typical anchor layout with respect to wind direction.

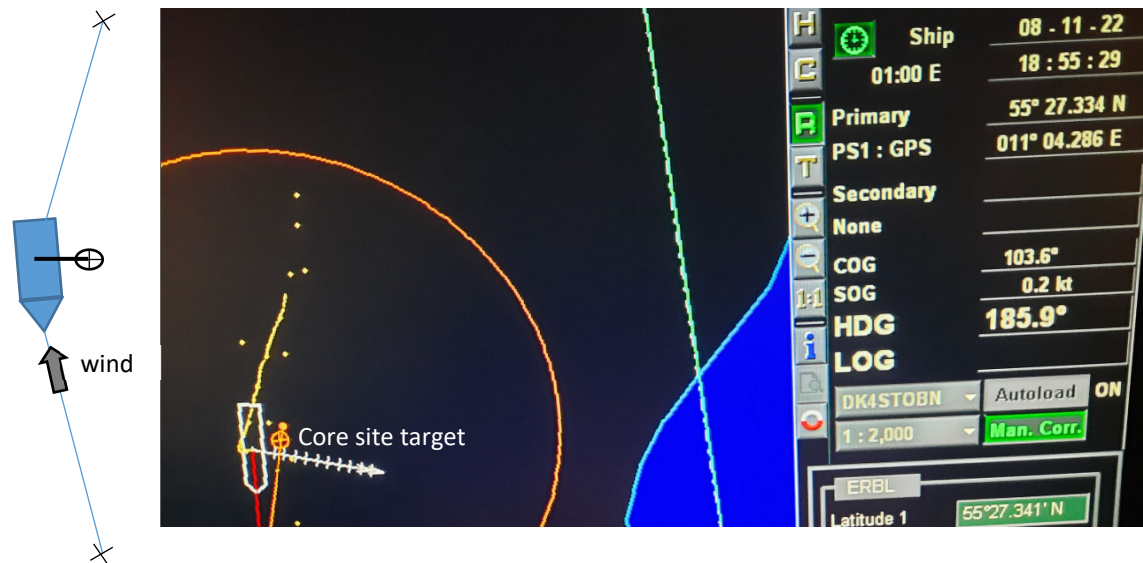


Figure 5.1 Navigation panel used when anchoring at the planned vibrocore or CPT locations. To the left is seen a typical anchor layout with respect to wind direction.

The actual vibrocore and CPT locations were collected in WGS84 Lat/Long degrees and decimal minutes with three decimals. Most often the actual positions were within a few meters from the planned positions and in general always within 30 m with very few exceptions.

5.1 Vibrocoring

The acquisition of vibrocores included sediment cores from the seabed and down to a maximum depth of 6 m with a Vibracorer MED-C VC(VKG)-6 operated using the ship crane.

The drilling crew prepared, deployed, operated, and recovered the vibrocore instrument (Figure 5.2). After the vibrocorer was back on deck, the 6 m long plastic core sleeve was extracted from inside the metal core barrel and cut into 1 m segments for storage and handling. GEUS geologists labeled the core segments with site-identifying codes and logged the lithology at the top of every core segment as well as any sediment in the core-catcher at the tip of the core barrel, to get an indication of the geology at the deepest penetration point.



Figure 5.2 Deck arrangement of Fortuna Crane during vibrocore operations, looking aft from the bridge. Port side is to the right and starboard is to the left. The crane is mounted on the starboard side, but the vibrocrorer (centre of deck) is deployed over the port side.

In Figure 5.3 below, the vibrocore instrument is shown in more detail. The vibrator part is the grey box just above the hexagonal foundation close to the deck. When loading, the vibrator unit is raised to the top of the tower, and a pvc tube is inserted into the steel core barrel before it is raised to vertical position. Then the crane is used for deploying the vibrocrorer into the water and lowering it to the seabed where the core barrel and pvc tube is vibrated into the subsurface. When no more penetration is possible, the barrel and pvc tube is pulled back again, and the vibrocore unit retrieved back on deck and unloaded.

The vibrocrorer contains an echo-sounder unit and a current-measuring unit. The echo-sounder unit measures the approximate distance from the vibrocore unit to the seabed, and the current-measuring unit measures the induced amperes within the vibrator part as a proxy for the amount of pressure the vibrocrorer uses to penetrate the subsurface.

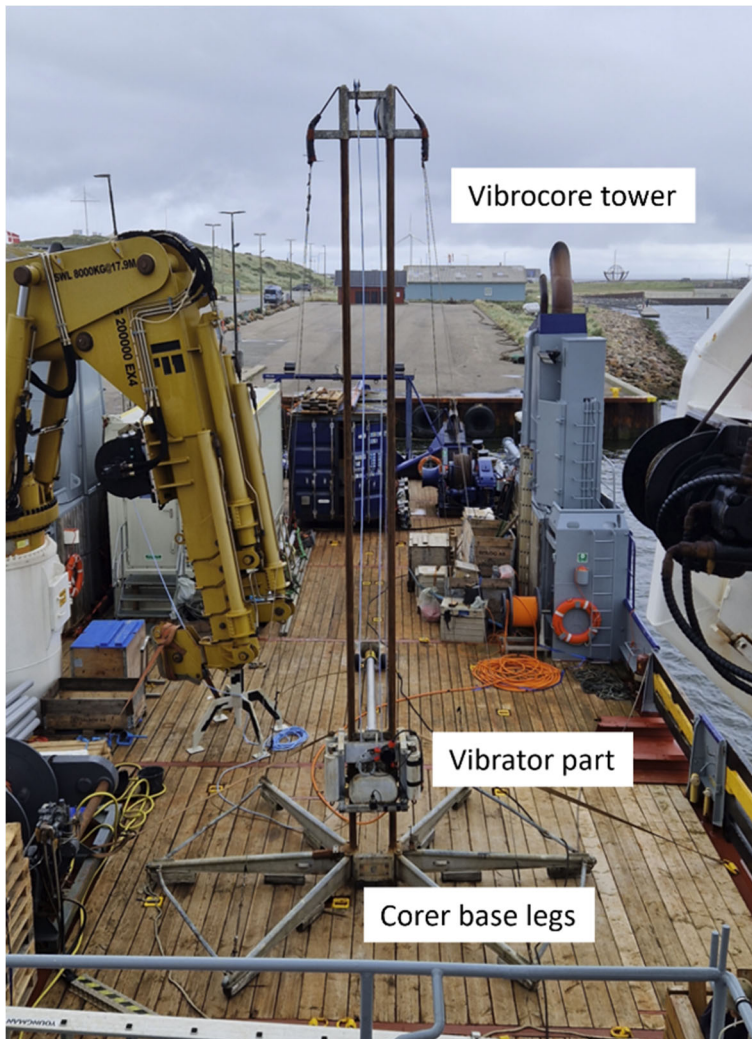


Figure 5.3 Vibrocore instrument used for sediment sampling. The vibrator part can be seen as the grey unit above the hexagonal foundation close to the deck.

5.2 CPT

The CPT measurements included cone push from the seabed and down to a maximum depth of 15 m with a GOST CPT unit from Geo-Engineering in Germany.

The CPT crew prepared, deployed, operated and recovered the CPT unit (Figure 5.4).

First the CPT rig is lowered over the side of the vessel and a gangway is positioned above it (Figure 5.5). Then CPT rods of 1,5 m length are sequentially mounted on the rig, with the CPT cone on the first one, and the rig lowered correspondingly until the desired length of 15 m CPT rod. This is a time-consuming, but necessary procedure, especially as the rod is build longer and have to be stabilized from movements in the water. Then the CPT rig is lowered to the seabed and the CPT measurements started.

The CPT measurements are controlled by an acquisition unit and logged on a pc. The CPT rod and cone is pushed into the seabed in push sequences of 25 cm each, while logging the

tip resistance, sleeve friction and pore fluid pressure. When the desired depth of 15 m is reached, or when tip resistance exceeds a set limit of 45 MPa, the CPU unit stops pushing.

After finishing the CPT measurements, the rods are pulled out of the seabed and the CPT rig raised with the crane until the first rod can be dismantled. Then the rods are sequentially dismantled from the rig, and the rig is brought back on deck.

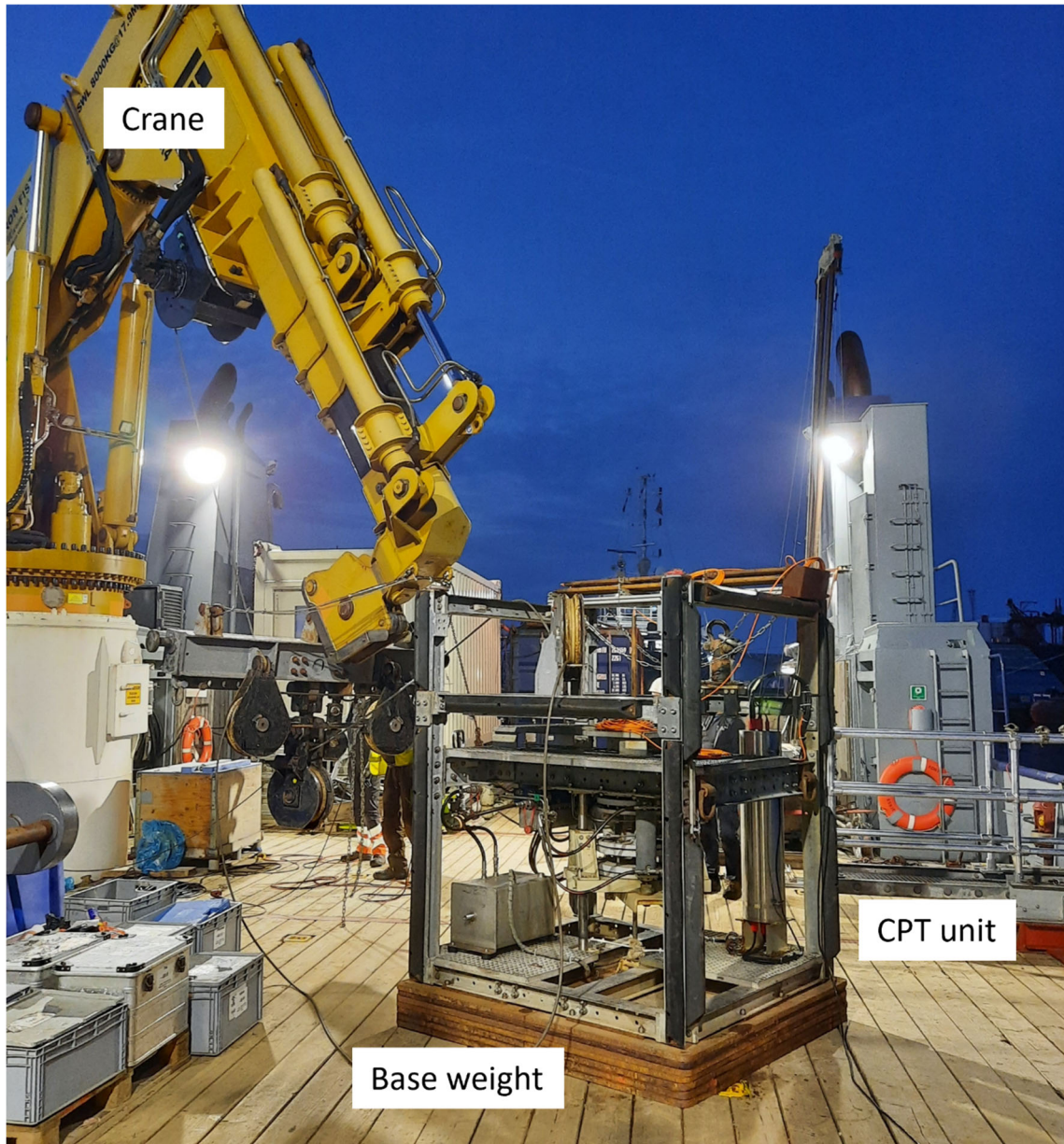


Figure 5.4 The GOST CPT unit on the deck of Fortuna Crane.

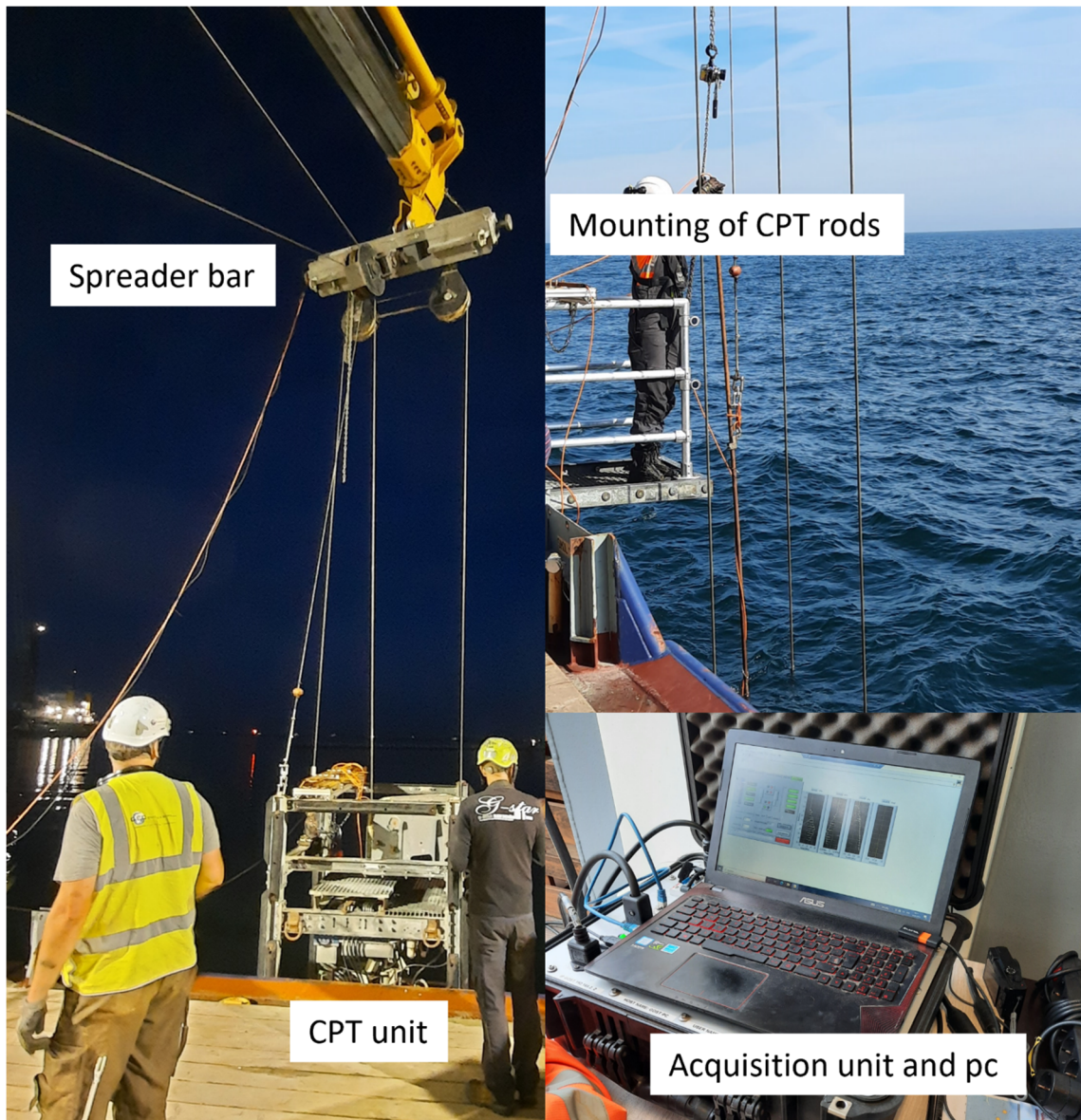


Figure 5.5 GOST CPT unit under deployment to the left with the stabilizing spreader bar seen just below the crane. On the upper right, the mounting of CPT rods during deployment is shown. On the lower right, the acquisition unit and pc are shown.

5.3 Activity report

Mobilization took place in Esbjerg on August 14 and the survey ended off Bornholm on September 16 after five survey legs. Below is given a more detailed overview of the activities during each survey leg.

Leg 1 – Vibrocoreing: 14/8 - 21/8

Leg 1 included vibrocore activities in four different areas: Near-coast Southern North Sea (6 cores), Southern North Sea (6 cores), Western North Sea (10 cores) and Potential gas seep sites, North Sea (1 core). In total 23 vibrocores were taken.

The survey activities started on August 15, but the weather conditions deteriorated and on August 15-16 there was a port call to Hvide Sande for weather standby, repair and ship crew change.

On August 20 there was a planned break in the survey to acquire 7 vibrocores on another project (raw material investigations near Blåvandshuk for Kystdirektoratet, permit J.nr. 2023-12401 from Miljøstyrelsen) before a planned crew change.

During Leg 1 technical problems with an autostop on the crane wire and with some of the anchor winches were encountered and caused delays on August 15, 19 and 21, see also chapter 6.

On August 21 there was a port call to Esbjerg for repair of anchor winches and for fixing the autostop on the crane wire as well as a planned GEUS crew change.

Leg 2 – Vibrocoreing: 21/8 - 30/8

Leg 2 started out with acquisition of 5 vibrocores on the Blåvandshuk project mentioned above on August 21 and 22.

Subsequently activities in the ENS survey were resumed and Leg 2 also included vibrocore activities in four different areas: Southern North Sea (1 core), Western North Sea (26 cores), Northern North Sea (11 cores) and Potential gas seep sites, North Sea (7 core). In total 45 vibrocores were taken.

On August 24 and 25 the weather conditions forced a weather standby period offshore in the western part of the North Sea.

Technical problems with some of the anchor winches continued during Leg 2 on August 23 and 27 (see also chapter 6) and on August 27-28 there was a port call to Hirtshals for repair and subsequently weather standby.

On August 30 there was a port call to Hirtshals for a planned GEUS crew change.

Leg 3 – Vibrocoreing: 30/8 - 7/9

Leg 3 included vibrocore activities in five different areas: Læsø North (8 cores), Læsø-Anholt (20 cores), Anholt South (23 cores), Vejsnæs Flak (9 cores) and Køge Krieger (13 cores). In total 73 vibrocores were taken.

On August 31 there were technical problems with an anchor winch for a short period and on September 2, a transit was made from Kattegat to south of Ærø due to weather conditions.

Before resuming vibrocoreing in Kattegat, vibrocores south of Ærø, southeast of Lolland and Falster and east of Sjælland were taken.

On September 2, an additional vibrocore was taken on another project (raw material investigations for Miljøstyrelsen, permit J.nr. 2023 – 17265 from Miljøstyrelsen) and on September 5, three additional vibrocores were taken on the same project.

On September 7 there was a port call to Grenaa for a planned GEUS crew change and mobilization of CPT equipment.

Leg 4 – CPT: 7/9 - 11/9

On September 7 mobilization of CPT equipment began in Grenaa and was finished late on September 8. During the port call in Grenaa further repair of anchor winches was carried out.

The first CPT measurement was performed on September 9 but followed by technical problems with the CPT equipment and damage of the CPT cone. After troubleshooting and repair, the second CPT measurement was performed on September 10 with a new CPT cone, but the CPT rod broke during the CPT push and the cone was lost. With one CPT cone out of two damaged and the second lost, it was not possible to perform further CPT measurements.

On September 10 there was a port call to Grenaa for demobilization of CPT equipment and GEUS crew change.

Leg 5 – Vibrocoreing: 11/9 – 16/9

Leg 5 started out with transit to Rønne on September 11 for ship crew change and GEUS crew change on September 12 before resuming vibrocoreing activities on September 13 with 24 vibrocores in the Bornholm area.

On September 14 there was a weather induced break in the ENS survey to acquire 11 vibrocores on another project (raw material investigations for Miljøstyrelsen, permit J.nr. 2023 – 17265 from Miljøstyrelsen).

The ENS survey was resumed on September 15 and finished on September 16, but after the survey, 3 additional vibrocores were taken in Kattegat off Grenaa during another project.

6. Unintended events

The general overview of the survey activities during the Vibrocore ENS 2023 survey appears from chapter 5 and 6, and below a number of unintended events are described.

6.1 Equipment breakdown

During the first week of survey there was a problem with an autostop function on the crane wire limiting the payout length. This was realized on August 17 and overcome by choosing vibrocore locations with water depth less than c. 43 m until the problem was fixed during a port call to Esbjerg on August 21.

On August 15 a loose anchor wire caused some hours of delay and had to be cut. This was later fixed during a port call to Hvide Sande on August 16.

On August 19, 21, 23, 27 and 31 there were several problems with breakdown of port side aft and starboard forward anchor winches. On August 19 repair was carried out offshore and on August 21 repair was carried out during a port call to Esbjerg. On August 23 repair was carried out offshore and on August 28 repair was carried out during a port call to Hirtshals. On September 1 repair was carried out offshore and on September 7 and 8 repair was carried out again during a port call to Grenaa.

During CPT measurements on September 9, the CPT cone got stuck in the subsurface in a depth of 3,2 m in the very beginning of a push. This caused problems in the hydraulic system of the CPT rig and at first it was not possible to pull out the CPT rod and cone. However, after a while, the clamps on the CPT rig suddenly released, and the CPT rod was pulled out of the rig very fast by the tension winch causing damage of the CPT cone. After bringing the CPT rig back on deck, the electronic communication to the unit was lost and troubleshooting and repair was started.

During CPT measurements on September 10 with a new CPT cone, the CPT rod broke during the CPT push in a depth of 9 m and the cone was lost. It first appeared that the CPT unit had stopped pushing because of tip resistance exceeding a set limit of 45 MPa and that it was not possible to pull back the CPT rod. It was therefore decided to use the crane to lift the CPT rig and pull out the rod. However, when bringing the CPT rig back on deck it became clear, that the CPT rod had been broken during the last push and before lifting the rig with the crane. With one CPT cone out of two damaged and the second lost, it was not possible to perform further CPT measurements.

6.2 Crew change

On August 16, the captain of Fortuna Crane was replaced because of illness. This caused some hours of delay until a new captain was on board.

7. Concluding remarks

GEUS has carried out vibrocoreing and CPT measurements in 2023 in Danish waters as part of a geological screening for offshore windfarms for the Danish Energy Agency (ENS).

The ENS 2023 vibrocoreing and CPT survey was conducted between August 14 and September 16 from the survey vessel Fortuna Crane and was divided into five survey legs.

During Leg 1, 23 vibrocores were taken in the North Sea and during Leg 2, 45 vibrocores were taken in the North Sea. During Leg 3, 73 vibrocores were taken in Kattegat, south of Ærø, southeast of Lolland and Falster and east of Sjælland. During Leg 4, 2 CPT measurements were carried out in Kattegat off Grenaa. During Leg 5, 24 vibrocores were taken around Bornholm and after the survey 3 additional vibrocores were taken in Kattegat off Grenaa during another project. Thus, a total of 168 vibrocores and 2 CPT measurements were carried out. In addition, 27 vibrocores were carried out as part of other projects on Leg 1, 2, 3 and 5. Details on the vibrocore and CPT locations are provided in the survey log included as Appendix A.

Technical problems with especially the anchor winches of the survey vessel were encountered and were causing delays, but this was compensated by a very efficient production during other times. The number of CPT measurements were less than expected due to technical problems with the CPT rig and loss of a CPT cone, but the experience learned is very valuable for future planning. Otherwise, the ship, crew and survey equipment performed satisfactorily and there were no incidents to report. The weather conditions were mostly good, and weather standby only had a minor impact on the overall productivity given the very long survey period. The first quality assessment of the sediment cores and CPT measurements reveals high quality for all data serving the purpose of the survey.

Appendix A – Vibrocore and CPT survey log

Project: ENS screening for havvind									Client: Energistyrelsen									Drilling Platform: Fortuna Crane (Call sign: OZWM2)		
Core-ID	Planned positions								Actual positions						Comments					
	UTM Zone 32, WGS84		WGS 84				UTM Zone 32, WGS84		WGS 84				Water depth	Water depth				Date	Date UTC	Time
	X	Y	LATITUDE		LONGITUDE		X	Y	LATITUDE		LONGITUDE		Echo sounder	Surface to seabed						
	m	m	Degrees	Decimal minutes	Degrees	Decimal minutes	m	m	Degrees	Decimal minutes	Degrees	Decimal minutes	m	m	Date	Date UTC	Time	Time UTC	m	
SN-K-4	437462	6168778	55	39,649	8	0,356	437461	6168778	55	39,649	8	0,356	13	16	15-08-2023	15-08-2023	14.20	12.20	5,52	
VN-57	361490	6183074	55	46,408	6	47,511	361464	6183048	55	46,393	6	47,486	32,4	35,4	17-08-2023	17-08-2023	08.00	06.00	5,98	
VN-60	342619	6184740	55	46,958	6	29,421	342623	6184769	55	46,975	6	29,423	38,4	41,4	17-08-2023	17-08-2023	11.30	09.30	5,94	
VN-67	316356	6172506	55	39,817	6	4,819	316346	6172492	55	39,809	6	4,810	43,6	46,6	17-08-2023	17-08-2023	14.00	12.00	5,77	
VN-69	317930	6186909	55	47,607	6	5,743	317900	6186894	55	47,598	6	5,715	43,1	46,1	17-08-2023	17-08-2023	16.00	14.00	4,02	Short core length due to temporary limitations on crane wire.
SEEP-16.1	310504	6187574	55	47,794	5	58,619	310501	6187561	55	47,787	5	58,617	43,9	46,9	17-08-2023	17-08-2023	19.15	17.15	4	
VN-50	314271	6203614	55	56,517	6	1,559	314266	6203613	55	56,516	6	1,555	43	46	17-08-2023	17-08-2023	22.00	20.00	4,23	Short core length due to temporary limitations on crane wire.
VN-52	323667	6214580	56	2,633	6	10,143	323665	6214586	56	2,637	6	10,141	42	45	18-08-2023	18-08-2023	02.30	00.30	3,61	Short core length due to temporary limitations on crane wire.
VN-53	328252	6217179	56	4,134	6	14,454	328233	6217217	56	4,154	6	14,434	41	44	18-08-2023	18-08-2023	04.00	02.00	3,26	Short core length due to temporary limitations on crane wire.
VN-84	324585	6234394	56	13,322	6	10,244	324561	6234402	56	13,327	6	10,220	37	40	18-08-2023	18-08-2023	06.00	04.00	5,16	
VN-09	326404	6246797	56	20,041	6	11,513	326393	6246807	56	20,046	6	11,502	42,9	45,9	18-08-2023	18-08-2023	09.00	07.00	3,77	
VN-05	356780	6231184	56	12,240	6	41,472	356771	6231197	56	12,247	6	41,463	40	43	18-08-2023	18-08-2023	13.00	11.00	1,76	
SN-17	371217	6213356	56	2,884	6	55,943	371223	6213376	56	2,894	6	55,947	33,9	36,9	18-08-2023	18-08-2023	16.00	14.00	5,39	
SN-16	378469	6224626	56	9,069	7	2,616	378485	6224611	56	9,061	7	2,632	30,5	33,5	18-08-2023	18-08-2023	19.00	17.00	5,45	
SN-12	364614	6244298	56	19,442	6	48,640	364614	6244294	56	19,440	6	48,641	34	37	18-08-2023	18-08-2023	22.30	20.30	5,91	
SN-K-12	435848	6259320	56	28,439	7	57,515	435847	6259343	56	28,451	7	57,514	17	20	19-08-2023	19-08-2023	5.30	3.30	3,49	
SN-K-14	435616	6273311	56	35,977	7	57,081	435630	6273364	56	36,006	7	57,094	17,4	20,4	19-08-2023	19-08-2023	8.05	6.05	4,34	
SN-05	379598	6280531	56	39,204	7	2,163	379595	6280522	56	39,200	7	2,161	35,8	38,8	19-08-2023	19-08-2023	23.35	21.35	4,42	
SN-10	385949	6257335	56	26,803	7	8,987	385941	6257340	56	26,806	7	8,979	30,9	33,9	20-08-2023	20-08-2023	04.05	02.05	2,27	
SN-15	387515	6242416	56	18,788	7	10,895	387501	6242425	56	18,792	7	10,881	30	33	20-08-2023	20-08-2023	06.50	04.50	2,80	
SN-K-8	436461	6222046	56	8,354	7	58,651	436475	6222043	56	8,352	7	58,665	13,7	16,7	20-08-2023	20-08-2023	09.50	7.50	3,98	
SN-K-3	436953	6199425	55	56,165	7	59,445	436979	6199412	55	56,158	7	59,470	17,5	20,5	20-08-2023	20-08-2023	14.00	12.00	5,78	
SN-K-2	433282	6198458	55	55,614	7	55,934	433284	6198461	55	55,615	7	55,936	19,5	22,5	20-08-2023	20-08-2023	15.20	13.20	3,34	
VN-61	339893	6154716	55	30,734	6	27,864	339907	6154711	55	30,732	6	27,878	40	43	22-08-2023	22-08-2023	10.15	8.15	5,8	
VN-63	327114	6155924	55	31,124	6	15,691	327123	6155909	55	31,116	6	15,700	40,3	43,3	22-08-2023	22-08-2023	13.30	11.30	5,15	
VN-81	264814	6137076	55	19,423	5	17,556	264816	6137066	55	19,418	5	17,558	40	43	22-08-2023	22-08-2023	19.00	17.00	5,54	
SEEP-14.1	255499	6148170	55	25,118	5	8,186	255507	6148159	55	25,113	5	8,194	41,5	44,5	22-08-2023	22-08-2023	20.30	18.30	5,6	For SEEP-14.1, we put numbers on geochemical samples as 7, 8, 9, 10, 11 and 12 for sections 1, 2, 3, 4, 5 and 6, respectively. For example, Section 5 top is written as 11 top and so on.
VN-79	240420	6149603	55	25,424	4	53,849	240430	6149591	55	25,418	4	53,859	38,6	41,6	22-08-2023	22-08-2023	22.30	20.30	4,45	
VN-78	228860	6151900	55	26,284	4	42,786	228876	6151876	55	26,271	4	42,803	42,2	45,2	23-08-2023	22-08-2023	00.15	22.15	5,15	
SEEP-13.1	234349	6150177	55	25,537	4	48,076	234354	6150168	55	25,533	4	48,082	42,5	45,5	23-08-2023	23-08-2023	18.00	16.00	5,87	
VN-83	228076	6180794	55	41,790	4	40,340	228097	6180819	55	41,805	4	40,359	37,6	40,6	23-08-2023	23-08-2023	21.00	10.00	4,90	
VN77	213189	6182174	55	42,019	4	26,087	213195	6182178	55	42,022	4	26,092	32,6	35,6	23-08-2023	23-08-2023	23.00	21.00	5,25	
VN-82	210113	6196419	55	49,564	4	22,252	210112	6196405	55	49,557	4	22,253	40	43	24-08-2023	23-08-2023	1.45	23.45	4,25	4.35 m was the original recovery. But top 10 cm cut off by mistake.
VN-33	203324	6212770	55	58,101	4	14,697	203317	6212754	55	58,093	4	14,692	50,7	53,7	24-08-2023	24-08-2023	04.00	02.00	4,68	
SEEP-17.1	176389	6214999	55	58,256	3	48,749	176363	6214995	55	58,253	3	48,725	55,7	58,7	24-08-2023	24-08-2023	07.20	05.20	6,0	
VN-28	170592	6207600	55	54,048	3	43,742	170590	6207588	55	54,041	3	43,740	53,3	56,3	24-08-2023	24-08-2023	09.20	07.20	5,85	
VN-25	171242	6215794	55	58,473	3	43,764	171267	6215793	55	58,473	3	43,788	59,6	62,6	24-08-2023	24-08-2023	11.30	9.30	5,1	
VN-21	172573	6232689	56	7,597	3	43,801	172599	6232697	56	7,603	3	43,825	67,5	70,5	25-08-2023	25-08-2023	12.30	10.30	3,0	
VN-19	220441	6257080	56	22,530	4	28,305	220427	6257059	56	22,519	4	28,294	62,5	65,5	25-08-2023	25-08-2023	11.20	9.20	5,53	
SEEP-5.1	236980	6255681	56	22,347	4	44,412	236992	6255692	56	22,353	4	44,423	58,8	61,8	25-08-2023	25-08-2023	13.50	11.50	5,0	
SEEP-4.1	256571	6253992	56	22,068	5	3,491	256578	6253983	56	22,063	5	3,498	53,9	55,9	25-08-2023	25-08-2023	16.25	14.25	5,34	

	UTM Zone 32, WGS84		WGS 84				UTM Zone 32, WGS84		WGS 84				Water depth																					
	X	Y	LATITUDE		LONGITUDE		X	Y	LATITUDE		LONGITUDE		Echo sounder	Surface to seabed	Date	Date UTC	Time	Time UTC	Recovery															
	m	m	Degrees	Decimal minutes	Degrees	Decimal minutes	m	m	Degrees	Decimal minutes	Degrees	Decimal minutes	m	m					m															
AS-11	648336	6263380	56	29,487	11	24,560	648341	6263391	56	29,493	11	24,566	17,8	20,8	06-09-2023	06-09-2023	12.00	10.00	1,77															
AS-12	650468	6266906	56	31,345	11	26,759	650483	6266903	56	31,343	11	26,773	21,7	24,7	06-09-2023	06-09-2023	13.30	11,3	5,66															
AS-13	649525	6269224	56	32,612	11	25,920	649531	6269227	56	32,614	11	25,925	19,9	22,9	06-09-2023	06-09-2023	15.00	13.00	4															
AS-15	636726	6263010	56	29,498	11	13,245	636727	6263009	56	29,498	11	13,245	15,3	18,3	06-09-2023	06-09-2023	17.00	15.00	3,82															
AS-22	632288	6263228	56	29,692	11	8,930	632294	6263232	56	29,694	11	8,936	14,9	17,9	06-09-2023	06-09-2023	18.00	16.00	5,77															
AS-CPT-09	636861	6260736	56	28,271	11	13,304	636864	6260734	56	28,270	11	13,307	15,7	18,7	06-09-2023	06-09-2023	19.20	17.20	5,92															
AS-21	636911	6259958	56	27,851	11	13,329	636914	6259963	56	27,854	11	13,332	15,6	18,6	06-09-2023	06-09-2023	20.00	18.00	0,32	Limited penetration probably caused by stones on the sea floor.														
AS-18	638969	6239434	56	16,760	11	14,680	638961	6239434	56	16,760	11	14,671	12,9	15,9	06-09-2023	06-09-2023	22.20	20.20	2															
AS-CPT-03	624374	6234426	56	14,305	11	0,404	624399	6234436	56	14,310	11	0,428	18,6	21,6	07-09-2023	06-09-2023	00.00	22.00	4,41															
AS-CPT-04	623826	6236595	56	15,482	10	59,934	623821	6236589	56	15,479	10	59,929	18,9	21,9	07-09-2023	06-09-2023	01.30	23.30	5,41															
AS-CPT-05	619908	6238696	56	16,674	10	56,199	619910	6238697	56	16,675	10	56,201	15,7	18,7	07-09-2023	07-09-2023	03.00	01.00	5,72															
AS-17	624091	6247592	56	21,402	11	0,502	624088	6247591	56	21,402	11	0,499	13,6	16,6	07-09-2023	07-09-2023	05.20	03.20	5,81															
UTM Zone 33, WGS84	WGS 84																UTM Zone 33, WGS84		WGS 84															
BO-21-NY	464694	6113537	55	10,032	14	26,746	464710	6113543	55	10,035	14	26,761	43,6	46,6	13-09-2023	13-09-2023	12.30	10.30	6															
BO-22	473359	6115994	55	11,389	14	34,893	473374	6115996	55	11,390	14	34,907	41,8	44,8	13-09-2023	13-09-2023	14.00	12.00	6															
BO-23	479225	6126818	55	17,242	14	40,373	479229	6126813	55	17,239	14	40,377	24,1	27,1	13-09-2023	13-09-2023	16.00	14.00	5,8															
BO-26	488046	6132835	55	20,503	14	48,691	488067	6132829	55	20,500	14	48,711	61,4	64,4	13-09-2023	13-09-2023	18.00	16.00	5,92															
BO-27	484972	6137237	55	22,872	14	45,769	484984	6137237	55	22,871	14	45,781	65,7	68,7	13-09-2023	13-09-2023	20.00	18.00	5,75															
BO-28	489995	6143398	55	26,201	14	50,512	490002	6143396	55	26,200	14	50,519	70	73	13-09-2023	13-09-2023	21.30	19.30	4,15															
BO-31	498731	6142663	55	25,811	14	58,797	498713	6142660	55	25,809	14	58,780	69	72	14-09-2023	13-09-2023	00.00	22.00	5,92															
BO-33	504788	6135380	55	21,883	15	4,531	504772	6135368	55	21,876	15	4,517	73,9	76,9	14-09-2023	14-09-2023	02.45	00.45	5,64	Two attempts where the vibrocoring tilted. Moving vessel with thrusters and fixed anchors, then successful attempt.														
BO-36	495489	6136843	55	22,672	14	55,729	495484	6136831	55	22,665	14	55,724	64,9	67,9	14-09-2023	14-09-2023	05.00	03.00	5,52															
BO-37	496333	6129810	55	18,880	14	56,533	496327	6129795	55	18,872	14	56,527	70,4	73,4	14-09-2023	14-09-2023	06.30	04.30	5,9															
BO-39	502693	6124723	55	16,138	15	2,543	502679	6124720	55	16,136	15	2,530	71,1	74,1	14-09-2023	14-09-2023	08.00	06.00	4,71															
BO-16	523000	6109513	55	7,906	15	21,644	523009	6109510	55	7,904	15	21,653	69	72	14-09-2023	14-09-2023	10.45	8.45	5,6															
BO-19	528838	6098509	55	1,954	15	27,071	528824	6098501	55	1,950	15	27,058	72,5	75,5	14-09-2023	14-09-2023	13.00	11.00	5,79	Two attempts where the vibrocoring tilted. Moving vessel with thrusters and fixed anchors, then successful attempt.														
BO-13	494096	6065391	54	44,145	14	54,498	494097	6065394	54	44,147	14	54,499	55,7	58,7	15-09-2023	15-09-2023	12.00	10.00	5,35															
BO-12-NY	489231	6061080	54	41,816	14	49,975	489247	6061145	54	41,851	14	49,989	52,2	55,2	15-09-2023	15-09-2023	14.10	12.10	5,91															
BO-02	495793	6054907	54	38,493	14	56,089	495794	6054910	54	38,495	14	56,090	50,4	53,4	15-09-2023	15-09-2023	15.40	13.40	5,8															
BO-01	506098	6062628	54	42,655	15	5,679	506090	6062632	54	42,658	15	5,672	60,1	63,1	15-09-2023	15-09-2023	17.40	15.40	5,52															
BO-14	495879	6077813	54	50,844	14	56,149	495880	6077816	54	50,846	14	56,150	50,2	53,2	15-09-2023	15-09-2023	20.00	18.00	5,95															
BO-20	506701	6090571	54	57,722	15	6,279	506703	6090581	54	57,727	15	6,281	31,4	34,4	15-09-2023	15-09-2023	22.00	20.00	4,33															
BO-08	512664	6081701	54	52,932	15	11,844	512668	6081708	54	52,936	15	11,847	60,4	63,4	15-09-2023	15-09-2023	23.45	21.45	5,94															
BO-06	549156	6092706	54	58,730	15	46,083	549131	6092696	54	58,725	15	46,059	78,5	81,5	16-09-2023	16-09-2023	06.00	04.00	5,88															
BO-04	559822	6093929	54	59,319	15	56,096	559817	6093944	54	59,328	15	56,092	74,7	77,7	16-09-2023	16-09-2023	07.40	05.40	5,91															
BO-09	541689	6102713	55	4,166	15	39,171	541682	6102718	55	4,169	15	39,164	76,4	79,4	16-09-2023	16-09-2023	10.15	08.15	5,98															
BO-18	533203	6105266	55	5,581	15	31,216	533211	6105281	55	5,589	15	31,223	69,3	72,3	16-09-2023	16-09-2023	11.45	09.45	3,8															
UTM Zone 32, WGS84	WGS 84																UTM Zone 32, WGS84		WGS 84															
AS-CPT-06	622544	6254102	56	24,934	10	59,183	622556	6254101	56	24,933	10	59,194	11,9	14,9	20-09-2023	20-09-2023	21.10	19.10	2,63															
AS-CPT-10	625586	6257725	56	26,838	11	2,244	625592	6257726	56	26,838	11	2,249	15,3	18,3	20-09-2023	20-09-2023	22.30	20.30	5,89															
AS-21-NY	636419	6259656	56	27,697	11	12,840	636402	6259653	56	27,696	11	12,824	15,4	18,4	21-09-2023	20-09-2023	00.30	22.30	3,27	End of survey														

Project: ENS screening for havvind				Client: Energistyrelsen												Drilling Platform: Fortuna Crane (Call sign: OZWM2)				
Core-ID	Planned position						Actual positions											Comments		
	UTM Zone 32		WGS 84				UTM Zone 32		WGS 84				Water depth	Water depth						
	X	Y	LATITUDE		LONGITUDE		X	Y	LATITUDE		LONGITUDE		Echo sounder	Surface to seabed	Date	Date UTC	Time		Time UTC	Penetration
	m	m	Degrees	Decimal minutes	Degrees	Decimal minutes	m	m	Degrees	Decimal minutes	Degrees	Decimal minutes	m	m						m
AS-CPT-06	622544	6254102	56	24,934	10	59,183	622549	6254103	56	24,934	10	59,188	11,6	14,6	09-09-2023	09-09-2023	13.30	11.30	3,2	Start anchoring 06.35 UTC. Restart anchoring 07.30 UTC as front anchors were put out to far from the position. Anchoring finished 08.45 UTC. Deployment of CPT and mounting of rods finished 10.00 UTC and ready to push. After 10 min. and 3,2 m push the CPT stopped at max. push strength. During retrieval of rods there was an error of the clamps on the CPT rig and the rods were pulled out of the CPT rig through the clamps by the tension wire. Dismantling of rods and bringing the CPT on deck was finished at 11.30 UTC. The CPT cone was damaged and communication to the unit lost and repair needed. Anchors pulled at 12.00 UTC, and anchor wire adjusted until 13 UTC on starboard anchor winch before transit to AS-16.
AS-CPT-16	624613	6245037	56	20,018	11	0,935	624617	6245041	56	20,020	11	0,939	17	20	10-09-2023	10-09-2023	10.00	8.00	9	Arrival at AS-16 at 13.45 UTC and start anchoring. Anchoring finished 14.45 UTC. Continuing repair of CPT. Deployment and mounting of rods started 05.45 UTC and finished 06.30 UTC. CPT push until reaching max. push strength at 7.00 UTC in 9 m depth. When retrieving the rods they apparently were stuck in the ground and needed to be pulled up by the crane together with the CPT rig. The rig was back on deck at 8.00 UTC and it turned out that the rods were broken right under the CPT rig during the last push. The anchors were pulled at 9.00 for transit to Grenaa with arrival at 10.00 UTC. End of CPT operations with one damaged and one lost CPT cone out of two.

