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TN328326 Supply of Metocean Data for IJmuiden Ver Investigation Area

ANNEX 5 - Section III

SCOPE OF WORK

Colophon

Project name	202109062-63/ TN328326 Supply of Metocean Data at IJV Investigation Area
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Definition of Terms

IJV WFZ	IJmuiden Ver – Wind Farm Zone
IJV IA	IJmuiden Ver Investigation Area: area where the field measurements take place
IJV MC	IJmuiden Ver Measurement Campaign
Metadata	Data or descriptions describing the measured data
Metocean data	Meteorological and oceanographic data
Monthly Post-processed Data Availability	Monthly average availability after processing of the measured data as defined in 2.7.6 of this Scope of Work.
SDE+ tender	Dutch tender system for renewable energy subsidies
Type Validation	Validation of a Type of floating Lidar system as defined in 1.6 RVO Reference Documents [2]
Unit Validation	Validation of an individual Unit floating Lidar system as defined in1.6 RVO Reference Documents [2]
UXO	Unexploded Ordnance
Validation of the measuring system	Verification of a measuring system, where the specified requirements of the used measuring system are adequate for its intended use, and it is thus fit for purpose as defined in 2.4 of this Scope of Work.
Metocean measurement campaign	Campaign in which the specific measuring system is used to measure metocean data [also called offshore measurement campaign]

1 Introduction

1.1 Scope introduction

The Scope of Work comprises the provision of validated meteorological and oceanographic measurement data at the IJmuiden Ver Investigation Area (IJV IA). These data are to be obtained by means of two field measurement campaigns using instruments fixed on floating systems. The main parameters to be measured are Wind, Wave, Current, Water-level, Atmospheric Pressure and Air Temperature.

The scope is subdivided into two Lots:

- Lot 1: Provision of validated measured metocean data at IJV IA, measurements starting in Q1 2022
- Lot 2: Provision of validated measured metocean data at IJV IA, measurements starting in Q2 2022

The requirements described in this document apply to both Lots..

1.2 Purpose

1.2.1 Meteorological data

The wind and other meteorological data obtained through the measurements at the IJV MC are intended for use in wind resource assessments compliant with the requirements for these assessments as stipulated in the reference documents mentioned in 1.6. With these local wind measurements and long-term reference wind data yield calculations of wind turbine generator systems can be performed at IJV IA.

1.2.2 Oceanographic data

The wave-, current- and water level measurements are intended for validation and calibration of the numerical metocean modelling studies performed by third parties. For this purpose, it is of particular importance to collect information not only during normal, daily circumstances, but also during severe sea-states, as the uncertainties under severe circumstances are largest and critical for design.

In addition, the measured wave-, current- and water level data will be used as reference for operations at sea during the various RVO survey campaigns (e.g. soil investigation campaigns, for planning of maintenance of the floating Lidar). For this purpose, it will be necessary to have the main parameters (both meteorological and oceanographic) in (near) real-time accessible over the internet through a web portal.

1.3 Measurement areas

The measurement locations and proposed measurement locations in IJV IA are shown in Figure 1.

For each of both measurement campaigns, two floating systems must be deployed and a dedicated, fit for purpose, spare system must be available for the total duration of each measurement campaign. This is because it has been assessed that for the floating systems currently on the market, the target redundancy (data-availability) of 100% cannot be guaranteed. Two systems close together will enable "gap-filling" to increase the likelihood of achieving a 100% availability and, furthermore, a dedicated spare system will reduce any data loss following operations and maintenance, or incidents.

General information and the coordinates are provided in 2.2 of this Scope of Work and the Starting Points and Assumptions (Annex 6).

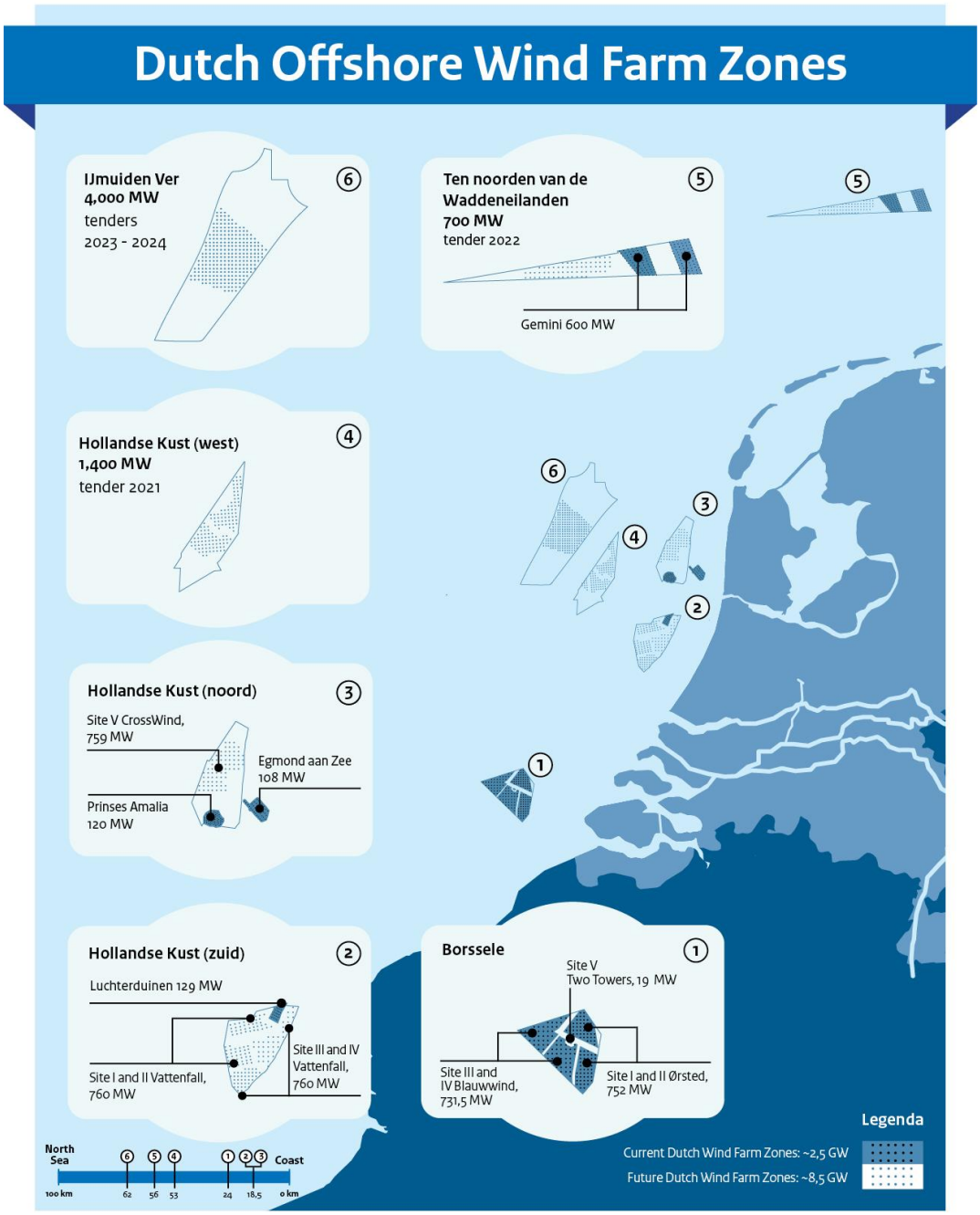


Figure 1: Offshore wind farm zones in the Netherlands.

1.4 Planning of the intended measurements

The planned duration of both measurement campaigns is 24 months.

For Lot 1, the measurements are required to start as soon as possible, on the 31th of May 2022 at the latest.

The measurements at Lot 2 are required to start on 31th August 2022 at the latest.

1.5 Available information

The Contracting Authority will make the following information available together with the tender documents:

A. UXO desk study, via https://offshorewind.RVO/obstructionsIJmuiden
B. Geological desk study, via https://offshorewind.RVO/soilIJmuiden
C. Persistence tables for IJVWFZ. Note that this information is not yet available for lot 2.
D. Base map (MPK) containing information on location.

A geophysical measuring campaign at IJVWFZ is currently in process, in which the bathymetry will be measured in detail and magnetometer data are available. The deliverables will be published when available on https://offshorewind.rvo.nl/soilIJmuiden

The results of the previous metocean measurement campaigns for Hollandse Kust (west) and Ten noorden van de Waddeneilanden can be found on https://offshorewind.rvo.nl/windwaterw and https://offshorewind.rvo.nl/TNW_WindAndWater .

1.6 RVO Reference documents

This document includes references to the following documents:

[1] IEA Wind Recommended Practices: 18 Floating LiDAR Systems: First Edition, 2017; September 2017.
[2] Carbon Trust Offshore Wind Accelerator: Roadmap for the Commercial Acceptance of Floating LiDAR Technology (Version 2.0, 9th October 2018);
[3] The Carbon Trust Offshore Wind Accelerator: Recommended Practices for Floating LiDAR Systems: Issue 1.0; 25th October 2016. https://www.carbontrust.com/media/673560/owa-floatinglidarrecommendedpractice-25oct2016-final.pdf
[4] MEASNET Evaluation of site-specific wind conditions - Version 1, November 2009;
[5] IEC 61400-12-1:2017.

In case of doubt, this Scope of Work (SoW) document prevails over the above-mentioned documents. In case of inconsistencies in the reference documents, the order of prevalence is Document Number 2, 1, 3, 4, 5.

2 Scope of Work

2.1 Parameters to be measured

2.1.1 Introduction

In this section, the required measurements are specified. The main parameters to be measured are meteorological (Wind, Atmospheric Pressure and Air Temperature) and oceanographic (Wave, Current, Water-level).

The aim for these measurements is to serve as input for (among others) a metocean desk study and a wind resource assessment. These measurements should complement existing measurements to:

1. Further reduce uncertainty bandwidth of wind predictions
2. Determine wind gradients in the Investigation Area
3. Determine local metocean characteristics, including (but not limited to) wave characterisation

For both the provision of meteorological data and for oceanographic data, the data resolution and parameter set-up should be equal for the three systems (two measuring and one spare system).

2.1.2 Provision of meteorological data

Contractor shall provide two sets of wind data over a period of 24 months. The wind measurements shall be carried out by means of floating systems equipped with LiDAR. These LiDAR systems shall preferably be new at the start of the project. They shall be in the pre-commercial (stage 2) or commercial stage (stage 3) according to [2]. If the Contractor plans re-using previously deployed LiDAR units, there must be written proof made available to Contracting Authority that (1) the systems have been recently maintained according to manufacturer's guidelines, (2) the systems have been through a new independent validation, and (3) the latest relevant firmware has been applied. The same measurement system and firmware must be installed on all systems including the spare system.

Before each measurement campaign, all floating LiDARs must be validated (unit) against tested reference instruments by an independent and accredited institute according to international guidelines, such as the reference documents described in 1.6. The Unit validation is described in 2.4.

Meteorological data to be measured, validated and provided include at least (see Table 1):

Table 1: meteorological parameters to be measured.

Parameter	Frequency	Main data set[1]
LiDAR wind speed and direction recorded at least 10 levels to a maximum recording height of 250m above mean sea level (MSL). Near surface wind speed and direction as per the LiDAR capability and/or Floating System ancillary measurement systems is also required.	1Hz, 10-minute average	Wind
Air temperature at LiDAR level	10-minute average	Temperature
Atmospheric pressure at LiDAR level	10-minute average	Atmospheric pressure

Furthermore, for quality control, a rain sensor shall be preferred.

[1] This Main Data Set is used to allocate the parameter to a specific data set, which is used to calculate the Monthly post-processed data availability, which is used calculate the payment as described in Annex 5 – Section II Remuneration.

Post-processed parameters that should be provided as well are:

- Wind shear and wind veer
- Turbulence intensity
- Inflow angle

For the wind measurements, besides the 10-minute averages, also the raw 1Hz data should be provided in the native file format of the LiDAR system. The data format requirements are described in section 2.7.2. The Project Execution Plan should contain description on how the risk of loss of data stored on the systems will be mitigated.

2.1.3 Provision of oceanographic data

The Contractor shall provide two sets of oceanographic data over a period of 24 months. Here, the used systems shall have a well proven track record in acquiring oceanographic data. Measured data shall include at least the following parameters (see Table 2):

Table 2: Oceanographic parameters to be measured

Parameter	Frequency	Main data set
Significant wave height	2Hz, 30-minute	Wave
Maximum wave height	30-minute	Wave
Spectral peak wave period	30-minute	Wave
Mean zero-crossing wave period	30-minute	Wave
Mean wave direction	30-minute	Wave
Peak wave direction	30-minute	Wave
Directional spreading	30-minute	Wave
Directional frequency spectrum: Energy density and mean direction for each frequency bin	30-minute sampling interval	Wave
Current speed at ≥ 30 positions[2] over the water depth	10-minute	Current
Current direction at ≥ 30 positions over the water depth**	10-minute	Current
Water level	10-minute	Water level
Sea water temperature	10-minute	Temperature

In addition to the parameters listed above, the raw measured data are to be provided such that additional parameters can be determined and wave frequency-direction spectra can be estimated.

The water level should be provided relative to Lowest Astronomical Tide (LAT). The method to perform this tidal correction should be specified in the proposal.

The Project Execution Plan should describe how scheduled and unscheduled maintenance will be planned to mitigate the risk of losing data or risk of poor quality data because of for example instruments suffering from biofouling.

[2] If possible with a higher resolution near the surface and the seabed. The final measurement elevations to be defined and agreed at the start of the project.

2.1.4 Measurement system

The wind measurement system and the execution of the wind measurements shall comply with the requirements for floating LiDAR systems that have reached the pre-commercial stage or the commercial stage, as stipulated in [1].

2.2 Location of system and measurements

The Contracting Authority will select the locations of the measuring systems for each Lot.

The exact locations will be defined at the moment of signing the contract.

2.2.1 Locations of the measurements at IJV IA

Target locations are given in Table 3 and Table 4 below for Lot 1 and Lot 2 respectively. However, please note that final positions/relocations can occur within the whole IJV IA. RVO will confirm the final target locations prior to deployment.

The measurement locations at IJV Investigation Area are based on a compromise between requirements of the wind measurements and the wave/current measurements. The two floating Lidar systems should be deployed close together to allow for gap filling if required and achieve the required redundancy. For validation of the wave and current models, it will be preferable to measure at both a deep and shallower water location (on a sand bank). The coordinates of the resulting target locations can be found in table 3 and 4. The resulting target locations can be found in figure 2. The bathymetry of the resulting target locations can be found in figure 3 and 4.

The approximate depths for Lot 1 target location is 24.4 – 33.6 m, and for Lot 2 28.6 – 32.1m. The distance from the shore for Lot 1 is 65 km and for Lot 2 is 108 km.

Table 3 Target locations of measurement systems for Lot 1 in IJV IA

IJV Investigation Area	Easting (UTM ETRS89 Zone 31N)	Northing (UTM ETRS89 Zone 31N)
System A	546,050	5,860,700
System B	547,800	5,859,700

Table 4 Target locations of measurement systems for Lot 2 in IJV IA

IJV Investigation Area	Easting (UTM ETRS89 Zone 31N)	Northing (UTM ETRS89 Zone 31N)
System C	510,000	5,912,000
System D	512,000	5,912,000

A tolerance area of ±100m is defined around these target locations**Fout! Verwijzingsbron niet gevonden.**. It is up to the Contractor to select a suitable location at his own risk within the tolerance radius as close as possible to the target locations. The Contractor is responsible for the mooring system and is expected to have an appropriate risk mitigation plan. Possible presence of UXOs or unfavourable soil, wind, waves, or weather, or claims of Third parties cannot constitute the basis of a claim against Contracting Authority nor any of its supporting experts.

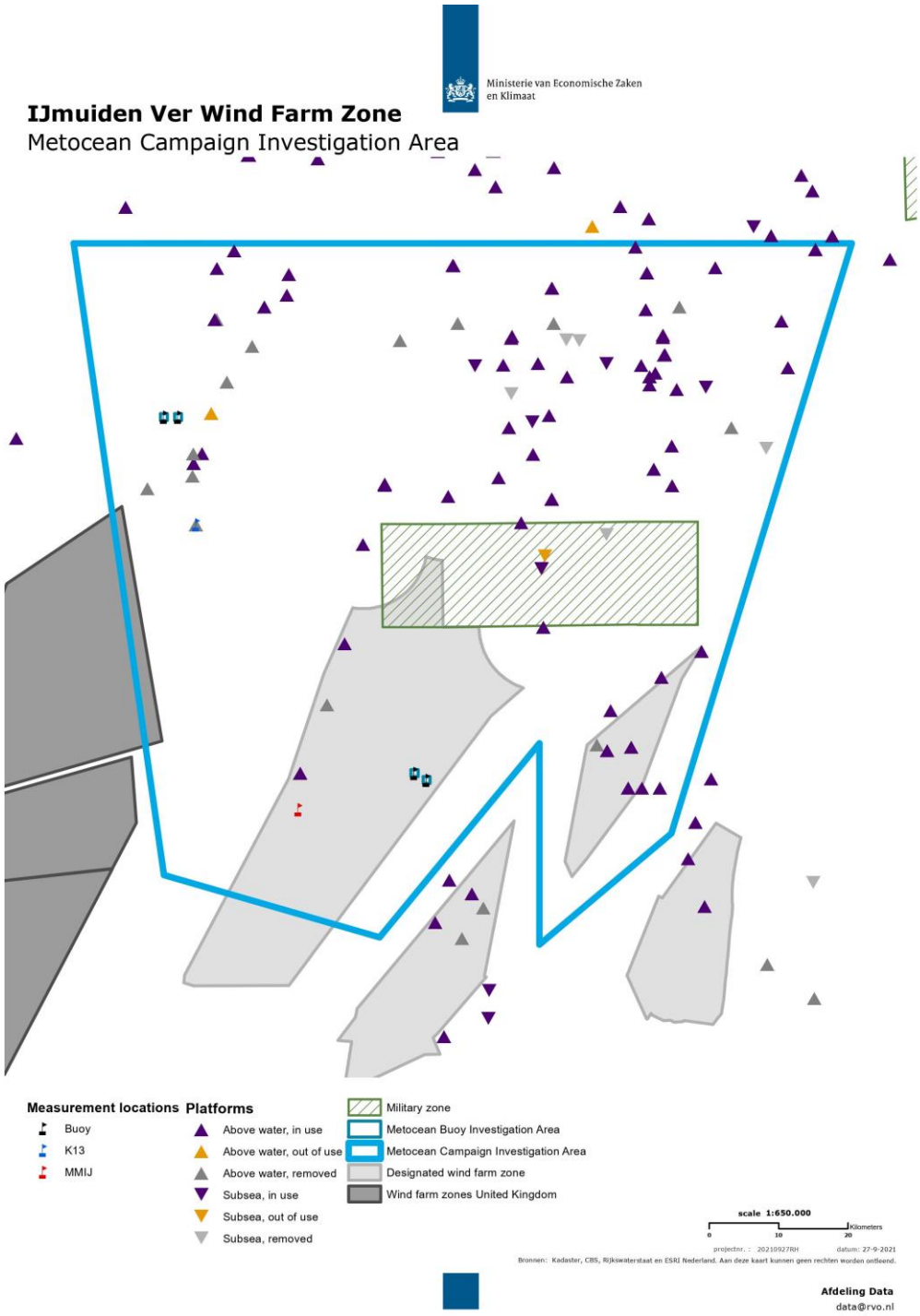


Figure 2: Locations of metocean measurement locations within the IJmuiden Investigation Area

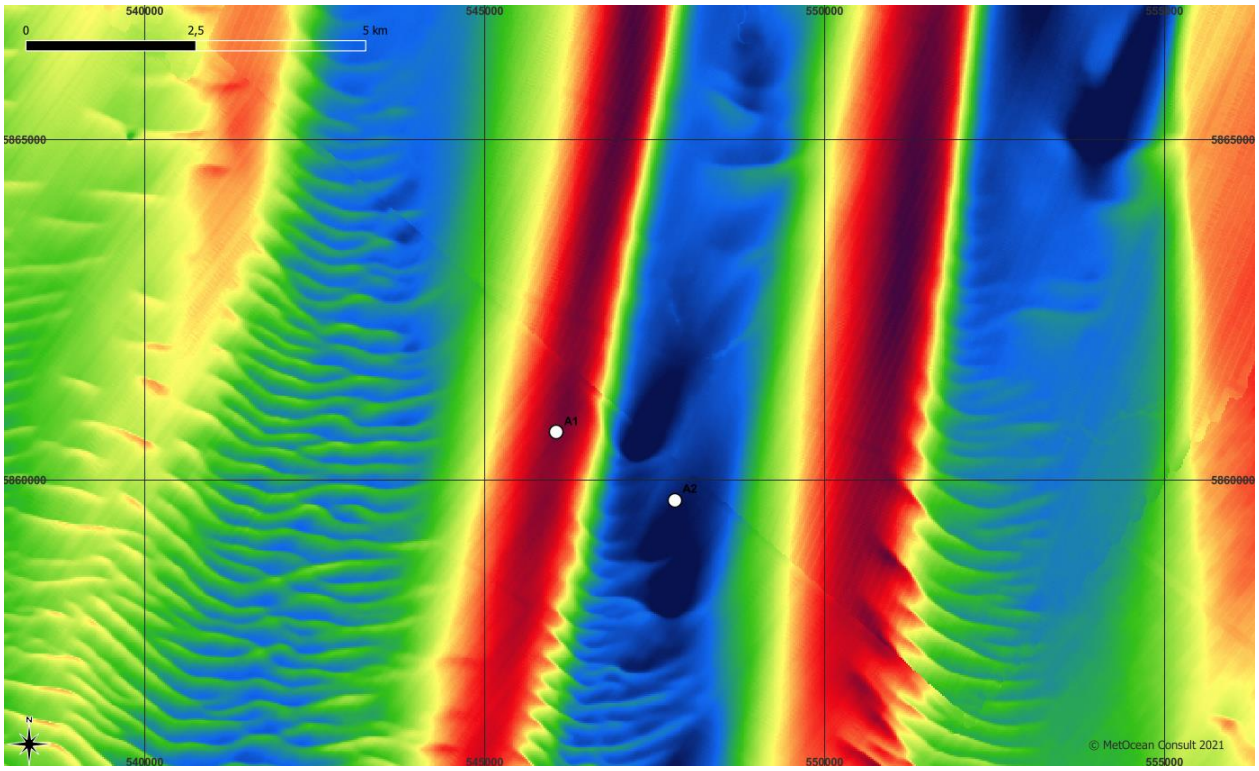


Figure 3: Locations of metocean measurement locations (lot 1) with respect to local bathymetry

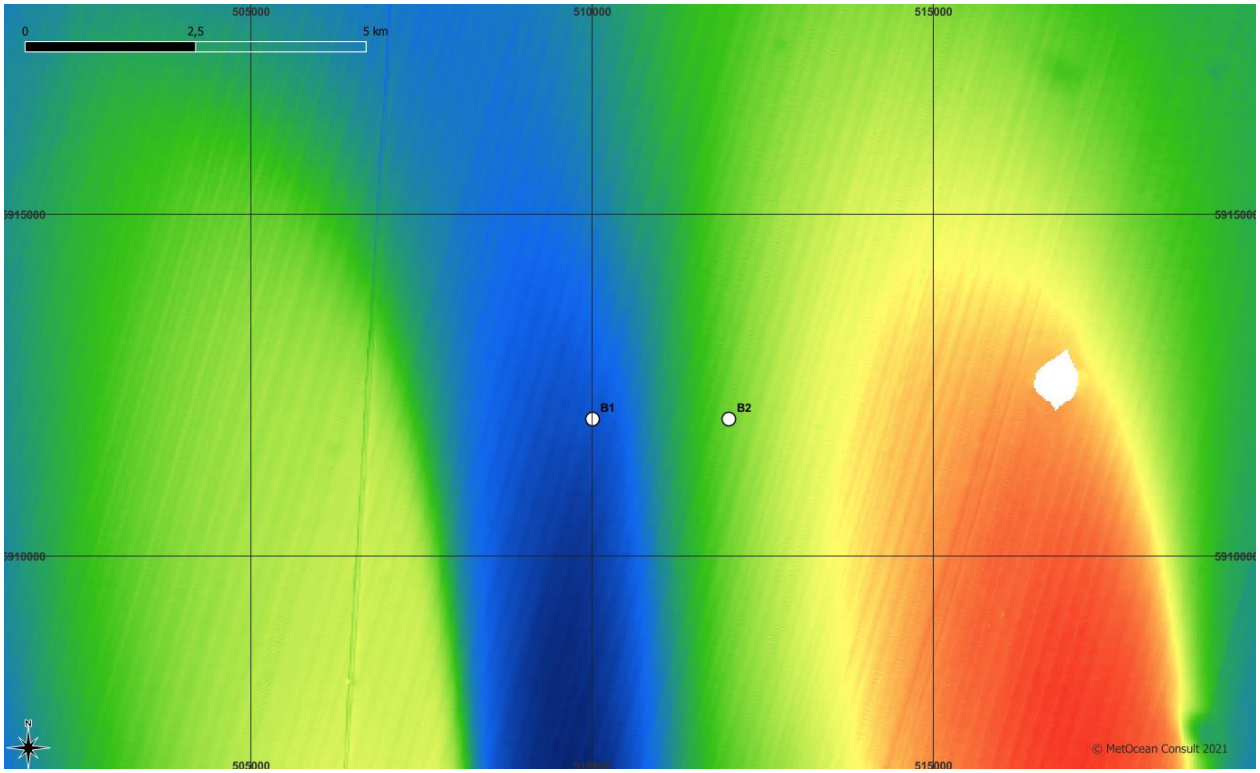


Figure 4: Locations of metocean measurement locations (lot 2) with respect to local bathymetry

Note that it is up to the Contractor to decide, per measurement location, whether to equip all instrumentation on a single device, or to use separate devices to measure the required parameters. However, the measurements must be located within tolerance radius of the target locations.

2.3 Weather risks

The contract price is based on a lump sum price including costs related to delays or damage caused by weather risks. This implies that these weather-related risks should be assessed and included in the price.

The Project Execution Plan should contain information on limiting weather conditions for deployment, removal or maintenance (e.g. limiting wind- and wave heights, minimum durations for operations, etc.). In the Project Execution Plan it should be discussed how scheduled maintenance will be planned to mitigate the risk of weather delays.

2.4 Pre-campaign validations

2.4.1 Meteorological data

2.4.1.1 General requirement

The proposed system(s) should be fully validated according to industry best practice recommendations as set out in references provided in Section 1.6.

This means that the Contractor should supply:

1. LiDAR System Classification report;
2. Valid Independent report on LiDAR component performance against a suitable fixed mast reference. The report should be via a reputable and recognised third party organisation;
3. Valid Independent report on Floating LiDAR system performance against a suitable fixed mast reference. The report should be via a reputable and recognised third party organisation and confirm the systems commercialisation level as according to [2];
4. Proposal for validation of system performance and accuracy during deployment phase.
5. If available Floating LiDAR Classification report

2.4.1.2 Type validation of LiDAR measurement system

The LiDAR measurement system (setup) must have been independently validated according to chapter 5 and 7 of [1] and/or 3.4.2 and 3.5.2 of [2] to assess the capability of the system (setup) to accurately and reliably measure wind speed and direction. The results must be reviewed and approved by an independent and accredited institute according to international guidelines. The quality of the system must be demonstrated through a Type validation report. The Type validation report of the Lidar measuring system that the Tenderer intends to use at each Lot should be included in the offer and made available to the Contracting Authority. The making of and paying for the validation report is the responsibility of the Tenderer. The Contracting Authority will make this report publicly available together with the first monthly data report. If the Type Validation results are more than 6 months old, a letter should be provided to confirm that no design change has taken place since the validation process and that the current Carbon Trust roadmap status is valid. Any changes that have been made to the system of any nature since the Type validation must be listed for evaluation.

2.4.1.3 Unit Validation Pre-deployment

The actual LiDAR measurement system(s) to be used must be independently validated according to the wind resource assessment campaign design of chapter 6 and 8 of [1] and/or 3.4.3 & 2.5.3 of [2]. The pre-deployment checks must be confirmed by an independent and accredited institute according to international guidelines. The validation of the actual measuring system to be used in this campaign must be demonstrated through a Unit validation report performed in similar sea states as to what can be expected. The pre-deployment Unit validation report should include uncertainty assessment. The pre-deployment Unit validation report should be delivered to and accepted by the Contracting

Authority two weeks before starting date of measurement campaign. The Contractor has to organise and to pay for the pre-deployment Unit validation report. Contracting Authority will publicly disclose this pre-deployment Unit validation report together with the first monthly data report.

In case an incident occurs during the campaign with a potential impact on the LiDAR measurements systems, a post-incident validation needs to be performed by comparing the first month of data after the incident with the second measurement system located at the project site. The post-incident validation needs to be confirmed by an independent and accredited institute and needs to be accepted by RVO before the unit is returned to measurement position.

In a similar manner the pre-deployment check, also a post-deployment check needs to be performed on the LiDAR system. This post-deployment validation report should be delivered to and accepted by the Contracting Authority ultimately 3 months after the completion date of the measurement campaign. After incidents a full inspection of the system should be performed in order to assess if the system is working properly and to share the lessons learned.

2.4.2 Oceanographical data

2.4.2.1 General requirement

The oceanographic measurements should be compliant with ISO Standard 19901-1:2015, listed below:

- International Standard ISO 19901-1, Part 1: Metocean design and operating considerations, Second edition 2015-10-15
- Contractor is requested to provide the guidelines followed for the data quality control. This document should at least contain a section of the quality tests to be performed, a complete description of the entire data processing chain (incl. the algorithms used in each step), the flagging system, description of the instruments used and a section on validation. The validation section should include a description of the instruments and their performance as well as the performance of the system as a whole.

2.4.2.2 Calibration of equipment

Calibration of instrumentation is to be performed where possible by an accredited calibration laboratory accredited to ISO17025 or national equivalent. The Contractor has to show that the instruments provide accurate measurements and Contractor has to give an indication of accuracy for summer and winter season, preferably cross-checked against measured data acquired with a different type of measuring system (e.g. surface tracking system vs. pressure sensor or acoustic sensor). The Contractor has to verify that the measurement system is able to measure accurately the entire range of expected conditions during the deployment period. Irregularities are to be reported in the validation report. The calibration report should be delivered to and accepted by the Contracting Authority two weeks before starting date of measurement campaign.

2.4.2.3 System validation of oceanographical measurements

Evidence should be provided of validation of the wave measurement system against a reliable reference source. Please provide details of validations undertaken of the wave measurement system confirming the system design, measurement equipment and firmware during the validation is the same as used in the campaign. The quality of the system should be demonstrated through a validation report, preferably less than 2 years old. Individual wave measurement validation reports are not required for each of the specific individual systems to be deployed. Validation is only required for the wave measurement system in general as in the configuration applied in the measurement campaign (e.g. the combined system of a system with a Lidar installed). This validation may be in the form of reports from trial campaigns or previous validations other systems of the same design that use the same wave measurement equipment. If validation of the wave measurement system is not previously available, please detail in the Project Plan how validation of the wave measurement system will be undertaken prior to the start of the measurement campaign.

2.4.3 Spare system fit for purpose

The Contractor is to provide a dedicated spare system for each Lot. Prior to the start of each campaign the Contractor will provide confirmation that the spare system is fit for purpose. This confirmation should include that the measuring system and firmware is consistent with that used on the other systems; that all measuring equipment is installed and has been calibrated / validated as required such that it is ready to operate; that the mooring system is also stored with the spare system and is ready for deployment; that the spare system is stored at a location in the Netherlands from which it can be readily deployed as needed. Confirmation that the spare system is fit for purpose is subject to review and acceptance by RVO.

2.5 Validation analyses of measured data

During the measurement campaign, the Contractor will prepare a detailed monthly validation report. The intention of this report is to validate the measured data. The analysis includes a comparison with other local measuring systems (or models, if no other measurements are available). This monthly report will be prepared by Contractor (or a subcontractor hired by the Contractor). It should contain information and metadata on:

1) the data availability per main parameter for the whole measurement campaign up to the specific month and the specific month itself,
2) the instrument and measurement configuration,
3) information from the reference data and
4) conclusions.

This monthly validation report will be made publicly available by the Contracting Authority together with the monthly data report (ref.2.7.3). The monthly validation report will be checked by an independent expert provided for by the Contracting Authority.

It is up to Contractor to propose in his Project Execution Plan (to be included in the offer) a set of suitable nearby reference stations for the purpose of the monthly analyses along with the methodology. The Contractor is responsible to obtain the reference data at its own costs. If using numerical models for this purpose, evidence of the consistency and accuracy of the model as well as methodology must be provided.

The monthly data analyses must fulfil the following minimum requirements:

<u>All parameters</u>

- For all parameters (wind, waves, currents, water levels, etc) an inter-comparison needs to be performed between both measurement systems.
- Quality flags to be generated for all parameters defining the quality of measure measurement. Please discuss in the Quality Plan the quality flagged system to be used, including how the quality flags will be assigned.

<u>Wind</u>

- Analyses of events with wind speed larger than 10.8 m/s (6 Bft): in-depth comparison required of the measured time series with comparable measurements or model values to provide a system performance sanity check as per [1].

<u>Waves</u>

- Analyses of events with significant wave height (H_s) > 4m: in-depth comparison is required of the measured time series with comparable measurements or model values.

<u>Currents</u>

- A comparison has to be made with a reference station or numerical modelling results.
- The validation must be done for timeseries of current speed and direction, and rose plots.

- Deviations between both sources or unexpected spikes must be explained in order to qualify the data as "validated".

If the measurements show large deviations from the comparable measurements or model values that cannot be explained and the Contracting Authority or supporting experts cannot be convinced that these measurements are correct, they should be removed from the dataset and will not qualify for reimbursement.

2.6 Configuration of system

The Contracting Authority requires a system which is fit for purpose. For guidance please refer to chapter 2 of [1]. The Contracting Authority holds the right to inspect the systems prior to deployment (see 3.2.2) and prior to re-deployment following any incidents or servicing.

2.7 Data disclosure during measurement campaign

2.7.1 Data logging and communication

The Contracting Authority stresses the importance of high-quality data logging and communication, due to the fact that early and reliable disclosure of data is required. Contracting Authority therefore has the following demands:

- Ideally the data logging system should have on-board storage capacity sufficient for the planned duration of the deployment, preferably with an extra 3 months' worth of storage for contingency. The data logging system should be accessible through a wifi connection (or wireless connection) to allow data transfer from on-board storage to service vessel. Alternatively please provide details in the Quality Plan how the risk of data loss will be mitigated.
- The communications system should enable data transfer to shore in real time, or close to real time of the sampling interval indicated in Table 2 of all main parameters. If power or bandwidth is limited, a subset of diagnostic data that includes system performance and health should be defined and agreed with Contracting Authority and take precedence over other data.
- The communications system should preferably have more than one channel of communication (e.g. cell phone network protocols, satellite communications, radio). Switching between channels of communication should be automatic or under remote control.

2.7.2 Format

For all parameters, the measured data shall be provided in the following format:

- Raw data to be made available on a 6-monthly basis through a secured sftp server or any other system suitable for sharing large quantities of data in a secured way.
- Processed and analysed data to be made available on a monthly basis.
- Data should be made available at a temporal resolution in conformity with table 1 and 2
- Metadata including the format of the data supplied must be clearly described.

2.7.2.1 Meteorological data

Minimum specific requirements for the wind data are, at each agreed measurement level:

- Horizontal wind speed corrected and uncorrected (if corrections are performed);
- Horizontal wind direction data corrected for unit heading and uncorrected;
- Standard deviation of horizontal wind speed corrected and uncorrected;
- Data quality parameter relating to LiDAR (e.g. CNR or similar);
- Data availability as defined by number of datapoints within each 10-minute average;
- Maximum wind speed in 10-minute period;
- Minimum wind speed in 10-minute period;

To help understand the specific nature of the proposed Floating LiDAR System, please provide a process diagram showing the inputs and outputs in the conversion from raw data to processed data. This process should describe the validated process as per the Carbon Trust Roadmap stage of the proposed system.

Please also provide sample raw data and processed data files to aid with understanding of the system process.

2.7.2.2 Oceanographical data

Minimum specific requirements for the wave data are:

- Raw wave data should be provided, specifically accelerations, compass, pitch, roll heave, all sampled with a minimum sampling frequency of at least 2Hz
- Full directional and frequency spectra should be provided which include the energy spectrum, E(f), and the first four Fourier coefficients, a1(f), b1(f), a2(f), b2(f), of the directional distribution of ocean waves at each wave frequency.
- Energy density wave spectra E(f, theta)
- Spectral moments: m-2, m0, m-1, m1, m¬2, m3, m4 and derived parameters: Hs, T1, Tm-10, Tm02, Tc, mean direction, peak direction, peak period, spreading
- Parameters from time domain analysis: Tz, Tmax, Hmax
- Spectral parameters to be provided for total spectrum and two partitions: low frequency energy ("swell") and high freq. energy ("wind sea")
- All data to be provided with sufficient decimals (at least 3) to be able to identify real duplicates from duplicates that are due to data processing. All data to be stored with sufficient number of bits

Additionally; the following data is preferred to be supplied for the wave measurements, though these parameters or only preferences, not specific requirements:

- Centred Fourier coefficients theta0, m1, m2, n2 as function of frequency. Spread (sigma), skewness and kurtosis
- Heave spectrum. Directional spectrum. Heave

Specific requirements for the current data are:

- Raw current data should be provided

Specific requirements for the water level data are:

- Raw water level data should be provided (e.g. pressures)

2.7.3 Data processing and reporting

2.7.3.1 Data disclosure

For every month of the measurement campaign, the Contractor shall process the gathered data and prepare a detailed report covering the total scope of work. This report shall include:

- A description of the purpose of the measurements;
- A description of the work carried out, including reference to specification and standards adopted and any deviations from them;
- Exact coordinates of the position where the measurements have been carried out;
- An overview table showing dates of maintenance activities and/or replacements of systems;
- A detailed description of the post-processing applied with the aim to make this reproducible;
- Data quality assurance and interpretation;
- Electronic copies of all raw and processed data from the measurements;
- The monthly post-processed data availability per main dataset (for the month and cumulative)
- A logbook of any system issues, including measurement system status flags, issue description, level of risk to measurements and mitigation;

Also, the Contractor shall produce a publicly accessible website showing all measurements in real-time, or near real-time. The results should be accessible without a password.

All steps in the data provisioning chain and procedures followed must be documented, open and reproducible, so that information on the data can be checked and assessed by the Contracting Authority or others. Different procedures may be applicable for different parameters. An example of the different processes and steps in the data provisioning chain is given in the figure below. The Contractor is requested to provide suggestions of measures to prevent data loss based on their experience.

The Contractor has to provide a brief description of error checking procedures and criteria when data are accepted and rejected.

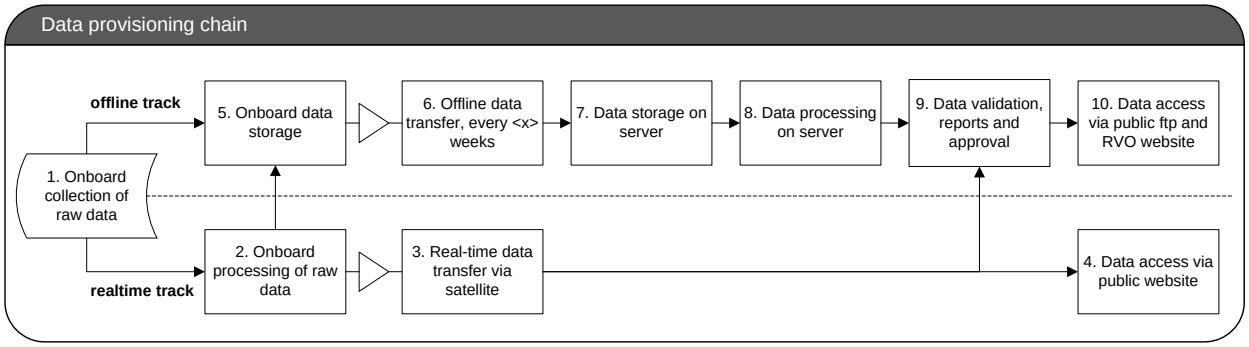


Figure 2.4 – Data provisioning chain (example only)

2.7.3.2 Review of draft and final documents and data delivered

If Contractor fails to provide the raw and processed Data, final Monthly data report(s) & Data Validation Monthly Report(s) 8 weeks (including review time by Contracting Authority) after the end of the calendar month of measurement, it shall receive a malus as described in the Agreement and Annex 5 -Section II Remuneration.

Contractor shall allow for sufficient time for review and revision considering the following review periods by Contracting Authority:

- 10 working days for the first revision and
- 5 working days for each revision thereafter.

This review period applies to the monthly data and reporting and to the 12-montly dataset and Final report.

2.7.4 12-monthly dataset

After the 12 months duration has been completed, the Contractor shall prepare a 12 monthly dataset, in which the results (12 months) are combined and submitted. The 12 months of raw and processed data should be combined into single datasets for the full year measurement period and be submitted. Summary of deployments and availability over the 12 months period must also be reported.

2.7.5 Final report

After the full campaign duration has been completed, the Contractor shall prepare a final report, in which the full campaign setup and results (24 months) are summarized and submitted. Also, the 24 months of raw and processed data should be combined into single datasets for the full two-year measurement period and be submitted.

2.7.6 Calculation of Monthly Post-processed Data Availability per main dataset

Reimbursement will be based on the availability of meteorological and oceanographic data accepted by the Contracting Authority and supporting experts (see Annex 5 – Section II Remuneration). The procedure for calculation of the availability is described next.

The calculation of Monthly Post-processed Data Availability of the wind dataset is based on [1] as detailed below;

A) Monthly System Availability: One-Month Average.

- The Floating LiDAR System is ready to function according to specifications and to deliver data, considering all time stamped data entries in the output data files including flagged data (e.g. by NaNs or 9999s) for the given month. *Note that for the system to be considered "ready", at least one valid data point must be recorded (at 100m height).*
- The Monthly Overall System Availability is the number of those time stamped 10-minute averaged data entries recorded relative to the maximum possible number of (here 10-minute) data entries including periods of maintenance within the respective calendar month.

B) Monthly Post-processed Data Availability: One-Month Average

- The Monthly Post-processed Data Availability is the number of those data entries remaining after subtraction of all non-valid entries caused by e.g.:
    - downtime (due to equipment failure, maintenance, severe weather, damage, malfunction, theft, or any other events),
    - any system filtering resulting in data rejection. Any system filtering must be flagged appropriately and the system filters applied must be defined. Any system filtering must be consistent with system filtering applied during the pre-deployment validation.
    - application of quality filters based on system's own parameters, to be defined and applied in a post-processing step on the basis of LiDAR guidelines and validated as part of the commercialisation stage of the system,

… divided by the maximum possible number of 10-minute data entries within the respective calendar month based on the given time interval of 10-minutes.

Note;

1. The Monthly Post-processed Wind Data Availability per system is the average of the 10-minute averaged Monthly post processed data availabilities per measured elevation, speed and direction.
2. In the case of multiple (redundant) measurement instruments determining one parameter value, the availability of at least one parameter value determines the data availability.
3. Similar or better limits in the quality filters should be applied during the measurement campaign as in the trial campaign.
4. The wind measurements above 200m shall be excluded from the availability calculation.

The Monthly Post-processed Data Availability of Wave, Current, Water-level, Atmospheric Pressure and Air Temperature will be calculated with a similar approach (for waves with a 30 minute interval). Note that for the current measurements, the availability of current speed and direction per elevation should be averaged to a single value.

Note that if, in the stage of analyses of the measured data, deviations arise from comparisons with alternative measurement sources or the inter-comparison between systems, that cannot be explained by physical processes and are considered erroneous by Contracting Authority and supporting experts are to be removed from the dataset and should be considered non-valid in the availability calculations.

The intended outcome is a single Monthly Post-processed Data Availability per main parameter per system (6 x 2 values) for each Lot. These values should be presented in the validation report.

As described in Annex 5 – section II, the Monthly Post-processed Data Availability per main parameter - system will subsequently be transformed into a Weighted Monthly Post-processed Data Availability per system.

3 Requirements

3.1 Time Schedule for the execution of works

3.1.1 Starting date of offshore measurement campaign

Contractor will execute the works on the basis of the schedule by means of a fully worked out Gantt chart and proposed starting date for the offshore measurement campaign as was proposed in the Tender. The Project Execution Plan should contain an elaboration and motivation in detail for realising this starting date.

3.1.2 Latest day for approval of obtained and/or corrected data

Data additions and corrections, due to additionally obtained and/or corrected data, are possible, if accepted by the Contracting Authority and supporting experts. Additionally obtained and/or corrected data can be due to for instance restored data after failing data communication. Contracting Authority will recalculate its payment schedule (however the received mala are excluded from this calculation) if this validated data is reported in the final report and approved by the Contracting Authority.

Bonus/malus will not be recalculated based on additionally obtained and/or corrected data.

3.2 Preparation of the Work

3.2.1 Scrutinise available information

Contractor shall scrutinise the information that has been made available by Contracting Authority. Information that is relevant for carrying out the Work shall be taken into account while preparing the Work.

3.2.2 Preparation before deployment offshore

<u>Kick-off meeting</u>

After the tender award decision, a kick-off meeting will be organised by Contractor with the Contracting Authority. During this kick-off meeting the exact objectives, timeline, quality & safety requirements, reporting, communication and scope of the assignment shall be agreed upon.

<u>Permits</u>

The Contractor is responsible for obtaining and arranging all necessary permissions and/or notifications to perform the Work (including all permissions and fees necessary for access and safety arrangements to harbours and offshore positions).

Any notices to mariners are the responsibility of Contractor.

<u>Project Plans</u>

Partly based on the comments received from the Contracting Authority in the bidding stage, the Contractor shall finalise all required project plans as required by the Contract, no later than two weeks before offshore deployment.

These documents include but are not limited to:

- Project Execution Plan
- Project HSE Plan
- Project Quality Plan
- Emergency Response plan.
- Contingency plan

The Contractor shall comply with Contracting Authority's HSE requirements as specified in Annex 5 – Section V of the Contract.

The Contractor shall only commence the offshore part of the Work when all project plans have been reviewed and approved by the Contracting Authority and comments have been processed (to the satisfaction of the Contracting Authority) in a final version of these plans.

Audit

The Contracting Authority has the right to audit during any mobilisation prior to offshore deployment and during recovery and/or relocation of the system.

The Contracting Authority may require an independent audit performed prior to the offshore deployment of the system (s) and re-deployment (i.e. after onshore maintenance and/or repairs). Only when the audit is positive Contractor can start the offshore part of the Works. Points of attention during the audit are:

1. Adherence to the Project Plans provided with special focus on the HSE plan.
2. Whether the system is fit for purpose

The Contracting Authority reserves the right to inspect and monitor the Contractor's Quality and HSE provisions and procedures, plus vessels and equipment used, during execution of the Work. The Contractor agrees to give unrestricted access to Contracting Authority personnel (or nominated representatives) to undertake such inspections.

Offshore operations

Before each offshore operation, documentation needs to be issued describing the intended procedures for deployment, removal or servicing of the systems. This documentation needs to be approved by the Contracting Authority 24 hours before sail-out. The Contracting Authority has the right to postpone the operation in case this requirement is not fulfilled. The Contracting Authority also has the right to stop the operation in case it is not executed according to the agreed procedure or in case of an unsafe situation.

Also, a kick-off meeting should be held the day before the operation.

The Contracting Authority has the right to request that up to 2 Client Representatives join offshore operations.

A close-out meeting should be held the day after operations are completed.

3.3 Completion of the Work

It is the intention of the Contracting Authority to leave the site and seabed as undisturbed as possible.

The Contractor is responsible for removing all equipment from the site after completion of the Work. This includes removing all equipment that has been temporarily placed on the seabed, such as external devices to measure currents or water levels.

Also, all operations should be designed to minimize the possibility of losing equipment, such as e.g. anchors, during the operation.

All equipment (including any lost equipment on the sea floor should be removed at the end of the campaign. In case it is not possible to remove all lost equipment a list must be provided to the Contracting Authority of any equipment that cannot be removed.

Payment of up to 15% of the contract value will be retained until all equipment (including items on the seabed) have been successfully removed.

3.4 Communication

The final results will be presented in a webinar. See examples at http://offshorewind.rvo.nl/

The Contractor is requested to include the following activities in the price mentioned in the proposal;

- Prepare for a presentation, including illustrations

- Present the presentation at a location in Netherlands.

- Participate with one expert in the panel (in addition to presenter) at a location in Netherlands to support in the answering of questions

- Support in the answering of questions after the webinar.

- Facility of webinar will be at the cost of the Contracting Authority. The Contractor shall present the results in a webinar to be organised by Contracting Authority.

The Contractor provides a summary including the aims, objectives and approach and the main results to be published in the Project and Site Description (PSD, 2-4 A4). (Example PSD Hollandse Kust (west)) The summary for the PSD shall be provided as Word file and high resolution illustrations.