Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

31122403-LD-Appendix 11-Required specification Requirements (VSE) LiDAR

Requirement specification Requirements (VSE) LiDAR

Case number: 3112 2403

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Colophon

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1 Introduction

1.1 Interpretation of this document

1.1.1 General

The requirements included in this VSE are minimum requirements. From the fact that many of the requirements have a technical nature, it cannot be assumed that this VSE is entirely and in all cases correct. The Contractor must have comprehensive know-how to design, to realise and deliver a high quality installation, based on these requirements.

If Contractor feels that one or more requirements in this VSE are not realistic or violating laws and/or common standards, contractor is required to make a substantiated notification to Client without delay.

1.1.2 Reading instructions

The following reading instructions apply to this document:

- The reader is strongly advised, prior to reading this document, to take note of the definitions and abbreviations used, which can be found in the VSA;
- Referrals to the VSA will be interpreted as a referral to the VSA itself and to all underlying documents;
- Referrals to specific documents, indicated by means of the brackets-notation "[xxx]" will be interpreted as a referral to that specific document and underlying standards and other documents referred to from that document.

1.1.3 Interpretation of requirements

With regard to the requirements included in this document, the following applies:

- Requirements can be recognised by a unique identification "VSE-nn" followed by a bold header that concisely states the requirement. Below this a list can be found which is identifiable by the word "Requirement:" followed by the formal requirement text;
- Below the requirement there is room for an explanation. This explanation is not part of the requirement; however, the requirement and the explanation are interconnected. The reason for this is that the explanation provides additional information as support for the interpretation of the requirement;
- Lastly, below each requirement a verification method is mentioned. Verification methods are further explained in §1.1.4.

1.1.4 Verification method

Contractor is required to carry out all relevant tests to prove that the installation(s) delivered, complies with the requirements. The different verification methods have been specified in Table 1 below. Each of the requirements in this document includes one or more verification methods; each of those verification methods must be met.

Method	Description
Analyse	The contractor must demonstrate compliance with the requirement by means of carrying out analyses and/or benchmarks and/or simulations and/or calculations and/or by means of the analysis of test data, measuring data, performance data and/or availability data.
Certificate	A document issued by a competent authority which proves that the current material, component or process complies with the required specifications.
Documentation	Meeting the requirement must be demonstrated by Contractor by means of documentation in which the current material, component or process is described in detail.
Inspection	Meeting the requirement must be demonstrated by Contractor by means of the visual inspection of materials, components, documentation and/or equipment supplied and/or installed.
Measurement	Meeting the requirement must be demonstrated by the Contractor, by means of carrying out measurements using measuring equipment, such as field-intensity meter, Ohmmeters, network testing equipment, etc.
Test	Meeting the requirement must be demonstrated by the Contractor by means of establishing that the behaviour of the (partial) system meets the requirement. Testing must take place using predetermined procedures and under well-defined conditions, configuration and input data, possibly using specific testing tools and/or test facilities.

Table 1: Verification methods

2 Referenced documents

This chapter contains a list of documents which are referenced by requirements in this **Fout! Verwijzingsbron niet gevonden.**. For the manner of interpretation of referenced documents and the relative ranking, we refer you to the **Fout! Verwijzingsbron niet gevonden.**.

Identificatie	Omschrijving
BIR-TNK	Baseline Informatiebeveiliging Rijksdienst (BIR), Tactisch Normenkader (TNK), Ministerie van Binnenlandse Zaken en Koninkrijkrelaties, 1 December 2012
Cesar Observatory	http://www.cesar-observatory.nl/
DNV GL	DNV GL Rules and standards, https://www.dnvgl.com/
ECN-E-015-058	Recommended procedures to determine Offshore Wind Farm yield losses due to Transmission System Unavailability, B.H. Bulder, M. van Roermund, E.T.G. Bot, M. Asagarpour, P. Warnaar, oktober 2015, Petten.
ECN-X—016-119	Instrumentation LiDAR Calibration Facility at EWTW, C.A. van Diggelen & J.W. Wagenaar, augustus 2016, Petten.
ECN Brochure	ECN Brochure "Remote Sensing Calibration Facility"
IEA wind RP 15	Ground-based vertically-profiling remote sensing for wind resource assessment, Expert group study on recommended practices, Edited by A. Clifton, D. Elliott, M. Courtney, januari 2013.
[RWS-ELEK]	"Generic requirements of electrical installations", 01-Jul-2010, RWS-DI
[RWS-NNV]	"New Network Facilities Public Works and Water Management – Connection Requirements", Version C, 26-Aug-2009
[NPR1014]	NPR 1014 "Dutch Guidance Protection Against Lightning" (published by NEN as addition/guidance to NEN-EN-62305), publication date 1-Nov-2009.
[NPR8110]	NPR 8110 "Dutch guidance risk management surge and transient protection", publication date 01-Jan-2003.
[NEN1010]	NEN-1010:2007 + correction sheet C1:2008: "Safety requirements for low-voltage installations".
[NEN3140]	NEN-3140:1998 "Operation of electrical installations – Low voltage".
[NEN-EN 50110]	NEN-EN-50110-1:2005 "Operation of electrical installations" and NEN-EN-50110-2:2010 "Operation of electrical installations – Part 2: National annexes".
[NEN-EN-IEC62305]	NEN-EN-62305 "Protection against lightning" consisting of: • Part 1 "General principles", publication date 01-March-2011; • Part 2 "Risk management", publication date 01-Dec-2006; • Part 3 "Physical damages to structures and life hazard", publication date 01-March-2011; Part 4 "Electrical and electronic systems within structures", publication date 01-March-2011.
[NEN-EN-IEC60529]	NEN-EN-IEC 60529 "Degrees of protection provided by enclosures (IP Code)", publication date 1-March-2000.
[Requirements TenneT]	Employer's Requirements TenneT, Borssele Alpha and Beta Platforms, ONL-TTB-03871
Wind op Zee	https://www.windopzee.net/
WJZ/16007215	Regeling schadevergoeding net op zee, Regeling Ministerie van Economische Zaken, 22 maart 2016.

Table 2: Referenced documents

3 Object description

The object tree depicted in Figure 1 below is used to identify objects that the technical and system requirements apply to. The number between brackets is a reference to the paragraph in which the requirements belonging with the object are specified.

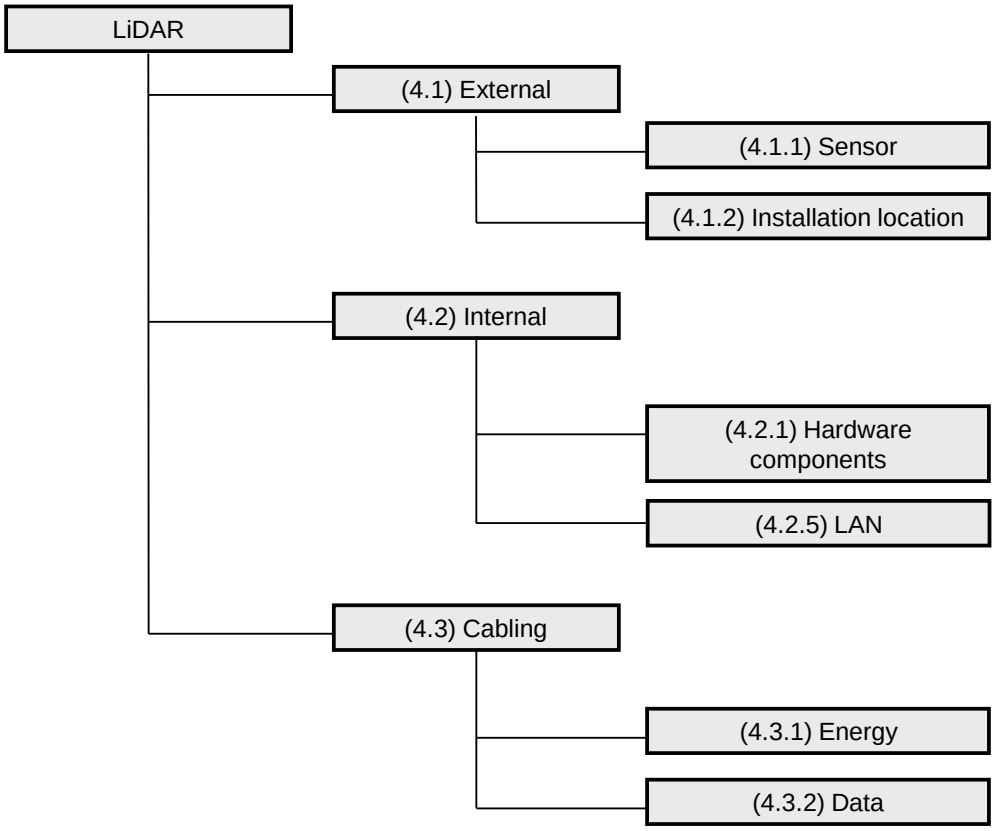

Figure 1: Object tree technical and system requirements

4. Functional, technical- and system requirements

4.1 External

4.1.1 Sensor

VSE-01	**COTS product**
Requirement: *Accept:* ☐	The LiDAR must be a COTS (Commercial Off The Shelf) product.
Explanation:	The product must be demonstrably reliable.
Verification:	Documentation

VSE-02	**Software release**
Requirement: *Accept:* ☐	All (computer) hardware which must be delivered within the framework of this contract, must be of the latest generation. Must demonstrate that all hardware is market conform or the latest release/generation.
Explanation:	
Verification:	Documentation, Inspection

VSE-03	**Operational**
Requirement: *Accept:* ☐	The LiDAR must be continuously operational 24 hours per day, 7 days per week.
Explanation:	
Verification:	Documentation, test

VSE-04	**Conditions North Sea**
Requirement: *Accept:* ☐	The LiDAR is required to be able to withstand the conditions on the North Sea.
Explanation:	The LiDAR is installed on a platform in the North Sea, 40 – 50 metres above sea level. The LiDAR must be able to withstand a salty environment.
Verification:	Certificate, documentation

VSE-05	**Measured values**
Requirement: *Accept:* ☐	The LiDAR must be able to measure and report the following values: 1. Wind speed; 2. Wind direction.
Explanation:	
Verification:	Certificate, documentation, measurement, test

VSE-06	**Height measurements**
Requirement:	The LiDAR must be able to measure and report the wind speed and wind direction for a number of heights, to be pre-set by the user.

Accept: ☐	
Explanation:	The main mode to be used is the vertical profiling of the horizontal and vertical wind speed, and wind direction.
Verification:	Certificate, documentation, measurement, test

VSE-07	**Height range**
Requirement: *Accept:* ☐	The measuring range of the LiDAR must be at least between 40 m and 200 m above the LiDAR device.
Explanation:	
Verification:	Documentation, measurement, test

VSE-08	**Resolution measurement wind speed**
Requirement: *Accept:* ☐	The LiDAR must be able to measure the wind speed with a minimal resolution of 20 m in a height range of 80 to 120 m above the device.
Explanation:	
Verification:	Documentation, measurement, test

VSE-09	**Resolution measurement wind direction**
Requirement: *Accept:* ☐	The LiDAR must measure the wind direction with a minimal resolution of 20 m in a height range of 80 to 120 m above the device.
Explanation:	
Verification:	Documentation, measurement, test

VSE-10	**Range gates**
Requirement: *Accept:* ☐	The height range must be dividable into at least 10 different heights, pre-set by users (range gates).
Explanation:	
Verification:	Documentation, measurement, test

VSE-11	**Accuracy in the measured values wind speed**
Requirement: *Accept:* ☐	The maximum deviation in the measured values of the reported wind speed is 0.1 m/s.
Explanation:	
Verification:	Documentation, measurement, test

VSE-12	**Accuracy in the measured values wind direction**
Requirement:	The maximum deviation in the measured values of the reported wind direction is 5 degrees.

Accept: ☐	
Explanation:	
Verification:	Documentation, measurement, test

VSE-13	**Evaluating uncertainty**
Requirement: *Accept:* ☐	The deviation of the measuring equipment must be determined by use of the 10 minute average of wind speed and wind direction.
Explanation:	The Contractor is required to carry out a test to be able to demonstrate this.
Verification:	Documentation, measurements, test

VSE-14	**Demonstrate uncertainty**
Requirement: *Accept:* ☐	The deviation of the measuring equipment must be measured by the comparison with the wind measurements in the vicinity, obtained by use of calibrated wind sensors in a meteorological tower
Explanation:	The Contractor is required to carry out a test to be able to demonstrate this.
Verification:	Documentation, measurements, test

VSE-15	**Carry out calibration**
Requirement: *Accept:* ☐	The Contractor must be calibrate the LiDAR.
Explanation:	In time of replacement, the LiDAR must be re-calibrated before it can be placed again.
Verification:	Documentation, measurements, test

VSE-16	**Deliver LiDAR**
Requirement: *Accept:* ☐	The Contractor must be deliver the LiDAR within 6 months
Explanation:	
Verification:	Documentation

VSE-17	**Wind speeds range**
Requirement: *Accept:* ☐	The minimal range of the measured and reported wind speeds is 1 to 60 m/s.
Explanation:	
Verification:	Documentation

VSE-18	**Range wind direction**
Requirement:	The range of the measured and reported wind direction is 360 degrees.

Accept: ☐	
Explanation:	
Verification:	Documentation

VSE-19	**Operational uptime**
Requirement: *Accept:* ☐	The LiDAR must have at least a 98% data delivery availability.
Explanation:	
Verification:	Inspection

VSE-20	**Incorrect data**
Requirement: *Accept:* ☐	The LiDAR must detect, identify, reduce and/or remove incorrect data caused by fog, precipitation and clouds.
Explanation:	
Verification:	Inspection, analyse, documentation, test

VSE-21	**Data supplied**
Requirement: *Accept:* ☐	Before use, the data supplied is required to include at least: 1. Horizontal and vertical wind speed, m/s; 2. Wind direction, degrees North; 3. Height, above LiDAR device, of the measurement, m; 4. Status information for operative LiDAR, time stamp and location.
Explanation:	Status information: uptime, data available, carrier to noise ratio (CNR), status flags.
Verification:	Inspection

VSE-22	**Figurative values wind speed**
Requirement: *Accept:* ☐	Figurative values of the average, maximum and minimum wind speed must be available per 10-minute intervals.
Explanation:	
Verification:	Inspection, documentation, test

VSE-23	**Figurative values wind direction**
Requirement: *Accept:* ☐	Figurative values of the average wind direction must be available per 10-minute intervals.
Explanation:	
Verification:	Inspection, documentation, test

VSE-24	**Synchronisation with external time**
Requirement:	The LiDAR must be equipped with a means to synchronise its time with an external

Accept: ☐	time reference.
Explanation:	
Verification:	Inspection, measurement

VSE-25	**Weather conditions**
Requirement: *Accept:* ☐	The LiDAR must report accurately measured values in all weather conditions.
Explanation:	Weather conditions, such as precipitation should not influence the reported measured values.
Verification:	Inspection, measurement

VSE-26	**Lifespan LiDAR**
Requirement: *Accept:* ☐	The LiDAR must be maintained for a period of 10 years.
Explanation:	Offshore preventive maintenance is carried out by a different party.
Verification:	Inspection, measurement

4.1.2 Installation location

VSE-27	**Offshore installation**
Requirement: *Accept:* ☐	It must be possible to replace and install the LiDAR within 4 hours by 2 persons.
Explanation:	The LiDAR is installed on an offshore platform and if necessary the LiDAR must also be replaceable offshore. Therefore the installation of the LiDAR should be uncomplicated.
Verification:	Inspection, documentation

VSE-28	**Offshore environment**
Requirement: *Accept:* ☐	The LiDAR and materials used must be resistant to the offshore environment of the North Sea on the platform and to comply with the directives of DNV GL and IEC.
Explanation:	
Verification:	Inspection, documentation

VSE-29	**Positioning LiDAR**
Requirement: *Accept:* ☐	The LiDAR must have the opportunity of fine level adjustment of the positioning of the LiDAR on the platform, particularly the horizontal placing (levelling).
Explanation:	
Verification:	Inspection, documentation

VSE-30	**North arrow**

Requirement: *Accept:* ☐	The LiDAR system must have an easily visually recognisable North arrow.
Explanation:	
Verification:	Inspection

VSE-31	**Weight of the LiDAR**
Requirement: *Accept:* ☐	The total weight of the LiDAR is maximally 100 kg.
Explanation:	Total weight includes the power unit
Verification:	Inspection

VSE-32	**Protective package**
Requirement: *Accept:* ☐	The LiDAR must be delivered in a reusable packaging, so in the event of removal or replacement, the LiDAR can be transported while being protected.
Explanation:	In the event of replacement of the LiDARs at sea, it must be possible to transport the equipment safely and without damaging it.
Verification:	Inspection, documentation

VSE-33	**Offshore transport OSS**
Requirement: *Accept:* ☐	The LiDAR is required to be able to withstand shocks of up to 0.7G as well as the possible negative impact caused by offshore transportation and installation of the LiDAR.
Explanation:	The LiDAR will be assembled on the platform at the wharf.
Verification:	Inspection, documentation

VSE-34	**Offshore transport LiDAR**
Requirement: *Accept:* ☐	The LiDAR is required to be able to withstand shocks, forces and the possible negative impact caused by offshore transportation and installation/replacement of the LiDAR.
Explanation:	The LiDAR is replaced once every two years.
Verification:	Inspection, documentation

VSE-35	**Humidity**
Requirement: *Accept:* ☐	The LiDAR must supply the required data at a humidity between 0 and 100%.
Explanation:	
Verification:	Documentation

VSE-36	**Temperature**
Requirement:	The LiDAR must supply the required data at a temperature between -30°C and

Accept: ☐	+45°C.
Explanation:	
Verification:	Inspection, documentation

VSE-37	**Wind speed**
Requirement: *Accept:* ☐	The LiDAR must supply the required data at a wind speed between 0 and 60 m/s.
Explanation:	
Verification:	Documentation

VSE-38	**Precipitation**
Requirement: *Accept:* ☐	The LiDAR is required to be able to withstand precipitation, in liquid and solid phases.
Explanation:	
Verification:	Documentation

VSE-39	**Soiling**
Requirement: *Accept:* ☐	Soiling as a result of precipitation or other causes should not affect the availability of required data of the LiDAR.
Explanation:	Offshore the LiDAR can be soiled as a result of different factors.
Verification:	Inspection, measurement, test

VSE-40	**Eye-safe**
Requirement: *Accept:* ☐	The LiDAR is required to operate with an eye-safe wavelength of 1.5 μm.
Explanation:	The LiDAR should not negatively influence aviation.
Verification:	Certificate, documentation

VSE-41	**Laser class**
Requirement: *Accept:* ☐	The LiDAR must be classified as a laser class 1 of class 1M device, as defined in IEC standard 60825-1.
Explanation:	The LiDAR should not negatively influence aviation.
Verification:	Certificate, documentation

VSE-42	**Eye-safe declaration**
Requirement: *Accept:* ☐	With the LiDAR an eye safe declaration must be issued.
Explanation:	The LiDAR should not negatively influence aviation.

Verification:	Certificate documentation

VSE-43	**Calibration**
Requirement: *Accept:* ☐	The LiDAR must deliver required data for at least two years without intermediate calibration.
Explanation:	
Verification:	Documentation

VSE-44	**Unmanned functioning**
Requirement: *Accept:* ☐	The LiDAR must be able to function unmanned for nine months.
Explanation:	The LiDAR will be subject to a maintenance interval of nine months.
Verification:	Documentation

VSE-45	**Documentation LiDAR**
Requirement: *Accept:* ☐	The Contractor is required to provide the Customer with installation and delivery documentation regarding the LiDAR.
Explanation:	The customer must install and maintain the LiDAR.
Verification:	Documentation, inspection

VSE-46	**Installation by third party**
Requirement: *Accept:* ☐	The contractor is required to provide a training for two persons, appointed by the Customer in the interest of the installation of the LiDAR.
Explanation:	The customer must be able to install the LiDAR.
Verification:	Documentation, inspection

VSE-47	**Maintenance by a third party**
Requirement: *Accept:* ☐	The contractor is required to provide a training for two persons, appointed by the Customer for the maintenance of the LiDAR.
Explanation:	The customer must be able to maintain the LiDAR
Verification:	Inspection, documentation

VSE-48	**Supporting the Customer**
Requirement: *Accept:* ☐	If requested, the contractor is required to offer support to the Customer during the installation and maintenance process.
Explanation:	The customer must install and maintain the LiDAR.
Verification:	Documentation, inspection, measurement, test

4.2 Internal

4.2.1 Hardware components

VSE-49	**Storage of data**
Requirement: *Accept:* ☐	The LiDAR should have the opportunity to store the required data, bases on 10-minute figurative values, for a period of at least one year.
Explanation:	
Verification:	Inspection

4.2.2 LAN

VSE-50	**Submitting data**
Requirement: *Accept:* ☐	The LiDAR must submit the 10-minutes data and status information within 2 minutes after observation, in a simple (ASCII) format.
Explanation:	
Verification:	Documentation, inspection, test

VSE-51	**Raw data**
Requirement: *Accept:* ☐	De raw data must be available at a time interval, defined by the user, of at least 10 minutes up to 24 hours.
Explanation:	Preferably on a 1 sec. basis
Verification:	Inspection, test

VSE-52	**Data availability**
Requirement: *Accept:* ☐	The LiDAR must supply the required data at an availability of minimally 95% at a measurement height of 120 m above the LiDAR device.
Explanation:	Non-available data includes time stamps with no signal available or which contains clearly incorrect data, or too low a CNR.
Verification:	Documentation, inspection

VSE-53	**Ethernet connection**
Requirement: *Accept:* ☐	The LiDAR is required to automatically submit figurative data over the internet to an FTP environment, every 10-minutes.
Explanation:	
Verification:	Inspection, test

VSE-54	**Network interface**
Requirement: *Accept:* ☐	The LiDAR requires at least one standard ethernet network connection, based on an RJ-45 interface.
Explanation:	

Verification:	Inspection

VSE-55	**Long distance connectivity**
Requirement: *Accept:* ☐	The LiDAR must be controllable from a distance via a standard web browser to solve problems that occurred and for the implementation of configuration changes or ad-hoc data recovery.
Explanation:	
Verification:	Documentation, inspection, test

VSE-56	**Access Long distance connectivity**
Requirement: *Accept:* ☐	The Customer requires access to use the standard web browser and the data that is required for remote maintenance and management.
Explanation:	
Verification:	Documentation, inspection, test

VSE-57	**Protecting connectivity**
Requirement: *Accept:* ☐	The possibility for long distance connectivity must be protected by means of a user name and password.
Explanation:	
Verification:	Inspection

4.3 Cabling

VSE-58	**Energy cables and connections**
Requirement: *Accept:* ☐	The energy cables and connection are required to be IP67 compliant.
Explanation:	
Verification:	Documentation, inspection

VSE-59	**Voltage supply LiDAR**
Requirement: *Accept:* ☐	The voltage supply of the LiDAR must be based on alternating current (AC).
Explanation:	
Verification:	Inspection

VSE-60	**Maximum power**
Requirement: *Accept:* ☐	The power is maximally 200 W (AC).
Explanation:	
Verification:	Documentation, inspection

VSE-61	**Spanning**
Requirement: *Accept:* ☐	The system should continue to work effectively in the event of voltage variations of ±10% and/or frequency variations of ±3%.
Explanation:	
Verification:	Documentation

VSE-62	**Directives Cables**
Requirement: *Accept:* ☐	The cables must meet the DNV GL Directives.
Explanation:	
Verification:	Documentation, inspection