[Redacted]

From: [Redacted]
[Redacted]
Sent: 12 February 2018 11:18
To: [Redacted]
Cc: [Redacted]
Subject: Working Outwith the Daylight Hours

Hi [Redacted]

As requested please see below the list of dates and hours that works have been taking place along the beach out with the daylight hours:

- 28/01/2018: 18:00 to 24:00
- 29/01/2018: 00:01 to 04:17 - 07:30 to 08:00 - 18:00 to 24:00
- 30/01/2018: 00:01 to 08:30 - 18:00 to 24:00
- 31/01/2018: 00:01 to 03:25
- 01/02/2018:18:00 to 19:45
- 05/02/2018: 05:40 to 08:30 - 18:00 to 24:00
- 06/02/2018: 00:01 to 03:00
- 07/02/2018: 18:00 to 23:55

We are waiting to receive the noise report by the consultants and will issue it as soon as possible.

Regards,
[Redacted]

[Redacted]
[Redacted]
Aberdeen Offshore Wind Farm

3rd Floor, The Tun Building
4 Jackson's Entry
Holyrood Road
Edinburgh
EH8 8PJ

[Redacted]
[Redacted]

DNV·GL

ABERDEEN OFFSHORE WIND FARM (AOWF)

Evaluation Report Design Evaluation

Aberdeen Offshore Wind Farm Limited

Report No.: ER-DE-IEC61400-22-02361-0
Date: 2018-02-07

Project name:	Aberdeen Offshore Wind Farm (AOWF)	DNV GL Energy Renewables Certification DNV GL Denamrk A/S Tuborg Parkvej 8, 2nd floor 2900 Hellerup Denmark Tel: +45 3945 4800 DK 89 83 23 14
Report title:	Evaluation Report Design Evaluation	
Customer:	Aberdeen Offshore Wind Farm Limited, Third Floor, The Tun Building, 4 Jackson's Entry, Holyrood Road, Edinburgh EH8 8AE, United Kingdom	
Contact person:	Esther Escudero	
Date of issue:	2018-02-07	
Project No.:	644259/10021311	
Report No.:	ER-DE-IEC61400-22-02361-0	

Applicable contract(s) governing the provision of this Report: Project Contract No. 4500375606 and letter ABE-DNV-CER-L-0001 Change in Address for AOWFL dated 31st January 2018.

Objective:

To confirm the successful evaluation of the site-specific design for the WTG Support Structures (excl. tower) of the Aberdeen Offshore Wind Farm according to IEC 61400-22.

Prepared by:	Verified by:	Approved by:
[redacted]	[redacted]	[redacted]
Project Manager	Senior Engineer	Project Sponsor

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Keywords: Aberdeen (AOWF), Design Evaluation

Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
0	2018-02-07	First issue	HEHU	ANTACA	NBK

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1 EXECUTIVE SUMMARY

This evaluation report documents the verification activities performed by DNV GL, as Certification Body, to approve the Design Basis Evaluation module for the Aberdeen Offshore Wind Farm (AOWF) according to IEC 61400-22:2010 certification system and the Project Contract No. 4500375606 and letter ABE-DNV-CER-L-0001 Change in Address for AOWFL dated 31st January 2018.

The documentation listed in Appendix A has formed the basis for the DNV GL verification in order to cover the elements for Project Certification Phase IV: Support Structure Design Evaluation.

DNV GL has performed the verification by document review of the Design Evaluation documents, issuing Verification Comment Sheets (VCS) when relevant raising Technical Queries, Non-Conformances and Advices to the documents. The DNV GL review is described in the appendices to this report.

DNV GL hereby confirms that the "Design Evaluation" module for the Support Structure with Suction Bucket Jackets part of the Aberdeen Offshore Wind Farm fulfils the requirements of the certification scheme listed in Section 2.

1.1 Introduction

The Aberdeen Offshore Wind Farm consists of eleven (11) turbines supported by Suction Bucket Jacket substructures. The wind farm will be located about 2.4 km offshore of the coastline of Aberdeenshire at Blackdog, on the north-east coast of Scotland. The maximum capacity of the wind farm is 96.8 MW produced by 11 MVOW V164-8.4 MW wind turbine generators. The turbines are capable of running at 8.4 MW as a power mode. The support structures are located in water depths ranging between 19 m and 32 m below LAT.

The developer is Aberdeen Offshore Wind Farm Limited which is owned by Vattenfall Wind Power Limited. The Sub-structure/Foundation designer is Boskalis who in turn has employed the services of Ramboll Offshore Wind as the jacket designer and SPT Offshore (SPT) as the Suction Bucket Designer. The wind turbine supplier is Mitsubishi Vestas Offshore Wind (MVOW).

The location and park layout can be found in the illustration below.

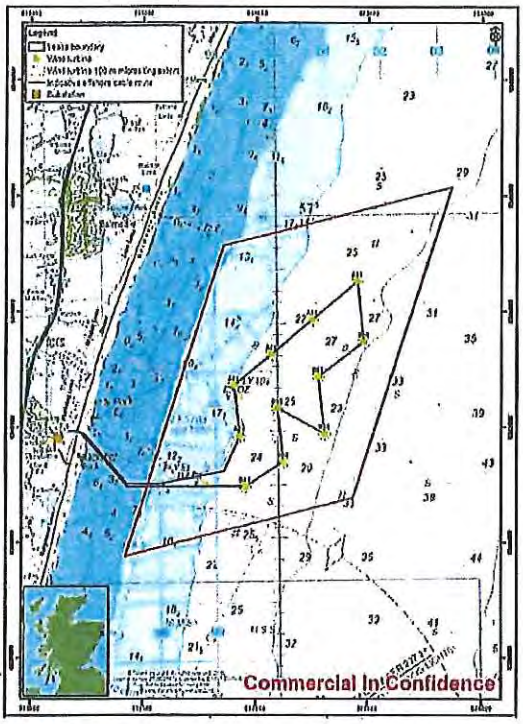

Figure 1 - Site location Ref. ER-SC-IEC61400-22-01569-1

2 CERTIFICATION SCHEME

Document No.	Title
IEC 61400-22:2010	Wind turbines – Part 22: Conformity testing and certification

The certification scheme is as defined above. The customer's interpretation of the IEC 61400-22 scope has been found by DNV GL to be in compliance with the scope of the relevant modules defined in DNVGL's Service Specification DNVGL-SE-0073. The Project Certification according to IEC 61400-22 and DNVGL-SE-0073 is part of DNV GL RC's accreditation for project certification.

3 LIST OF REPORTS

The appendices to this report comprise the detailed DNV GL evaluation reports which normally include reference standards/documents, list of design documentation as well as summary and conclusion of the DNV GL evaluation.

APPENDIX	Revision	Subject
A	0	Design Evaluation – WTG Support Structures Structural Design (Excl. Tower)
B	0	Design Evaluation – WTG Support Structures Geotechnical Design

4 CONDITIONS

The conditions identified during the technical evaluation are listed in the appendices. The conditions are assigned to the certification phases in which they need to be considered and evaluated.

Installation phase:

The following conditions shall be complied with to ensure the structural safety:

- The sea-state during lift from barge and subsequent lowering shall be one in which peak periods of the waves do not exceed Tp,max = 7.0 sec. Significant wave heights Hs during same phase of lift and lowering shall be limited to Hs,max = 1.5 m for the deep-water positions (bucket diameter 10.5 m) and Hs,max = 3.0 m for the shallow-water positions (bucket diameter 9.5 m).
- During on-bottom stability, particularly against sliding of the structure, the significant wave height shall be limited to Hs,max = 1.5 m.
- Structure shall remain hooked by crane after the lowering procedure has been accomplished and while both self-weight penetration of the bucket skirts and initial stages of suction are ongoing, until a skirt penetration of 2 m or more has been achieved for all three buckets in the structure's foundation.
- Suction in buckets during skirt penetration shall be limited to 3.78 kPa and 4.21 kPa for the Ø9.5 m and Ø10.5 m buckets respectively.
- While suction operation is ongoing and at its termination, mutual differences in bucket penetrations shall be limited to 250 mm. The jacket rotation relative to perpendicular shall also be less than 1.0°.
- Properly functioning earthing/electrical connections connecting all parts to be protected by the cathodic protection system must be confirmed by testing during manufacturing/installation to ensure full electrical continuity with due consideration of the connection resistance and potential voltage drop across electrical continuity cables. However, this is also considered common practice. Please e.g. refer to DNV-RP-B401, Sec. 7.12.

- The designer may intent to use pressure cycling to mitigate an unexpected higher installation soil resistance. This will disturb the mechanical properties of the soil, and these effects have not been considered in the design. Thus, the design has been approved with the condition of avoiding pressure cycling. If pressure cyclic is applied nevertheless, the design strength of the foundation must be re-evaluated again.
- It is noted that the grouting is an interface between SPT and Boskalis regarding its feasibility and procedure. The grouting procedures have not been issued to DNV GL at this point of time as a part of the certification work. Since the soil may be in contact with the mud-mat, it must be ensured that a sufficient grout filling can be ensured.

Operation & maintenance phase:

- Based on the findings from the verification of the fatigue design; inspection and monitoring of the welded connections of the jacket structures including transition piece shall be performed. The inspection and monitoring plan shall be developed in such a manner that remedial action can be taken should cracks in the welded connections develop.
- Specified coating systems are based on Employer's specification and subject to a condition of maintenance throughout the design life time.
- Inspection and maintenance of the corrosion protection system in general must be performed. This include cathodic protection survey and coating inspections and repair.
- An inspection and maintenance plan is prescribed in the Scour Protection Design documentation which must be upheld throughout the design lifetime.

5 OUTSTANDING ISSUES

There are no outstanding issues for this evaluation.

6 CONCLUSIONS

Present evaluation report is to be seen in conjunction with evaluation reports for preceding IEC 61400-22 modules, namely the Site Conditions Assessment (ER-SC-IEC61400-22-01569-1), the Design Basis Evaluation (ER-DB-IEC61400-22-02359-0), the Integrated Load Analysis (ER-ILA-IEC61400-22-02360-0) as well as the site-specific design evaluation of the rotor nacelle assembly and tower for the wind turbine (ER-SSDE-IEC61400-22-02583-1).

This report includes the design evaluation of the Aberdeen Offshore Wind Farm substructure/foundation (i.e. support structure excl. tower), whereas the tower design evaluation is included in site-specific design evaluation of the rotor nacelle assembly and tower for the wind turbine (ER-SSDE-IEC61400-22-02583-1). In combination, the tower, sub-structure and foundation comprise the support structure for the wind turbines.

DNV GL hereby confirms that the site-specific support structure design evaluation module for the Aberdeen wind turbines (excl. tower) as described by the documentation from customer listed in the relevant section of the appendices fulfils the requirements of the Certification scheme listed in Section 2, however with the conditions as listed in Section 4.

Design of the secondary structures (e.g. J-tubes, boat landing and access platforms) is not within the certification Scope of Work performed by DNV GL.

APPENDIX A
Design Evaluation - WTG Support Structure Structural Design (Excl. Tower)

A1 DESCRIPTION OF VERIFIED COMPONENT, SYSTEM OR ITEM

This evaluation document describes the verification of the primary steel design of the Suction Bucket Jacket (SBJ) structures intended as supports for a selection of 11 Wind Turbines for the Aberdeen Bay site.

The Jacket is designed as three-legged structure with two bays of X-bracings in each of its sides, which transfer wind loads from turbine and hydrodynamic loads on the jacket to the actual foundation. Each Jacket includes three suction buckets and a Transition Piece (TP) which is placed between the turbine tower and the Jacket to transfer the loads from the turbine to the Jacket. The TP is designed as a plate structure with a central cylinder which adapts the tower geometry and is integrated with three box-type beams (legs) supported at their feet by the heads of the jacket legs. Please see Figure A1.

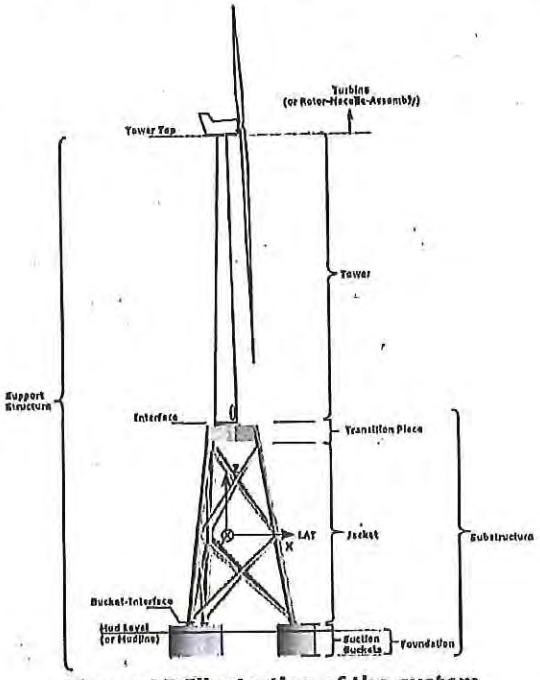

Figure A5:Illustration of the system

The design of the transition piece and the upper section of the jacket structure is identical for all eleven wind turbine positions in the farm. Four different types of the lower section of the jacket and, likewise, four varieties of the suction buckets have been designed to accommodate the variations in water depth and soil properties over the area of the farm. The jacket leg batter is identical for all eleven positions.

The primary steel structure is a fully welded structure, prepared for a bolted connection with the turbine tower. Once the structure is installed, all jacket legs and all braces will be flooded to the level defined by the local water depth.

Cables and grout pipes are traced through the interior of jacket legs and transition piece.

The detailed design comprises verification of sufficient structural strength and fatigue lives for significant loading conditions experienced by the foundation structure during the construction, installation and operation phases.

The verification covers design and analysis of the primary steel in the suction buckets, Jacket and transition piece including the specifications made for fabrication and installation of the structures. The verification also covers the impact and safety of the primary steel from secondary structures, to the primary, e.g. boat landing, cathodic protection system and vessel impact.

The flange between the turbine tower and the transition piece is not handled in the context of present Support Structure Design Evaluation, SSDE. Along with the steel tower and the RNA said interface flange is covered by the type certification of the turbine and the site-specific approval of its application.

The primary steel design is based on the Site Conditions and Design Basis documents, which have been verified in the project phases preceding present SSDE. This also means that design scenarios including sea ice or earthquakes are considered of no relevance for Aberdeen Offshore Windfarm (AOWF).

A2 BASIS FOR THE EVALUATION

Applied codes and standards:

Document No.	Date	Title
IEC 61400-1	2005-08 / AMD1:2010	Wind turbines – Part 1: Design requirements incl. Amendment 1
IEC 61400-3	2009-02	Wind turbines – Part 3: Design requirements for offshore wind turbines
DNV-OS-J101	2014-05	Design of Offshore Wind Turbine Structures
DNV-RP-C203	2014	Fatigue Design Offshore Steel Structures
DNV-RP-B401	2011-04	Cathodic Protection Specification
DNV-RP-C204	2010-10	Design against Accidental Loads
ISO 19902	2007-12-01	Petroleum and natural gas industries – Fixed steel offshore structure 1st edition
EN 12495	2000-02	Cathodic protection for fixed steel offshore structures,
EN ISO 20340,	2009-04	Paints and Varnishes – Performance requirements for protective paint systems for offshore and related structures, Second edition
NORSOK M-501,	2012-02	Surface preparation and protective coating, rev. 06
DNVGL-OS-C401	2015-07	Fabrication and testing of offshore structures
-	1988-10	Efthymiou, M.: Development of SCF formulae and generalized influence functions for use in fatigue analysis, OTJ 88, London
Bultrago, J. et al.	1993	Local Joint Flexibility of Tubular Joints. Proceedings of the 12th International Conference on Offshore Mechanics and Arctic Engineering, Glasgow
DNV-RP-C208	2014-05	Determination of Structural Capacity by Non-linear FE analysis Methods, 2013
	1994-12	Sterndorff, M. J.: Recommended Force/Deformation Curves for Supply Vessels, rev. A
BS EN-1993-1-5	2007	Eurocode 3 – Design of Steel Structures – Part 1-5: Plated Structural Elements,
BS EN 1993-1-6	2012	Eurocode 3 – Design of Steel Structures – Part 1-6: Strength and Stability of Shell Structures

Document No.	Date	Title
EN 10025 Part 1 to 6:	2004-11	Hot rolled products of structural steel
EN 1991-1-4	2009	Actions on Structures – Part 1-4: General Actions – Wind Actions
DNV-RP-C205	2014-04	Environmental Conditions and Environmental Loads
DNV-RP-F105	2006-02	Free Spanning Pipelines
DNVGL-ST-0126	2016-04	Support structures for wind turbines
DNVGL-ST-N001	2016-06	Marine operations and marine warranty
DNV-RP-H103	2014-02	Modelling and Analysis of Marine Operations

The evaluation has been based on the following loads, design basis as well as other site specific criteria:

A3 DOCUMENTATION FROM CLIENT

List of Design Reports:

Document No.	Revision and date	Title
ABE-BOS-0956	02:2017-08-07	Design Report - Extreme Event Analysis
AOWF-513-003	01:2017-03-28	Design Report - Natural Frequency Analysis
ABE-BOS-0256	03:2017-12-11	Design Report - Time Domain Fatigue Analysis
ABE-BOS-0958	03:2017-08-18	Design Report - Corrosion and Cathodic Protection
ABE-BOS-0258	02:2017-07-03	Design Report - Vessel Impact Analysis
ABE-BOS-0092	03:2017-09-08	Design Report - Finite Element Analysis
ABE-BOS-0263	04:2017-11-10	Design Report – Global Analysis Model
ABE-BOS-0959	02:2017-06-14	Design Report – Vortex Induced Vibration
ABE-BOS-0367	02:2017-05-29	Design Report – Anode Inserts
ABE-BOS-0265	07:2018-01-29	Design Report – Jacket Installation Analyses
AOWF-514-017	01:2017-06-06	Engineering Report – Fatigue life comparison of bucket interface weld
AOWF-514-019	05:2017-11-10	Engineering Report – Updated hot spot stress extrapolation for FLS
ABE-BOS-1506	D:2017-11-29	Suction Bucket Foundation Detailed Structural Design - Stress Relation Factors for Fatigue Calculations
ABE-BOS-1505	C1: 2017-06-23	Suction Bucket Foundation Detailed Structure Design – In-place Conditions

List of specifications/manuals/instructions:

Document No.	Revision and date	Title
N/A		

List of structural drawings of Transition Piece and Jacket (**301000327-AOWF-519-WTG**):

Document No.	Revision	Date	Title
PS-00-001	7	2017-05-11	General Note - Primary Steel Sheet 1
PS-00-002	10	2017-09-28	General Note - Primary Steel Sheet 2

Document No.	Revision	Date	Title
PS-00-003	5	2017-02-03	General Note - Primary Steel Sheet 3
PS-00-004	4	2016-12-14	General Note - Primary Steel Sheet 4
PS-00-005	4	2017-10-11	General Note - Corrosion Protection Sheet 1
PS-00-006	5	2017-10-11	General Note - Corrosion Protection Sheet 2
PS-02-001	12	2017-12-07	Transition Piece - Bill of Materials
PS-02-101	6	2017-07-04	Transition Piece - Main Layout
PS-02-201	9	2017-07-04	Transition Piece - Section and Details 1
PS-02-202	5	2017-05-11	Transition Piece - Section and Details 2
PS-02-203	5	2017-05-11	Transition Piece - Section and Details 3
PS-02-205	5	2017-05-11	Transition Piece - Section and Details Pad Eye
PS-02-208	3	2017-05-11	Transition Piece - Longitudinal Welds
PS-02-209	3	2017-05-11	Transition Piece - Section and Details 5
PS-02-301	7	2017-05-31	Transition Piece - Interface Flange
PS-04-001	7	2017-07-04	Jacket Structure - Bill of Materials - Jacket - Upper Part
PS-04-002	6	2017-07-04	Jacket Structure - Bill of Materials, Lower Part - Cluster 1 (2 Positions)
PS-04-003	6	2017-07-04	Jacket Structure - Bill of Materials, Lower Part - Cluster 2 (2 Positions)
PS-04-004	7	2017-07-04	Jacket Structure - Bill of Materials, Lower Part - Cluster 3 (3 Positions)
PS-04-005	7	2017-07-04	Jacket Structure - Bill of Materials, Lower Part - Cluster 4 (4 Positions)
PS-04-101	6	2017-07-04	Jacket Structure - Jacket - Upper Part
PS-04-102	3	2017-03-08	Jacket Structure - Upper Part - Ring Stiffener for Boat Landing Supports
PS-04-105	5	2017-07-04	Jacket Structure - Lower Part - Cluster 1 (2 Positions)
PS-04-110	4	2017-07-04	Jacket Structure - Jacket Leg - Lower Part Cluster 2 (2 Positions)
PS-04-115	5	2017-07-04	Jacket Structure - Jacket - Lower Part Cluster 3 (3 Positions)
PS-04-120	4	2017-07-04	Jacket Structure - Jacket Leg - Lower Part Cluster 4 (4 Positions)
PS-04-201	3	2017-07-04	Jacket Structure - Flooding Holes - Typical for Jacket Cluster 1-4
PS-02-206	5	2017-12-07	Transition Piece – Weld Grinding 1
PS-02-207	5	2017-07-04	Transition Piece – Weld Grinding 2
PS-04-202	1	2017-05-11	Jacket Structure – Joint Welding

List of Transition Piece and Jacket drawings taken for information only (**301000327-AOWF-519-WTG**):

Document No.	Revision	Date	Title
PS-02-204	3	2017-05-11	Transition Piece - Section and Details 4
PS-04-501	5	2017-06-16	Jacket Structure - Anodes - Cluster 1
PS-04-502	5	2017-07-06	Jacket Structure - Anodes - Cluster 2
PS-04-503	5	2017-06-29	Jacket Structure - Anodes - Cluster 3
PS-04-504	6	2017-07-04	Jacket Structure - Anodes - Cluster 4