Base Load Power Hub (BLPH)

STRUCTURAL FABRICATION SPECIFICATION

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.1.1 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.

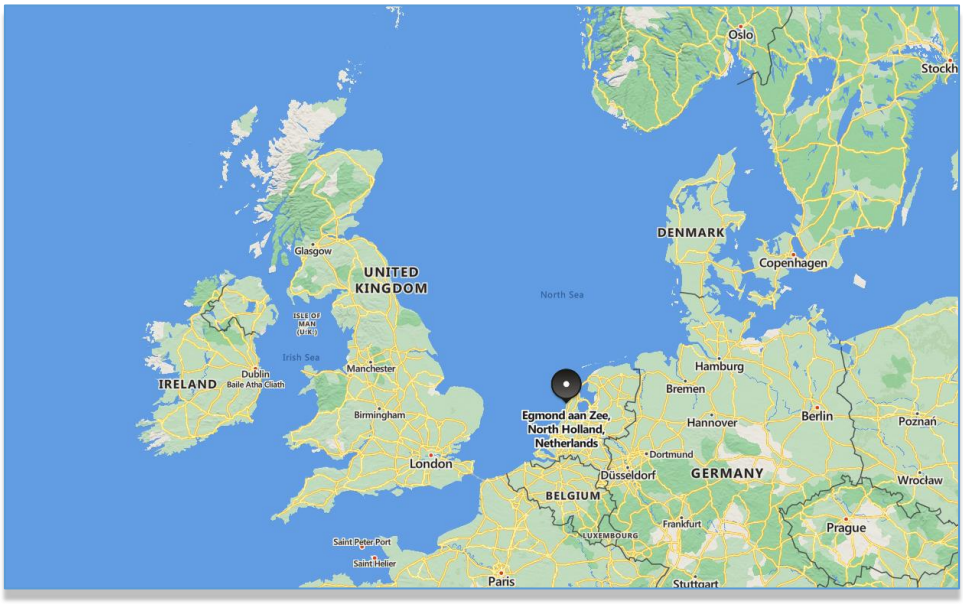


Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map

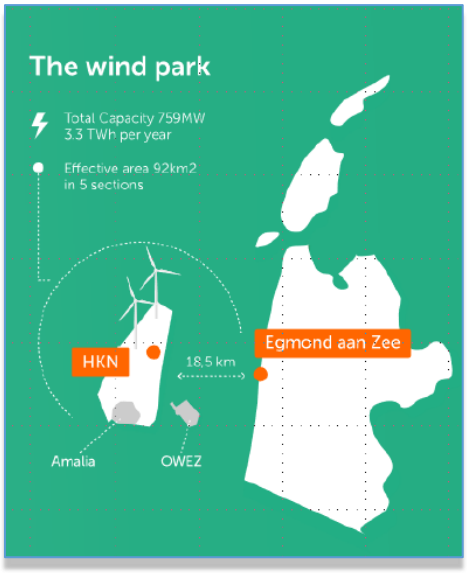


Figure 2 - Wind Park Details

The wind farm will consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile located on coordinates E 590719.1, N 5841602.3 is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

1.1.2 Project Concept

All components included in the BLPH will be integrated onshore on a topsides and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

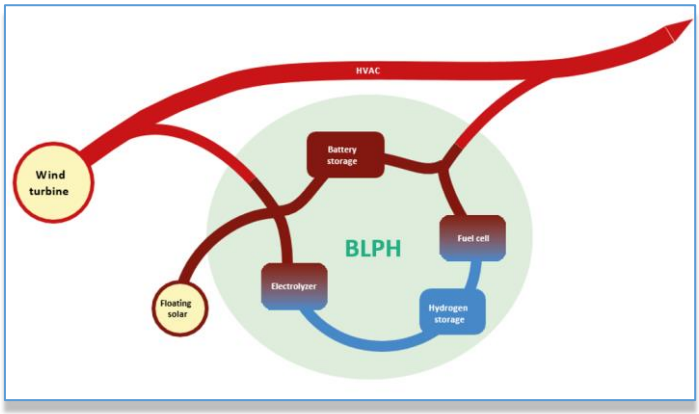


Figure 3 – BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining power output. This will be by discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.

The purpose of the BLPH s to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

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2 DOCUMENT SCOPE

This specification applies to the fabrication of topside structures and component's part, such as welded tubulars and plate girders.

2.1 REFERENCES

Doc. No.	Description
1. 123A90-DDL-SP-90018	Structural Material Specification

Table 1 - Reference Documents

2.2 DEFINITIONS AND ABBREVIATIONS

2.2.1 Definitions

COMPANY or Client (CPY):	Crosswind
CONTRACTOR (CTR):	ROSETTI MARINO S.p.A.
PROJECT:	HOLLANDSE KUST NOORD WIND PARK Project
MANUFACTURER	The mill responsible for the manufacture of the material and / or the entity or sub-supplier producing the welding consumables
SUBCONTRACTOR	Refers to fabricator to whom the CONTRACTOR awards any part of the work (as defined by EEMUA 158)

Table 2 - Definitions

2.2.2 Abbreviations

NA	Not applicable
AWS	American welding society
CTOD	Crack Tip Opening Displacement
EEMUA	Engineering Equipment and Materials Users Associations
THK	Thickness
LAST	Lowest anticipated service temperature
TT	Through-thickness;
CVN	Charpy V-notch
SHS	Seamless hollow section

DC	Design class
SQL	Steel Quality
MPI	Magnetic particle inspection
NDT	Non destructive testing
PHWT	Post weld heat treatment
RT	Radiographic testing
UT	Ultrasonic testing

Table 3 - Abbreviations

3 CODES, STANDARDS AND SPECIFICATIONS

The following codes, standards and Specifications shall be considered as part of this Specification. It shall be the CONTRACTOR / SUBCONTRACTOR's responsibility to acquire possession of all required Codes and standards and specifications referenced in this document.

Internationally recognised fabrication standard other than EEMUA 158, Ref.2 may be used subject to COMPANY approval.

1. AWS D1.1	Structural welding code, 2020
2. EEMUA 158	Construction Specification for fixed offshore structures, Ed.3 2014
3. NORSOK M101	Structural steel fabrication, Ed. 5 2011
4. EN ISO 17640	Non-destructive testing of welds-ultrasonic testing-Techniques, testing levels and assessment.
5. EN ISO 19902:2020	Petroleum and Natural gas industries – Fixed steel offshore structures, Second edition 2020-11
6. EN ISO 19901-3:2014	Petroleum and Natural gas industries – Specific requirements for offshore structures – Part 3: topside structure, Second edition 2014-12-15.

3.1 AMENDMENTS TO EEMUA 158

This section shall be read in conjunction with EEMUA 158. The following paragraph numbering corresponds to paragraphs in Edition 3 of EEMUA 158 where amendments are made. All other paragraphs remain unchanged and shall apply.

3.1 Replace "EN 10225:2009 with EN 10225 parts 1-4 2020. Grades are listed in the Structural Topsides Design & Installation Philosophy K559-2254-ST-PHI-001.

3.2 Insert after paragraph 2 to: For Shielded Metal Arc Welding (SMAW) electrodes, electrode lot classifications of Class C4 or C5 shall be used.

3.3.1 Add to second paragraph: Or hot dip galvanised to ISO 10684 [Ref 15]

4.1 Add: Welding procedures shall be qualified by the CONTRACTOR / SUBCONTRACTOR undertaking the fabrication. The use of welding procedures qualified by other companies or CONTRACTORS / SUBCONTRACTORS shall not be permitted.

4.2.1.2. Add new 1st paragraph: Welding procedures shall be qualified by testing in conformance to this Specification and EEMUA 158. Welding procedures defined as "prequalified" in conformance to AWS D1.1 or similar welding codes and standards are not acceptable.

4.4.1 Figure 3: Revise heading at top of figure to read "Welding Procedure Qualification Test Report" (similar to Figure 3 in Edition 2 of EEMUA 158).

4.4.3.2 Insert: The inspection of welds shall comply with the requirements of ISO 19902 Annex F as amended by Table 5.1 of this specification.

Replace Table 2:

Steel Classification	Inspection Category[11]		Type of Connection	Visual Examination	RT	UT	MPI
	ISO	EEMUA					
DC1 and DC2[9]	A[13]	I	Butt Welds	100%	10%	100%	100%
			T, K, Y, joints[16]		-	100%	100%
			Fillet welds		-	-	100%
DC3 and DC4	C[13,14)]	III	Butt Welds	100%	Spot[15]	50%[16,17]	50%[16,17]
			T, K, Y, joints[16]		-	50%[16,17]	50%[16,17]
			Fillet welds		-	-	50%[16,17]
DC5	D	V	All welds	100%			10%
	E	N/A	All welds	100%			

Notes:

1. These testing requirements are also applicable to padeyes and trunnion connections associated with lifting. All lifting connections shall be subjected to 100% MPI and 100% UT (where possible) and they shall be recoated in accordance with the requirements NORSOK M-501 [Ref 9]
2. The percentage (%) of NDT shall mean the required percentage of examination of each type of weld. All WPS's and welders shall be assessed by the testing. The percentage of examination shall be 100 % of each weld where secondary and tertiary steel are attached to the primary steel.
3. When a defect is found the extent of testing shall be increased in accordance with the requirements of ISO 19902 A.20.3.

4. Partial penetration welds shall be examined by ultrasonic longitudinal scanning techniques to verify the depth of fusion.
5. Classification of steel is defined in APPENDIX A .
6. In case of partial penetration welds on those joints, the requirements are only applicable if the specified metal cross-section (weld throat) exceeds 8 mm.
7. UT applies when material thickness is more than 12.7 mm. UT may be replaced by radiography where wall thickness is less than or equal to 12.7 mm.
8. Permanent magnets shall not be used for magnetic particle testing.
9. Notes relating to Inspection Category A and B in ISO 19902 Table F.2. apply.
10. For welds between two design classes, the higher class shall be used to determine NDT requirements.
11. Design and Inspection classes for steel structures are defined in APPENDIX A .
12. Long seam SAW tubulars greater than 12mm thick shall be subjected to UT for chevron cracking.
13. In addition to the requirements in this table, the following shall apply for category A welds:
    - A) One RT film at each end and one in the middle for longitudinal welds of tubulars (including tubulars for nodes and stubs).
    - B) Where radiographic testing is required, intersection welds, and those locations where presence of defects is deemed to be most harmful, shall be tested.
    - C) Ultrasonic and radiographic testing shall not overlap, except when 100 % UT is specified. However, ambiguous imperfections revealed by UT shall in addition be tested by RT
    - D) Ultrasonic testing is normally not applicable for thickness less than 10 mm. For such thickness, UT may be replaced with RT. In general, RT should be considered if UT is not possible. Radiographic testing is normally not applicable for thickness above 40 mm.
    - E) MPI shall be performed on both external and internal surfaces as accessible.
14. During initial fabrication, the extent of UT and MPI of inspection category C welds shall be intensified, normally to twice the level given in this table. This extent shall be maintained for a weld and test length sufficient to conclude that the weld repair percentage is at a reasonable level. The increased initial testing may be accounted for in the overall extent provided the initial testing confirms consistent good workmanship.
15. Spot means approximately 5 %.
16. Includes complete joint penetration welds in tubular T,Y, and K-connections and other applications.
17. The extent may be reduced to 20 % of the specified extent, based on experience and documented records with similar joints, provided the defect rate for UT/RT is < 2,0 % and for MPI is < 0,2 % during the l ast 100 m of weld. The last 100 m shall be continuously updated every week. If the defect rate exceeds the limits given above, the normal extent of NDT shall apply again. A possible reduction in the extent of NDT shall be considered separately for each welding method and each production area.
18. The extent of NDT shall be increased for inspection categories C and D if repeated occurrence of planar defects are revealed or if the weekly defect rate for any NDT method, including all types of defects, exceed the rates shown in ISO 19902 A.20.3-1. The increase in extent of NDT shall be in accordance with ISO 19902 A.20.3-1.

4.4.4 Table 3: Note (e) referred to in the table for Charpy tests for both the Cap (All Pipe thicknesses ≤ 40 mm) and for Root (Pipe 20 < t ≤ 40 mm) is incorrect and should instead refer to Note (c). This should read similar to Table 1 in Edition 2 of EEMUA 158.

4.4.4 Table 3: Note (a) referred to in the table for weld metal Crack Tip Opening Displacement (CTOD) test sets is incorrect and should instead refer to Note (n). This should read similar to Table 1 in Edition 2 of EEMUA 158.

4.5.3 Add new bullet point: Any change in electrode or electrode / flux brand name or place of manufacture (as per ISO 19902).

4.5.4 Add new bullet point: An increase of more than 28°C over the maximum interpass temperature attained during the procedure qualification test (as per ISO 19902).

4.5.6 Add: Additional essential variables.

For welding procedures that are qualified with CTOD testing, the additional essential variables listed in 20.2.2.5.4 of ISO 19902 shall apply.

4.6.3 Revise 2nd paragraph in third bullet point to: Welders that will not perform root and hot passes in production, i.e. will only do fill and cap, may qualify by the 6G position.

5.2.3 Add: Spacing of seams and splices shall also comply with requirements listed in Section 20.4.2.2 of ISO 19902.

Note: If conflict arises between EEMUA 158 and ISO 19902, this shall be brought to the attention of COMPANY.

5.3.3 Add commentary note:

Structural steels are procured based on well-defined chemical composition limits in order to limit degree of hardenability and to prevent hydrogen cracking of the HAZ. However, preheat levels still need to be controlled based on guidance in EN 1011-2. Attention is also needed to ensure preheat levels used during production welding will prevent hydrogen cracking from occurring in the weld metal which may still occur even when welding steels supplied with lean chemistry.

5.3.7 Add: The CONTRACTOR / SUBCONTRACTOR is permitted to implement two weld repairs to full penetration butt welds without seeking approval unless otherwise instructed by COMPANY.

6.1 Revise second sentence in paragraph 11 to: Fabrication tolerances shall be in accordance with EEMUA 158 unless otherwise agreed by the COMPANY. Where EEMUA 158 is silent, fabrication tolerances given in ISO 19902 shall apply for topsides structures. Tolerances in AWS D1.1 shall apply only when agreed by the COMPANY.

7.4.2 Insert: UT shall be carried out in accordance with ISO 17640 with accept / reject criteria as indicated in ISO 11666 and in the table below.

Inspection Category	ISO 17640 Testing Level	ISO 11666 Acceptance Criteria
A	C	2
C	B	2

Auto UT techniques including TOFD to EN ISO 16828 and phased array to EN ISO 13588 may be proposed for COMPANY approval.

For critical welded joints which are shown on the fabrication drawings as requiring toe or profile grinding, more onerous EN ISO 17640 Level D acceptance criteria shall apply. Additionally, based on fracture mechanics a defect 1mm deep by 10mm long defect within 6mm of the surface shall be rejected. A specific UT procedure shall be developed as required by section 7.4.2.

7.4.3 Modify first paragraph to read: Radiographic testing shall be carried out in accordance with ISO 17636-1, Class A using X-Ray technique. Use of Gamma Ray shall be subject to COMPANY approval.

Insert:

Inspection Category	ISO 17636-1 Testing Level	ISO 10675-1 Acceptance Criteria
A & C	B	1

Insert: Weld defect acceptance criteria shall be in accordance with ISO 10675-1 [Ref 14].

7.5.3 Add commentary note:

The CONTRACTOR / SUBCONTRACTOR should note that although EEMUA 158 UT acceptance criteria, which are given in Table 15, do not allow any planar defects within 6 mm of the surface, effective UT inspection of near-surface regions may be problematic for single-sided nodal joints.

In order to ensure that defects larger than the stated acceptance criteria are not present, enhanced Non Destructive Testing (NDT) methods such as creep wave probe technique may need to be applied in lieu of conventional UT to the external near-surface regions of critical welds.

In such cases, the use of alternative methods of detecting subsurface defects shall be demonstrated by the CONTRACTOR / SUBCONTRACTOR to the satisfaction of the COMPANY.

It should also be noted that methods such as Direct Current MPI have proved to be unsuccessful in detecting subsurface defects based on detection of a series of 1 mm diameter x 20 mm length holes side drilled into a test block at depths ranging from 1 mm to 6 mm.

APPENDIX A SELECTED MATERIALS AND INSPECTIONS

Joint / Component		Design Class	Steel quality SQL	Inspection Category ISO 19902	Equivalent Inspection Category EEMUA 158
Main Vertical Support Trusses, Longitudinal and Transverse					
Lift Nodes Complex	Butt Welds	1	I (Zprop.)	A	I
	Butt or Fillet Welds in Shear or Compression			C	III
Lift Nodes Simple	Butt Welds	2	II	A	I
	Butt or Fillet Welds in Shear or Compression			C	III
Support Nodes	Butt Welds in Tension	2	II	A	I
	Butt or Fillet Welds in Shear or Compression			C	III
Columns and Diagonal to Lift	Butt Welds to Nodes	2	II	A	I
All Other Columns and Diagonals	Butt and Fillet welds	3	II	C	III
Stiffeners	Butt Welds	4	III	C	III
	Fillet			C	III
Remaining Truss Systems, and Deck Structures					
Horizontal Bracing	Transverse Butt Welds	3	II	C	III
	Fillet and Longitudinal Welds			C	III
Deck Beams / Girders	Transverse Butt Welds	3	II	C	III
	Longitudinal Welds			C	III
Bulkhead Plates and Stringers	All Welds	4	III	C	III
Grating Supports Beams	All Welds	4	III	C	III
In-deck Support Beams and Tanks	All Welds	4	III	C	III
Mezzanine Structures	All Welds	4	III	C	III
Outfitting Steel					
Crane Pedestal and Pedestal	Butt Welds	3	II	C	III
Major Supports	All Welds	4	III	C	III
Minor Supports	All Welds	5	IV	D	V
Laydown and Infill Structures	All Welds	5	IV	D	V
Runway Beams and Lift Lug	Butt Welds	4	III	C	III
General Outfitting Structures	Butt Welds	4 or 5	IV	D	V
	Partial		IV	D	V
Non-load bearing welds	All Welds	5		E	N/A

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