Base Load Power Hub (BLPH)

Override Procedures for Process Safeguarding System

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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.

1.2 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.

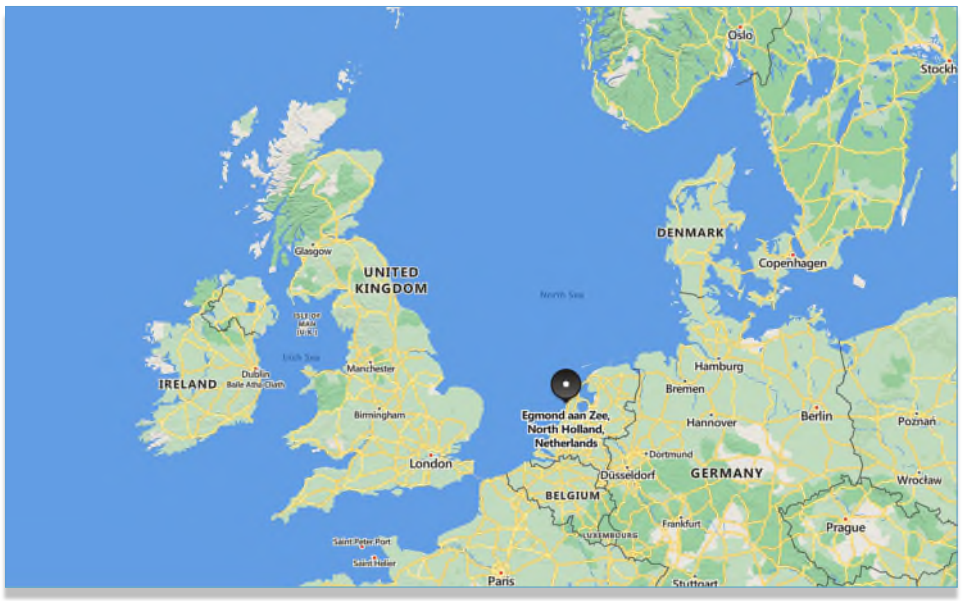


Figure 1 - HOLLANDSE KUST NOORD WIND PARK Location Map

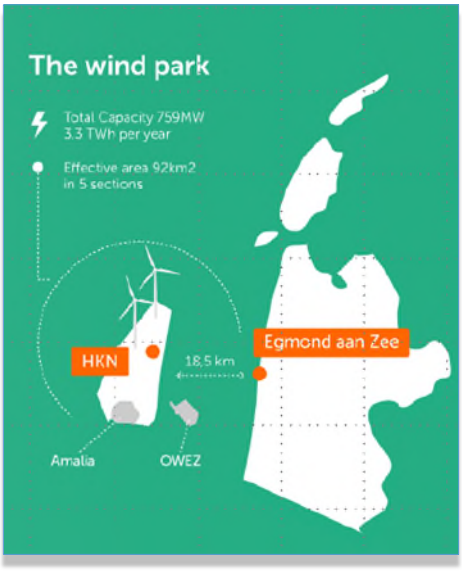


Figure 2 - Wind Park Details

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.

1.2.1 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.

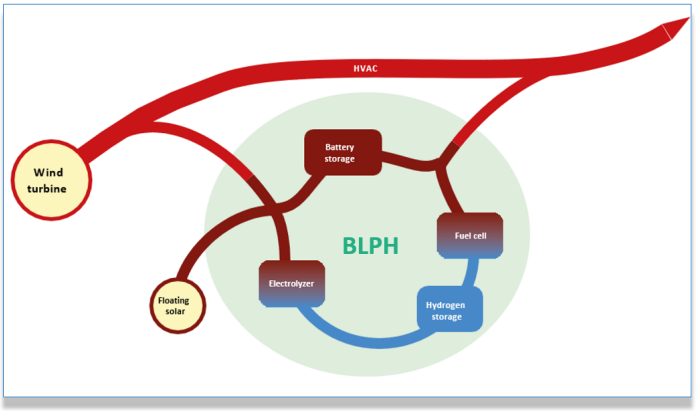


Figure 3 – BLPH Concept

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.

2 DOCUMENT SCOPE

This document defines the baseline for the definition of Maintenance Override function to be managed and

configured for the Safety System (SIS and FGS) initiators without causing unnecessary plant shutdown.

3 REFERENCES

The design of the Safety System shall be based on the requirements described on the following documents.

VENDOR shall read, understand, and take into account all requirements indicated in this specification and in all referenced document listed below.

PROJECT SPECIFICATIONS	
123A90-DDL-PRE-RE-80040	PROCESS DESIGN PHILOSPHY
123A90-DDL-IN-RE-40093	CONTROL SYSTEM PHILOSOPHY
123A90-DDL-SAF-RE-30001	FIRE PROTECTION PHILOSOPHY
123A90-DDL-SAF-RE-30046	HSE DESIGN PHILOSOPHY
123A90-DDL-IN-SP-40097	SYSTEM SPECIFICATION FOR MAIN AUTOMATION CONTRACTOR
123A90-DDL-IN-CE-40000	PROCESS SAFETY CAUSE AND EFFECT MATRIX
123A90-DDL-IN-CE-40002	FIRE AND GAS CAUSE AND EFFECT MATRIX
123A90-DDL-PR-DG-80000	Process Safety Cause and Effect Block Diagram
123A90-DDL-PR-RE-80031	Process Control, Operation, Start-up and Shutdown philosophy
123A90-DDL-IN-RE-40095	Process Control Logics Description

Table 1 - Reference Documents

4 DEFINITIONS AND ABBREVIATIONS

4.1 DEFINITION

Within this document, unless otherwise specified, the following terms shall have the meaning as defined below:

BIDDER:	Entity invited to submit a technical and commercial offer for the provision of the GOODS
COMPANY or Client (CPY):	CROSSWIND
CONTRACTOR (CTR):	ROSETTI MARINO S.p.A.
PROJECT:	HOLLANDSE KUST NOORD WIND PARK Project
SUPPLIER:	Means the entity defined as such in the PURCHASE ORDER
GOODS:	The items listed in section 4.2 of the present requisition
Shall	Used to indicate requirements strictly to be followed in order to conform to the specification and accepted by all involved parties
Should	Used to indicate that among several possibilities one is recommended as particularly suitable without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required
May	Used to indicate a course of action permissible within the limits of the specification
Can	Used for statements of possibility and capability, whether material, physical or casual

Table 2 – Definitions

4.2 ABBREVIATIONS

BLPH	Base Load Power Hub
CAP	Critical Action Panel
CCR	Central Control Room
CCS	PCS + EMCS
DEP	Design Engineering Practice
EMCS	Electrical Management Control System
EWS	Engineering Workstation
FGS	Fire & Gas System

F&G	Fire & Gas
GUI	Graphical User Interface
HMI	Human Machine Interface
IEC	International Electrotechnical Commission
ITER	Instrumental Telecom Electrical Room
LOPA	Layer Of Protection Analysis
MOS	Maintenance Override Switch
OWS	Operator Workstationd
PAS	Process Automation System (PCS+EMCS+SIS+FGS)
SIF	Safety Instrumented Function
SIS	Safety Instrumented System
SOR	Start-up Override
SOV	Solenoid Operated Valve
SS	Safety System (SIS + FGS)

Table 3 – Abbreviation

5 APPLICABLE CODES, STANDARDS, AND REGULATIONS

5.1 GENERAL

The Safety System shall be designed, manufactured, tested, and delivered in accordance with the philosophy, Project documents, codes, standards, Life saving rules, process safety fundamental and regulations listed below. It is the VENDOR responsibility to ensure complete compliance in their design, inclusive of all sub-vendors. The normative documents listed below contain requirements that, through reference in this text, constitute the requirements of this Project. Latest editions of all referenced documents shall apply.

The project shall apply relevant Standards and Codes as detailed in this Part. Where there is a conflict of requirements the more conservative standard or code shall be followed. In all other cases the following order of precedence shall be adhered to:

1. Selected DEM-1.
2. Industry Codes and Standards

5.2 DEP

The following DEPs shall have the DEM-1 'Process Safety' requirements applied to the project.

Document Name	Document Title
DEP 32.30.20.11	Fire, Gas and Smoke Detections
DEP 32.80.10.10	Safety Instrumented Systems

Table 4 – Process Safety DEP

5.3 INDUSTRY STANDARDS

Document Name	Document Title
IEC 61511	Functional Safety – Safety Instrumented Systems for the Process Industry Sector – Framework, Definitions, System, Hardware, and Application Programming Requirements

Table 5 – Industry standards

6 OVERRIDE DEFINITIONS

- Inhibit:

A hardwired device and/or software function within a functional safety system that is designed to ensure the logic input is held in a healthy condition to avoid tripping of SIS or FGS logic.

- Override:

A hardwired device and/or software function designed to ensure the SIS or FGS output to the field is held in the healthy position such to avoid tripping of the field device, system or equipment (i.e. a SOV, equipment trip, deluge or platform alarm initiation, etc.).

In summary, an inhibit is applied to the input of the control and safety system, an override is applied to the output of the control and safety system.

In BLPH project the Override Switch shall only be used to override SIS and FGS Logic Solver inputs (not outputs).

7 INTRODUCTION

In the design of the SIS/FGS systems, engineer shall consider a Maintenance Overrides feature, to allow the periodic testing of the Interlocks initiators (calibrations, functional tests, etc…), without causing unnecessary plant shutdown. This is valid in particular for plants where the safety systems are designed in compliance with IEC61511 standard, which requires planning since the engineering phase the testing of the field instruments.

In BLPH project there aren't SIF designed in compliance with IEC61511 standard (from LOPA Study there were not SIF with SIL ≥1).

In general, the MOS is intended to be used for routine operations and shall be implemented in a way that does not require involvement of the SIS/FGS specialists and not the access to the Engineering Workstations of the systems.

Anyhow, each project requires a customisation on the basis of the specific process constraints, of the operating procedures of the End user.

All functional processing equipment of the Safety System shall be located in both the ITER (Offshore) and the CCR (Onshore) included any equipment required for the Software Critical Action Panel (CAP) located in the onshore control room CCR (GUI of the CAP shall also be available in offshore ITER).

CAP shall provide executive action Software push buttons, trip status information and the Software Switch "MOS Override Enabled/Disabled".

Each SIS/FGS input shall have the facility for a maintenance override to enable testing without causing a shutdown.

There isn't any required grouping of MOS.

The overrides shall be selected and applied through the GUI in both Onshore and Offshore.

The overrides shall only become active when the CAP Software switch "MOS Override Enabled/Disabled" is in enabled position.

The override state shall be indicated on the SIS / FGS graphic displays.

Input overrides shall only affect SIS / FGS logic, not input alarming, i.e., overrided inputs shall alarm to the Operator.

7.1 MAINTENANCE OVERRIDES

The Maintenance Override Switches (MOS) shall be set upon request of the maintenance engineers.

End user shall set up a proper work permit procedure, which will ensure the safe operation of the plant during the period needed for the maintenance of the initiators.

The procedure shall consider the following steps:

- Maintenance engineer shall issue a Work Permit as per plant operation procedures.
- Operators Supervisor, Maintenance or Maintenance Supervisor shall enable the Software Switch "MOS Override Enabled/Disabled", by means of an HMI based soft override switch located on the

CAP panel. The access to the enable switch shall be restricted to the authorized personnel login only (Operators Supervisor, Maintenance or Maintenance Supervisor) and shall be enabled only for the time required for the intervention.

- Operator will set the Inhibit (MOS) on the initiator subject of the work permit in offshore, by means of a soft pushbutton implemented on a dedicated HMI graphics (i.e. Matrix Cause & Effect video pages). The MOS can only be applied if the soft override switch located on CAP panel is enabled by authorized personnel. Individual soft override switch shall be available for each SIS/F&G initiator.
- A dedicated MOS Enable feedback status flag to HMI is foreseen for each SIS/FGS initiator. The HMI shall record time and date of the MOS enable, the tag of the variable overridden and the ID of the operator who enabled the MOS. The record of MOS operation log shall be logged in dedicated "MOS ACTIVE ALARM" page.
- A cumulative "Light Alarm" on the CAP HMI graphics shall be foreseen to alert operators that at least one SIS/FGS initiator is currently overridden.
- Setting the MOS will prevent the process/FGS alarm triggering the safety interlock/executive action but will not inhibit the visualization of the device status itself. The overridden variable shall be properly indicated on all the relevant HMI graphic pages (i.e. Matrix Cause & Effect video pages).
- The SIS/F&G alarms will be displayed despite of the MOS status.

The MOS shall be deactivated in the following three ways:

1. Expiring of set duration time
2. By clicking on the relevant graphic icon
3. From CAP HMI graphics by disabling the soft override switch "Override Enabled/Disabled" (in that way all MOS present in the offshore system will be deactivated).

The MOS shall be identified in the project documents "PROCESS SAFETY CAUSE AND EFFECT MATRIX" and "FIRE AND GAS CAUSE AND EFFECT MATRIX".

7.2 SAFETY CONSIDERATIONS

The safety inputs provided with a MOS feature are identified in a dedicated column in the C&E Matrix documents. In general, they shall be available where required for maintenance purposes, without introducing a possible cause of danger.

Maintenance Override Switch (MOS) shall only be used to override SIS Logic Solver inputs (i.e., not outputs). All MOS related events such as MOS enable, MOS active and MOS removal shall be logged (i.e., journaled) with date and time stamp.

Logic degradation in case of MOS activation in FGS voting loop is according to the "FIRE AND GAS CAUSE AND EFFECT MATRIX".

7.3 START-UP OVERRIDES

Start-up override Is a software function designed to hold an input which is in a tripped state, in a healthy state for a pre-defined time and/or until the input is shown healthy from the field for a pre-defined time to enable start-up of the process {i.e. a lowlow pressure trip on Nitrogen Manifold, etc.).

In BLPH some services will require manual start up overrides that will be activated through Software push buttons on CAP panel.

Start-up overrides shall be provided for selected inputs and shall normally be automatic reset type.

Failure of a start-up override to reset shall be alarmed to the operator.

The Start-up overrides shall be deactivated in the following three ways:

1. Expiring of set duration time
2. The input is shown healthy inside the pre-defined time
3. From CAP HMI graphics by disabling the relevant graphic icon

In BLPH the following Start-up override shall be considered:

1) 63-PALL-004: Low-Low pressure on instrument Air manifold
2) 64-PALL-002: Low-Low pressure on Nitrogen manifold
3) 80-PALL-002: Low-Low pressure on Fuell Cell package inlet line

Refer to project doc "Process Safety Cause and Effect Block Diagram" for the BLPH start-up overrides.

Additional Start-Up Overrides to be implemented during 1St BLPH Start-Up after Black Start:

1. *HVAC UPS Equipment Room B-300*

7	In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signal: - 77-XS-003 = TRUE (SHUT-DOWN B-300 UPS room HVAC) N.B. Operator is instructed to record the action of signal forcing in the dedicated Override/Inhibit Register.

2. *HVAC I&T Equipment Room B-400*

7	In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signal: - 77-XS-004 = TRUE (SHUT-DOWN B-400 I&T Equip. Room HVAC) N.B. Operator is instructed to record the action of signal forcing in the dedicated Override/Inhibit Register.

3. *HVAC HV/MV Switchgear Room B-100*

2	In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signals: - 77-XS-001 = TRUE (SHUT-DOWN B-100 HV/MV SWGR room HVAC) - 84-XS-004 = TRUE (ELECT. ISOLATION UPS POWER UCP HVAC B-100) N.B. Operator is instructed to record the action of signal forcing in the dedicated Override/Inhibit Register.

4. *HVAC LV Switchgear Room B-200*

2	In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signals: - 77-XS-002 = TRUE (SHUT-DOWN B-200 LV SWGR room HVAC) - 84-XS-005 = TRUE (ELECT. ISOLATION UPS POWER UCP HVAC B-200) N.B. Operator is instructed to record the action of signal forcing in the dedicated Override/Inhibit Register.

5. *Instrument Air Package (A-63000)*

5	In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signals: - 63-XS-001 = TRUE (SHUT-DOWN A-63000 Instrument air PKG) - 84-XS-003 = TRUE (ELECT. ISOLATION UPS POWER UCP (INSTRUMENT AIR A-63000) N.B. Operator is instructed to record the action of signal forcing in the dedicated Override/Inhibit Register.

7	In Yokogawa SIS graphic pages, select from menu SIS C/E→ESD1-1D and proceed to enable the start-up override (OOS) on the LL pressure alarm for 63PI-004 As an alternative, in case the timer will not be sufficient to allow a proper start-up of the package, the operator can proceed with the following: In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signal: - 63PI-004 = 50% (Instrument air to distribution header low pressure)

6. *Nitrogen Generator Package (A-64000)*

2	In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signal: - 64-XS-001 = TRUE (SHUT-DOWN U-64000 Nitrogen PKG) - 84-XS-002 = TRUE (ELECT. ISOLATION UPS POWER UCP (NITROGEN A-64000) N.B. Operator is instructed to record the action of signal forcing in the dedicated Override/Inhibit Register.

4	In Yokogawa SIS graphic pages, select from menu SIS C/E→ESD1-1D and proceed to enable the start-up override (OOS) on the LL pressure alarm for 64PI-002 As an alternative, in case the timer will not be sufficient to allow a proper start-up of the package, the operator can proceed with the following: In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signal: - 64PI-002=50% (Nitrogen Pressure to Distribution Header)

7. *Water Desalination Package & Distribution*

4	In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signal: - 50-XS-001 = TRUE (SHUT-DOWN A-500003 Sea water treatment PKG) - 84-XS-001 = TRUE (ELECT. ISOLATION UPS POWER UCP (WATER TREAT. A-50000) N.B. Operator is instructed to record the action of signal forcing in the dedicated Override/Inhibit Register.

10	In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signal: - 83-XS-001A = TRUE (SHUTDOWN SEAWATER LIFT PUMP P-50001A) - 83-XS-001B = TRUE (SHUTDOWN SEAWATER LIFT PUMP P-50001B) N.B. Operator is instructed to record the action of signal forcing in the dedicated Override/Inhibit Register.

8. *Hydrogen Storage Vessels Header (Outlet)*

	In Yokogawa SIS graphic pages, select from menu SIS C/E→PSD and proceed to enable the start-up override (OOS) on the LL pressure alarm for 80PI-002 As an alternative, in case the timer will not be sufficient to allow a proper start-up of the package, the operator can proceed with the following:
2	In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signal: - 80PI-002=50% (Hydrogen storage to A-80000 Package) N.B. Operator is instructed to record the action of signal forcing in the dedicated Override/Inhibit Register.

9. *Electrolyser Package (A-20000)*

	In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signal to the Electrolyser:
7	- 20-XS-001=TRUE (SHUT-DOWN A-20000 Electrolyser PKG) N.B. Operator is instructed to record the action of signal forcing in the dedicated Override/Inhibit Register.

10. *Hydrogen Fuel Cell Package (A-80000)*

	In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and force the following signal to 6.6kV Switchgear SG-100D1 column A7:
5	82-XS-003=TRUE (OPEN FUEL CELL A-80000 INC. CIRCUIT BREAKERS) N.B. Operator is instructed to record the action of signal forcing in the dedicated Override/Inhibit Register.

11. *BESS Package (A-85000)*

13	In Yokogawa Engineering Workstation (EWS0164), open Prosafe Maintenance, then SCS0110 (SIS) and confirm following signal to the BESS - 85-XS-001=TRUE is healthy (SHUT-DOWN A-85000 BESS PKG)

7.4 AUTOMATIC OVERRIDES

In some control and safety logics the use of Automatic Overrides will be applied to permit the motor/equipment starts without being tripped (e.g. in case of pump it is required to override the Low discharging Pressure for a delay time to start the pump itself).

Automatic overrides remove the need for the operator to apply and remove overrides in sequences etc

In BLPH the following Automatic Overrides shall be considered:

1) 50-PAL-001: Low pressure on discharge line sea water pump P-50001A
2) 50-PAL-002: Low pressure on discharge line sea water pump P-50001B

The Automatic overrides shall be deactivated in the following two ways:

1. Expiring of set duration time
2. The input is shown healthy inside the pre-defined time