Base Load Power Hub (BLPH)

OTP – ONSHORE INTEGRATED TEST

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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.

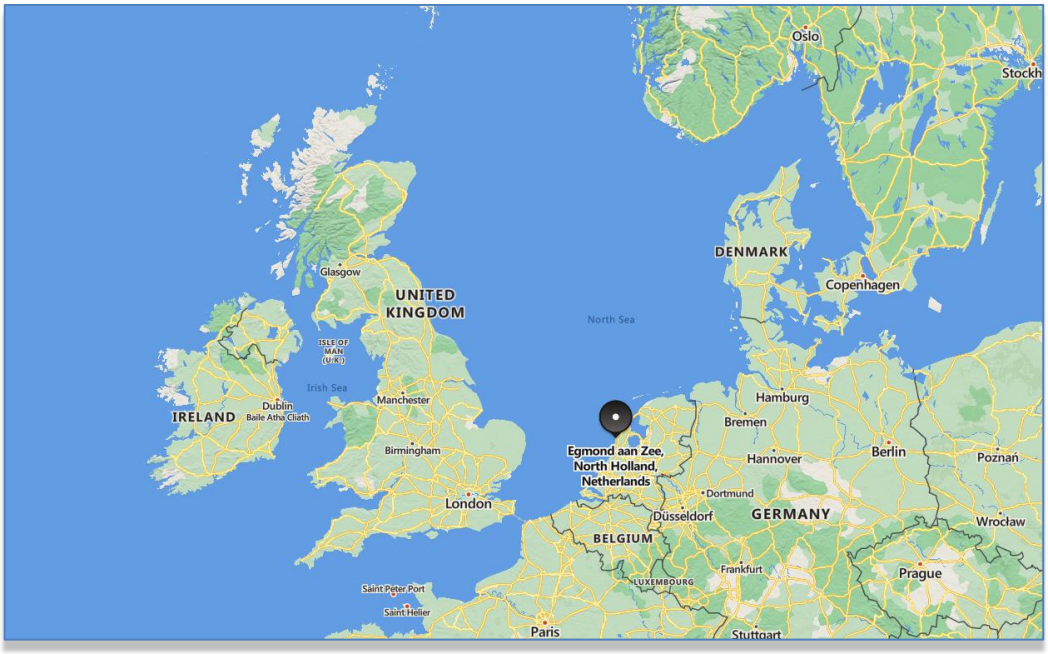


Figure 1 - HOLLANDSE KUST NOORD WIND PARK Location Map

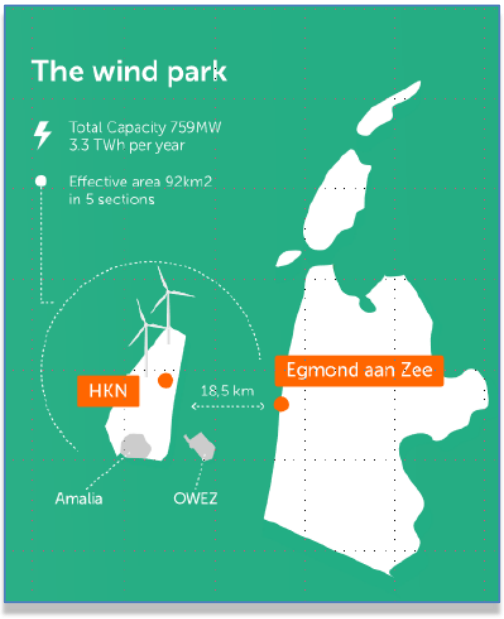


Figure 2 - Wind Park Details

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 is located on coordinates E 590719.1, N 5841602.3 and 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.

1.3 Project Concept

All components included in the BLPH will be integrated onshore on a topside 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.

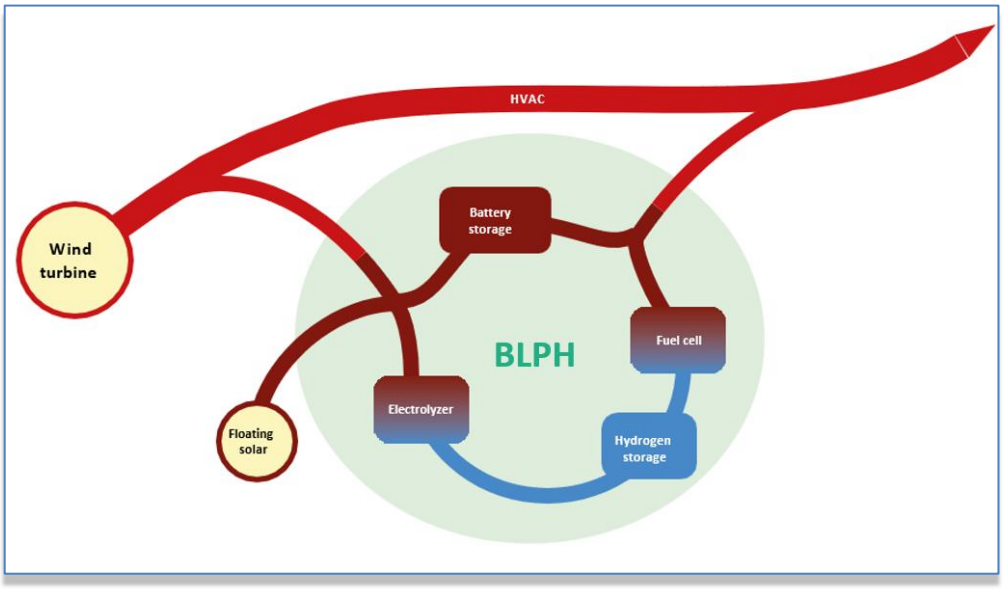


Figure 3 – BLPH Concept

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 is 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

The purpose of this document is to define the dedicated Commissioning procedure together with the detailed test steps to be implemented for the preparation and execution of the BLPH Onshore Integrated Test.

The procedure will include the necessary detail to demonstrate that BLPH can be fully operated remotely from a temporary yard control room location, will have the real-time capability to both start-up and shut-down in a safe and controlled manner, and consequently confirm achievement of the principal design premise of 'Innovation and Time Shifting Flexibility' as defined by the energy management design Operating Modes.

Furthermore, all main equipment packages will be simultaneously tested to the maximum extent possible with the objective to demonstrate 1 MW of power output using the full capacity of the inventory stored on the platform.

The document will cover all related test steps to be performed at the onshore Worksite construction yard.

3 OTP SUMMARY

3.1 Test Objective

The aim of this procedure is to provide the sequence of appropriate actions to prepare and execute the Onshore Integrated Test and prove that transitioning between the Operating Modes summarised below can be achieved.

This will also demonstrate the unmanned operations requirements, including control from the temporary yard control room location, since all the Operating Modes must be achieved and controlled remotely.

Operating Modes Summary Definition:

- MODE 0 IDLE (Power Import Only)
- MODE 1A IMPORT (Able to Charge)
- MODE 1B IMPORT (Not Able to Charge)
- MODE 2 HOT STANDBY (Ready to Discharge)
- MODE 3 EXPORT (Discharge)
- MODE 4 COLD STANDBY (Power Import: Not Able to Export)
- MODE 4A EMERGENCY (Island)
- MODE 5 POWER OUT (Black Out)
- MODE 6 MAINTENANCE
- MODE 7 RESEARCH
- MODE 8 NONE

For execution of the Onshore Integrated Testing, the energy stored in the BESS and one H2 vessel (out of six) will be used.

The main test criteria are listed as follows:

- Achievement of the operating Envelope: Ability to achieve the Operating Modes of Operation
- Maximum system electrical output, Including BESS and Fuel Cell: Achievement of 1 MW power "Export"

- Maximum charge capability for both BESS and H2 storage: Achievement of 1 MW power "Import"
- Remote Start-Up: Confirm ability to start-up BLPH utilities and process Remotely
- Remote Operation: Confirm ability to operate remotely,
  - Transitions between Operating Modes
  - Trip scenarios with recovery and reset
  - Equipment switchover between duty / standby
- Power Management: Demonstration of power management system integrating controllers of different packages.
- SECE Performance: In line with requirements of the TIV and agreed inspection plans.

In order to facilitate the management of the testing activities, this procedure will breakdown execution of the Operating Modes into two main sequences.

- TEST SEQUENCE 1
  - ➔ EMCS AUTOMATIC
  - ➔ GRID TIED (Supply Guarantee ON)
  - ➔ HNA5 Able to Produce Power
  - ➔ BLPH Able to Export (BESS Charged & H2 Storage Vessels Full)
  - ➔ MODE 2 HOT STANDBY (Ready to Discharge)
  - ➔ MODE 3 EXPORT (Discharge)
  - ➔ MODE 4 COLD STANDBY (Power Import: Not Able to Export)
  - ➔ OFF GRID (Supply Guarantee Inactive)
  - ➔ MODE 4A EMERGENCY (Island)
  - ➔ BLPH Not Able to Export (BESS Discharged & H2 Storage Vessels Empty)
  - ➔ MODE 5 POWER OUT (Black Out)
- TEST SEQUENCE 2
  - ➔ MODE 5 POWER OUT (Black Out)
  - ➔ EMCS MANUAL
  - ➔ MODE 7 RESEARCH
  - ➔ GRID TIED (Supply Guarantee ON)
  - ➔ HNA5 Able to Produce Power
  - ➔ BLPH Not Able to Export (BESS Discharged & H2 Storage Vessels Empty)
  - ➔ EMCS AUTOMATIC
  - ➔ MODE 4 COLD STANDBY (Power Import: Not Able to Export)
  - ➔ HNA5 Power ≥ 1 MW and ≤ 2 MW
  - ➔ MODE 1B IMPORT (Not Able to Charge)
  - ➔ HNA5 Power ≥ 2 MW
  - ➔ MODE 1A IMPORT (Able to Charge)
  - ➔ MODE 2 HOT STANDBY (Ready to Discharge)
  - ➔ EMCS MANUAL
  - ➔ MODE 7 RESEARCH

- ➔ HNA5 Not Able to Produce Power
- ➔ EMCS AUTOMATIC
- ➔ MODE 0 IDLE (Power Import Only)
- ➔ MODE 2 HOT STANDBY (Ready to Discharge)

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3.2 System Boundary Limits

See below the interested systems and subsystems on the Overall Single Line Diagram (extract from Doc. N. 123A90-PML-COM-DG-03012).

For the purposes of the Onshore Integrated Test, this procedure will require the availability of all BLPH permanent equipment and packages, with the exception of the following that will *not* be tested:

- SS 81-10 GIS 66 kV (HNA6-AFA70)
- SS 81-20 Power Transformer 7 MVA (TR-100AD1)
- SS 83-30 Solar PV Package 0.5 MW (CPI)
- SS 82-50 Solar PV Package Power Transformer 0.5 MVA (TR-200ED1)
- SS 83-10 400 V Switchboard Solar (SG-200D2)
- SS 50-00 Seawater Intake System (Lifting Pumps)
- SS 25-02 Hydrogen Storage Vessel B (V-25001B)
- SS 25-03 Hydrogen Storage Vessel C (V-25001C)
- SS 25-04 Hydrogen Storage Vessel D (V-25001D)
- SS 25-05 Hydrogen Storage Vessel E (V-25001E)
- SS 25-06 Hydrogen Storage Vessel F (V-25001F)

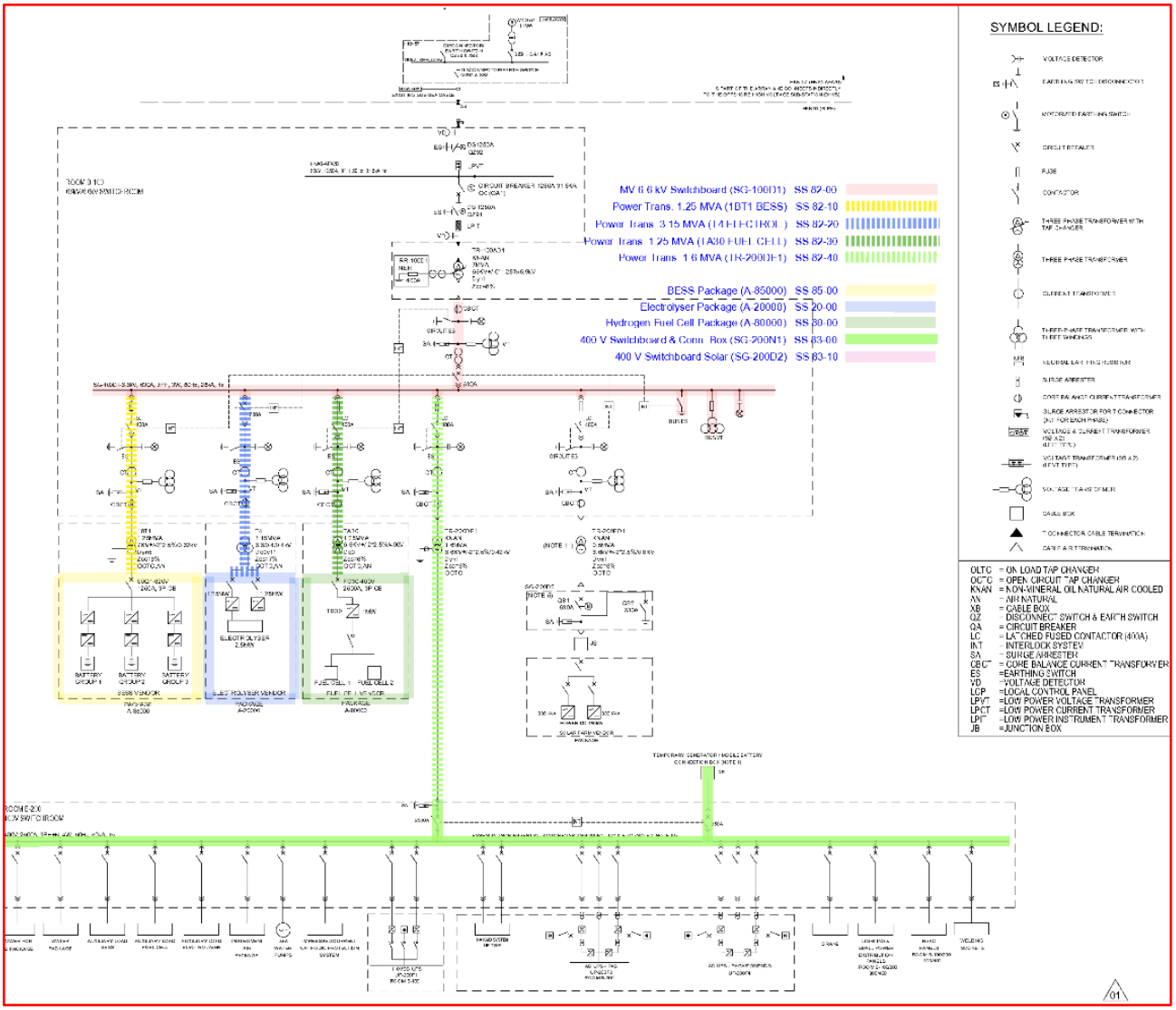


Figure 4 – OTP System Boundary Limits

3.3 Test and System Description

This document is related to the following systems/ subsystems that are specifically required and successively detailed within the procedure test steps:

- Company Provided Items (CPI)

- SS 20-00 Electrolyser Package (A-20000)
- SS 82-20 Power Transformer 3.15 MVA (T4 ELECTROLYSER)
- SS 80-00 Hydrogen Fuel Cell Package (A-80000)
- SS 82-30 Power Transformer 1.25 MVA (TA30 FUEL CELL)
- SS 85-00 BESS Package (A-85000)
- SS 82-10 Power Transformer 1.25 MVA (1BT1 BESS)

- Process Systems

- SS 25-01 Hydrogen Storage Vessel A (V-25001A)
- SS 25-07 Hydrogen Storage Vessels Header (Inlet)
- SS 25-08 Hydrogen Storage Vessels Header (Outlet)

- Process Support Systems

- SS 43-00 Hydrogen Vent Header & Drum System

- Electrical & Instrumentation Systems

- SS 82-00 MV 6.6 kV Switchboard (SG-100D1)
- SS 82-40 Power Transformer 1.6 MVA (TR-200DE1)
- SS 83-00: 400 V Switchboard & Connection Box (SG-200N1)
- SS 87-00 Electrical Monitoring & Control System (EMCS)
- SS 87-10 Process Control System (PCS)
- SS 87-50 OER & CCR ONSHORE (temporary yard testing installation)

System boundary limits are defined in OVERALL SINGLE LINE DIAGRAM Doc. 123A90-PML-COM-DG-03012.

3.4 Safety Devices

Notwithstanding the objective to execute the test steps of the Onshore Integrated test from a temporary remote yard location, there will be a daily necessity for the commissioning team to be present on both lower and upper decks to check and maintain all equipment and packages in normal operation.

- Appropriate Personnel Protective Equipment (PPE) and safety equipment e.g., antistatic clothing, safety shoes, hand gloves, helmet, glasses, earplugs etc. are to be available and must be used in line with the site requirements,
- For Arc Flash Risk Category to be considered without maintenance switch ON, for SG-200N1 and DP-200N1 PPE Level 1 online Side Fault and for SG-200N1 PPE Level 2 and DP-200N1 PPE Level 1 on Bus Side Fault, as per Arc Flash Energy Calculation 123A90-DDL-EL-RE-20172, section 3.7 and attachment 2,
- Warning safety signs are to be posted with restricted access to essential personnel only,
- Adequate firefighting equipment in accordance with final engineering design,
- All personnel authorised to access the BLPH must be equipped with individual hydrogen gas sensors and ATEX rated radio communication devices (use of cellular mobile phones will not be permitted).

3.5 HSE Management

All necessary safety precautions must be taken to avoid any risk for personnel injury.
Safety checks will also be foreseen on a daily basis, e.g. H2 sniffing tests on related flanged joints.

- All personnel involved in this operational test shall be competent for the tasks they will be required to undertake,
- Place safety / warning signs and segregate the entire area with barrier tapes (safety barriers) of a colour distinguished (blue and white) from those used for construction activities,
- Restrict access into area only to authorized personnel with specific PTW,
- Conduct daily "Toolbox Talk" with all personnel prior to starting test work,

- Appropriate Personnel Protective Equipment (PPE) and safety equipment e.g. safety shoes, safety glasses, hand gloves, helmet, earplugs etc. are available and must be used in line with the site requirements,
- All activities carried out on the project shall be performed in accordance with the "Permit to Work" system Doc. PRO-HSE-23,
- Additional reference corporate safety documentation to be observed and adhered to; PRO-HSE-30 Working with Electricity, PRO-HSE-25 Simultaneous Operations (SIMOPS) and PRO-HSE-07 HAZID,
- Electrical and mechanical isolations are to be assured as per Doc. PRO-HSE-08 and "Commissioning and start-up operation" procedure,
- Ensure that the working area is clean, tidy, well illuminated and that access and escape routes are free from obstructions.

Before starting work on any of the activities in this OTP it is the responsibility of the persons performing the work to:

- Familiarize themselves with the plant/equipment to be worked on,
- Ensure they are aware of all other work activities that are taking place, or due to take place,
- If necessary, re-plan any situation/activity,
- Ensure proper communications between parties involved in the execution of the OTP,
- Review any relevant Vendor documentation for the equipment covered by this OTP and observe special requirements and limitations recommended or imposed by Vendor,
- Verify that all personnel involved in the implementation of this procedure are familiar with its content as well as the associated safety requirements (Toolbox Talk).

3.6 Acceptance Criteria

It is expected that all BLPH Construction, Mechanical Completion, Pre-Comm & Commissioning activities will have been completed as principal pre-requisite to initiation of this testing procedure.

Furthermore, individual items of equipment and packages will have been individually performance tested with respective OTP's completed and signed off.

The acceptance criteria for this procedure will be governed by the methodical execution of each test step detailed under section 5.4, to be accepted with the signature and the test date handwritten by Contractor performing authority.

Test Sequences 1 and 2 will be performed and consequently demonstrate the seamless transition between Operating Modes.

4 DOCUMENTS REFERENCES AND ABBREVIATIONS

4.1 Reference Documents

4.1.1 Company Documents and Standards

Document ID	Document Title
[1] K559-2254-CG-PHI-001	Commissioning Philosophy
[2] K559-2254-EL-ELL-002	BLPH Electrical Load List (CCS MODE 2(A) 'HOT STANDBY')
[3] K559-2254-EL-ELL-003	BLPH Electrical Load List (CCS MODE 3(C) 'DISCHARGING')
[4] K559-2254-EL-ELL-004	BLPH Electrical Load List (CCS MODE 4(A) 'COLD STANDBY')
[5] K559-2254-EL-ELL-005	BLPH Electrical Load List (CCS MODE 4A(D) 'EMERGENCY MODE (Island))
[6] K559-2254-EL-ELL-006	BLPH Electrical Load List (CCS MODE 5(D) 'POWER OUT (Blackout))
[7] K559-2254-PR-PHI-001	Main process control philosophy

Table 1: Company Key Reference Documentation

These documents were produced in FEED and made available to RM for info. They have subsequently been superseded by Detailed Design, similar or same deliverables.

4.1.2 Project Commissioning Documents

Document ID	Document Title
▪ 123A90-PML-PM-LIS-01001	Master Document Register
▪ 123A90-PML-PM-PL-00001	Project Execution Plan
▪ 123A90-PML-QHSE-PL-00001	Project HSE Plan
▪ 123A90-PRO-HSE-23	RM Yard Permit To Work Procedure
▪ 123A90-PML-COM-LIS-03011	System/Sub-Systems List
▪ 123A90-PML-COM-LIS-03012	System/Sub-System Boundary Limit Diagrams
▪ 123A90-PML-COM-PRO-03038	Leak Test Procedure
▪ 123A90-PML-COM-PRO-03019	OTP – Onshore Performance & Integrated Test Procedure
▪ 123A90-PML-COM-PRO-03036	OTP - Black Start Procedure
▪ 123A90-PML-COM-SP-03057	Worksite WEF (Work Execution Flow Scheme)
▪ 123A90-PML-COM-PRO-03041	OTP - Hydrogen Storage & Venting Systems
▪ 123A90-PML-COM-PRO-03042	OTP - Sea Water Intake & Fresh Water Treatment Systems
▪ 123A90-PML-COM-PRO-03043	OTP - Instrument Air System

Document ID	Document Title
▪ 123A90-PML-COM-PRO-03055	OTP - Nitrogen Generation System
▪ 123A90-PML-COM-PRO-03046	OTP - 6.6 kV Switchgear & Transformer Systems
▪ 123A90-PML-COM-PRO-03047	OTP - LV Switch Boards & LV Distribution Board Systems
▪ 123A90-PML-COM-PRO-03050	OTP - DC UPS System 10kVA UP-200F1
▪ 123A90-PML-COM-PRO-03051	OTP - Data Network Systems
▪ 123A90-PML-COM-PRO-03054	OTP - F&G and ESD C&E Logics
▪ 123A90-PML-COM-PRO-03059	OTP - AC UPS System 35kVA UP-200F3
▪ 123A90-PML-COM-PRO-03060	OTP - AC UPS System 15kVA UP-200F4
▪ 123A90-PML-COM-PRO-03063	OTP - BESS
▪ 123A90-PML-COM-PRO-03061	OTP - Electrolyser
▪ 123A90-PML-COM-PRO-03062	OTP – Fuel Cell

Table 2: Reference Project Commissioning Deliverables

4.1.3 Project Engineering Documents

Document ID	Document Title
[1] 1724000594-IN-SP-00019	EMCS FDS-SW
[2] 123A90-DDL-IN-RE-40095	Process Control Logics Description
[3] 123A90-DDL-EL-SP-20141	Electrical System Description & Design Philosophy
[4] 123A90-DDL-IN-SP-40098	Control System (PCS) Specification
[5] 1724000594-IN-DD-00015	EMCS System Architecture
[6] SRN – 04270	Operations Modes Review – Base Load Power Hub
[7] 123A90-DDL-IN-SP-40097	System Specification for Main Automation Contractor
[8] 123A90-DDL-IN-SP-40100	Safety System (ESD, Fire and Gas) Specification)
[9] 123A90-MOM-RM-STAT-CW-003	Minute of Meeting - Freqcon & Statron-Control Workshop with Rosetti's MAC
[10] 123A90-PML-PM-TQ-00053	Technical Query – Interface with BESS
[11] 123A90-MOM-ELO-ROS-CW-003	Minute of Meeting- Electrolyzer- CPI Interface Meeting
[12] 123A90-PML-PM-TQ-00052	Technical Query – Interface with Electrolyzer
[13] 123A90-PML-PM-TQ-00051	Technical Query – Interface with Fuel Cell
[14] 123A90-MOM-RM-BAL-CW-004	Minute of Meeting – Control Workshop with Rosetti's MAC

[15] 123A90-PML-PM-TQ-00055	Technical Query – Interface with Solar Farm
[16] 123A90-PML-PM-TQ-00054	Technical Query – Interface with Windfarm and HNA5
[17] 123A90-MOM-ELE-ROS-CW-023	Minute of Meeting - Control Workshop with Rosetti's MAC
[18] C63-AUT-002	Electrolyser – Communication Table
[19] CWHKN-INN-INP-SPC-00005	SCADA Functional Design Specification
[20] 123A90-DDL-EL-LIS-20016	Electrical Load List & Balance (CCS MODE 1 'IMPORT')
[21] 123A90-DDL-EL-LIS-20143	Electrical Load List & Balance (CCS MODE 2 'HOT STANDBY')
[22] 123A90-DDL-EL-LIS-20144	Electrical Load List & Balance (CCS MODE 3 'EXPORT')
[23] 123A90-DDL-EL-LIS-20145	Electrical Load List & Balance (CCS MODE 4 'COLD STANDBY')
[24] 123A90-DDL-EL-LIS-20146	Electrical Load List & Balance (CCS MODE 4A 'EMERGENCY MODE')
[25] 23A2007_240628_PROFINET_Register BESS_V1_0_0_3	BESS_PROFINET_SIGNAL LIST
[26] CW-BALL-TQ-0008 - Fuel Cell - Rev B - BAL RESPONSE	Minute of Meeting Response
[27] Crosswind Modbus Table - Main PLC - External Cut	Fuel Cell MODBUS Map
[28] 1724000594-IN-LIS-00005	EMCS IO LIST

Table 3: Reference Project Engineering Deliverables

4.2 Acronyms and Abbreviations

Acronyms / Abbreviations	Description
AIS	Automatic Identification System
ALARP	As Low as Reasonably Possible
AHU	Air Handling Unit
AOC	Achievement of Commissioning
AVR/OLTC	Automatic Voltage Regulator/On Load Tap Changer
BESS	Battery Energy Storage System
BLPH	Base Load Power Hub
C&E	Cause & Effects
CCS	Central Control System
CCTV	Closed Circuit Television
CMS	Completions Management System
CPI	Company Provided Item
CRS	Comments Response Sheet
CSU	Commissioning & Start-Up
E&I	Electrical & Instrumentation
EMCS	Electrical Monitoring & Control System
ESD	Emergency Shut Down
FAT	Factory Acceptance Test
FT	Functional Test
F&G	Fire & Gas
GALT	Gross Air Leak Test
HAZID	Hazard Identification Studies
HAZOP	Hazard and Operability Studies
HMI	Human Machine Interface
HKN	Hollandse Kust Noord
HV	High Voltage
HV-SCADA	The given name for the COMPANY's control system for the HKN wind farm infrastructure. BLPH's control system shall operate autonomously but will interface with HV-SCADA
HVAC	Heating, Ventilation and Air Conditioning
HSE	Health, Safety, & Environment
ICSS	Integrated Control and Safety System
ITR	Inspection & Test Record
LC	Locked Closed
LO	Locked Open

Acronyms / Abbreviations	Description
LoSH	Limits of System Handover
LOTO	Lock-Out / Tag-Out
LV	Low Voltage
MC	Mechanical Completion
MDR	Master Document Register
MOC	Management of Change
NUI	Normally Unmanned Installation
OEM	Original Equipment Manufacturer
OER	Onshore Equipment Room
OMAR	Operating Modes Assurance Review
OTP	Operation Test Procedure (Commissioning)
OR	Operations Readiness
ORR	Operations Readiness Review
PACO	Process Automation, Control and Optimisation
PAS	Process Automation System
PCS	Process Control System
PID (P&ID)	Piping and Instrumentation Diagram
PSV	Pressure Safety Valve
PTW	Permit to Work
PVP	Piping and Vessels Preparation
PC&C	Pre-Commissioning & Commissioning
PSUA	Pre Start-Up Audit
PSSR	Pre Start-up Safety Review
RFC	Ready for Commissioning
RFO	Ready for Operation
RFSA	Ready For Sail Away
RFSU	Ready For Start-Up
SAT	Site Acceptance test
SECE	Safety Environmental Critical Element
SCADA	Supervisory Control and Data Acquisition
SIF	Safety Instrumentation Function
SIL	Safety Integrity Level
SIMOPS	Simultaneous Operations & Maintenance
SIS	Safety Instrumented System
SLD	Single Line Diagram

Acronyms / Abbreviations	Description
SoF	Statement of Fitness
TA	Technical Authority
TQ	Technical Query
TIV	Technical Integrity verification
UPS	Uninterruptible Power Supply
VHF	Very High Frequency
VSAT	Very Small Aperture Terminal
WTG	Wind Turbine Generator

Table 4: Acronyms and Abbreviations

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5 OTP AT ONSHORE WORKSITE

This chapter refers to the activities on the Contractor worksite (construction yard).

5.1 Planning and Manpower

5.1.1 Planned tasks with estimated manpower

Estimated manpower for the entire duration of the Test:

- 1 Commissioning Manager
- 1 Commissioning Automation Lead
- 1 Commissioning Instrumentation Lead
- 1 Commissioning Mechanical/Process Lead
- 4 Commissioning Electrical Field Technicians
- 4 Commissioning Instrumentation Field Technicians
- 1 Commissioning Mechanical Field Technicians
- 1 Vendor Field Engineer (Yokogawa - PCS)
- 1 Vendor Field Engineer (Yokogawa - EMCS)

In addition to Contractors above listed commissioning team and vendor representatives, additional field engineers commissioning support will be requested to Company for the CPI packages:

- 2 Vendor Field Engineer (BESS)
- 2 Vendor Field Engineer (electrolyser)
- 2 Vendor Field Engineer (Fuel Cell)

5.1.2 Test duration estimate

The test duration is planned as follows:

- 22 days

It should be noted that the time allocated for execution of the entire Onshore Integrated Test has been precisely defined according to the end of project constraints, namely BLPH shut down, preservation, load out, sea fastening and sail away.

5.1.3 Vendor Assistance

Vendor Yokogawa Italia will provide qualified specialists to assist with the execution of the Onshore Integrated Test.

5.1.4 Items Postponed

Not applicable

5.1.5 HOLDS

Not applicable

5.2 OTP Test Requirements – Onshore WORKSITE

5.2.1 Pre-Commissioning Achievement

Prior the commissioning operation starts, the relevant pre-commissioning ITRs should be fully signed.

5.2.2 Commissioning Achievement

The commissioning achievement will be the successful start-up, execution and transitioning of the BLPH Operating Modes from a remote location (temporary yard control room).

5.2.3 Status of Required Associated Subsystems

- TEST SEQUENCES 1 & 2

Subsystems required RFO (Ready for Operation):

- SS 20-00 Electrolyser Package (A-20000)
- SS 82-20 Power Transformer 3.15 MVA (T4 ELECTROLYSER)
- SS 80-00 Hydrogen Fuel Cell Package (A-80000)
- SS 82-30 Power Transformer 1.25 MVA (TA30 FUEL CELL)
- SS 85-00 BESS Package (A-85000)
- SS 82-10 Power Transformer 1.25 MVA (1BT1 BESS)
- SS 25-01 Hydrogen Storage Vessel A (V-25001A)
- SS 25-07 Hydrogen Storage Vessels Header (Inlet)
- SS 25-08 Hydrogen Storage Vessels Header (Outlet)
- SS 43-00 Hydrogen Vent Header & Drum System
- SS 82-00 MV 6.6 kV Switchboard (SG-100D1)
- SS 82-40 Power Transformer 1.6 MVA (TR-200DE1)
- SS 83-00: 400 V Switchboard & Connection Box (SG-200N1)
- SS 87-00 Electrical Monitoring & Control System (EMCS)
- SS 87-10 Process Control System (PCS)
- SS 87-50 OER & CCR ONSHORE (temporary yard testing installation)

5.2.4 Special Tools & Test Equipment

The following items of Test Equipment are required:

- Portable Hydrogen Gas wearing protection device as requirement for PPE
- Hand help Hydrogen Gas measuring device (rated to 1000ppm for process flanged joints sniffing)
- Portable ATEX radios
- Temporary Yard Control Room equipped with PCS and EMCS Operator Workstations
- Voltage, frequency, continuity tester (Multimeter), HART Communicator

TESTING & MEASUREMENT INSTRUMENT USED			
Type	Serial N.	Calibration certificate	Validity

5.2.5 Consumable List

Not applicable

5.2.6 Commissioning Spare Parts

Reference is made to all related equipment and packages vendors deliverables.

5.2.7 Temporary Facilities

- Electrical 400V reserve Yard Power Supply (P approx. 120 kW) to feed main switchboard SG-200N1 via drawer A2/+08 "Temporary Diesel Generator / Mobile Battery Pack" JB-200E2.
- Electrical 6,6 kV main Yard Power Supply (P approx. 4 MW) from dedicated Diesel Generator Yard facilities, incorporating a resistive load bank with rating 1,25 MW.
- Sea water storage and pumping facilities, required by the sea water treatment package for the preparation of softened water utilised by the Electrolyser package.

5.3 OTP Description – Onshore WORKSITE

5.3.1 OTP Test Preparation

Step	Description	Result	Verified by	Date
1	Associated Systems Ready for Operation Certificates (RFC) are issued and approved.			
2	No Mechanical Completion or Pre-commissioning punch list 'A' items are outstanding against the systems to be tested.			
3	All personnel involved with the execution of this procedure are familiar with its content as well as with associated safety requirements (Toolbox Talk to be conducted before initiation of activities).			
4	A final walkdown of the systems and packages has been completed, to ensure that all equipment and areas area are ready for the Integrated Test.			
5	Check that areas are free for work and escape routes are clear of any obstructions.			
6	All safety barriers and warning signs have been installed. Access to BLPH will be severely restricted to authorised personnel only.			
7	Ensure that proper communications have been established between parties involved in the implementation of the procedure.			
8	Verify availability of test and safety equipment as per section 5.2.4.			

Step	Description	Result	Verified by	Date
9	System(s) electrical isolations as per LOTO procedure defined within HSSE Permits to Work and Commissioning procedures duly prepared and approved			
10	System(s) process isolations as per LO-LC procedure defined within HSSE Permits to Work and Commissioning procedures duly prepared and approved			

5.3.2 Electrical Preparation

Step	**Description**	**Result**	**Verified by**	**Date**
11	Check related punch list 'B' items and confirm acceptability for start of Integrated Testing activities.			
12	Verify that all relevant associated systems / subsystems are completed.			
13	Check that any equipment not required for the Integrated Test has been duly isolated.			

5.3.3 Mechanical Preparation

Step	**Description**	**Result**	**Verified by**	**Date**
14	Check related punch list 'B' items and confirm acceptability for start of Integrated Testing activities.			
15	Verify that all relevant associated systems / subsystems are completed.			
16	Check that any equipment not required for the Integrated Test has been duly isolated.			

5.3.4 Instrument Preparation

Step	**Description**	**Result**	**Verified by**	**Date**
17	Check related punch list 'B' items and confirm acceptability for start of Integrated Testing activities.			

Step	Description	Result	Verified by	Date
18	Verify that all relevant associated systems / subsystems are ready.			
19	Check Inhibit and Override register has been prepared and validated.			

5.3.5 Piping Preparation

Step	Description	Result	Verified by	Date
20	Check related punch list 'B' items and confirm acceptability for start of Integrated Testing activities.			
21	Verify that all relevant associated systems / subsystems are completed.			
22	Check and confirm that all vessels and valves isolations have been completed. Particular reference is made to Hydrogen storage vessels V-25001B / C / D / E / F and valves according to LO-LC register.			

5.3.6 Additional Discipline Preparation

Not applicable.

5.4 OTP Test Steps – SCOPE AND DEFINITIONS

The detailed Onshore Integrated Test steps have been carefully prepared in alignment with the engineering design document listed in section 4.1.3.

5.4.1 Central Control System (CCS) and Testing Control Dashboard

The Central Control System (CCS) is responsible for managing the normal operations of BLPH, with an independent system from the elements of the Safety System. The equipment and packages that CCS is required to control are all process (power generation) systems, utilities systems, and electrical equipment on the platform in accordance with doc. n. 123A90-DDL-IN-DD-40019 Data Network Architecture.
A single operator will be required for both electrical and process systems on BLPH. CCS reacts to signals received from HV SCADA, in particular changes from the HNA5 Wind Turbine, power output only.

Only the real time power output and operational status of HNA5 Wind Turbine affects the Operating Modes.

As the HNA5 wind turbine will not be either unavailable nor suitable for the Onshore Integrated Test, the testing sequences will consequently utilise a dedicated user interface on CCS HMI, or test control dashboard, whereby the procedure performing authority will manually input the desired value of the HNA5 wind turbine.

- HNA5 Power Output and Operational Status (via FO subsea cable) to be simulated via the test control dashboard:
  - Active Power (selected value expressed in kW)
  - It is Grid Tied (Yes / No)
  - Supply Guarantee is ACTIVE (Yes / No)
  - HAN5_Fault = True (Yes / No)

The status and values above listed signals will be user selectable during the Onshore Integrated Test in substitution of the future real time values received from HNA5.

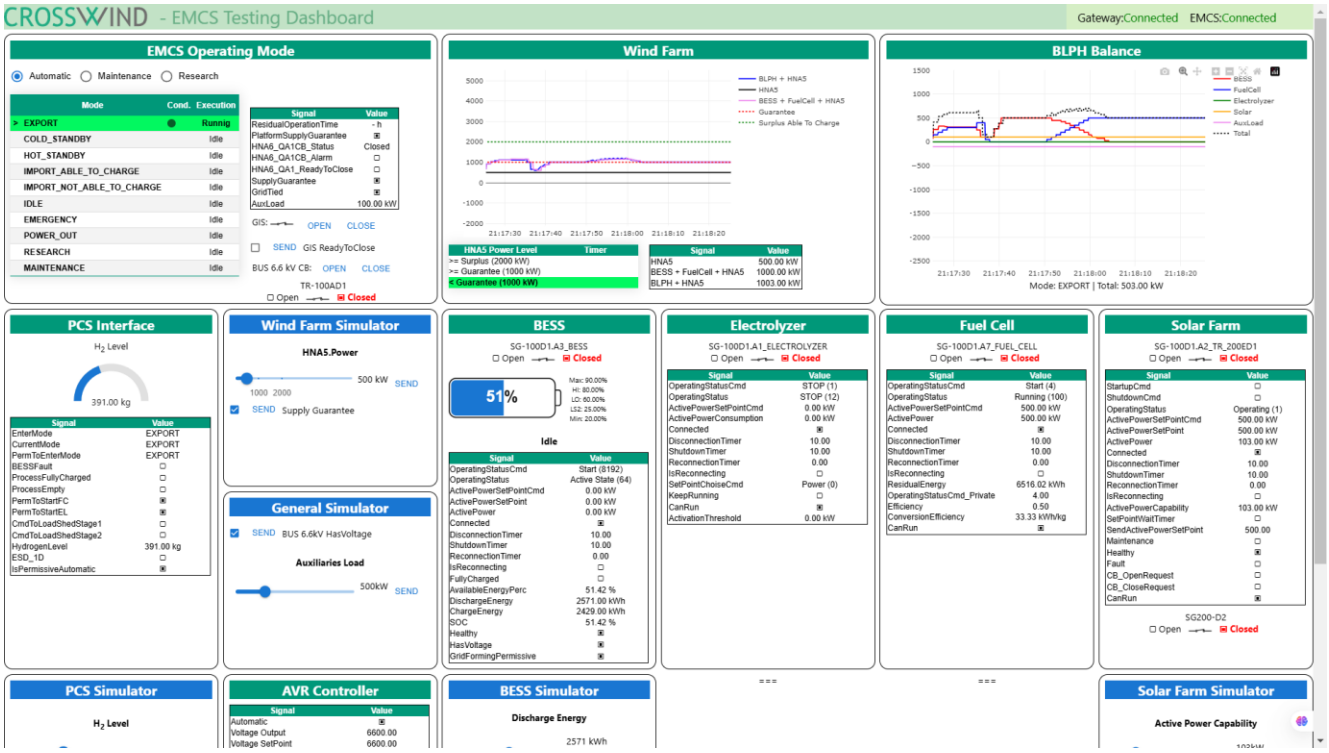


Figure 5 – Onshore Integrated Test Main Control Dashboard

The CCS shall act independently of the safety system and shall not interfere with any of its functions.
The objective of the BLPH and this testing procedure is to demonstrate the time shifting flexibility and capability of providing 1MW Power output using the full capacity of the inventory stored on the platform.

BLPH does not plan its output on weather forecast; BLPH output is managed according to the actual power output of the HNA5 Wind Turbine.
Moreover, BLPH will be operated remotely from a dedicated on-shore Control room, which will have the ability to shut down, start-up, to adjust and/or tune, to connect and disconnect to the grid (excluded during the Onshore Integrated Test) and to monitor BLPH.
The measured response of BLPH will be tied to the power generation profile of an individual wind turbine HNA5.

The principal equipment packages to be tested onshore are as follows:

1. Short term Battery Energy Storage and Power Generation (BESS),
2. Long term Hydrogen Energy Storage (Electrolyser to create green H2),
3. Fuel Cell Power Generation

N.B. all project references to the floating Solar Farm will be omitted from the Onshore Integrated Testing procedure.

It is important to note that the Fuel Cell is relatively slow-acting whilst the BESS is fast acting.

Therefore, the BESS (whenever available) will be used as 'lead supply' / 'load follower' and operate in its most efficient / effective manner with the Fuel Cell operating in parallel or series to optimize both the efficiency and availability of the entire system.

Note that the parallel power output simultaneous operation will be restricted to approximately 200 kW due to operating constraints imposed by the temporary yard 6.6 kV power supply facilities. The parallel operation principle however will be validated.

The CCS will be programmed to act upon multiple inputs / factors e.g. BESS Available Energy, stored hydrogen availability, operation mode and HNA5 output/status (EMCS will receive the simulated data via the HNA5 test control dashboard and based on these values will react), equipment operating status, equipment operating mode, circuit breaker status, etc.

Whenever possible the Fuel Cell will consume the platform's stored hydrogen prior to discharging the BESS.

5.4.2 Electrical Management Control System (EMCS)

The EMCS has the following primary functionalities:

1. Enable Supervision and Control by CCS and Higher-Level SCADA
2. Power Control & Energy Management
3. Load Shedding
4. Manage the Electrical Distribution Equipment
5. Wind Farm Grid Connection Procedure

5.4.2.1 Enable Supervision and Control by CCS and Higher-Level SCADA HMI

The "CCS SCADA" is referred to as the CI Servers, which consequently implement the CCS HMI.

The user interaction with the EMCS within the CCS will be made through the HMI according to the following high level system architecture – see Figure 6.

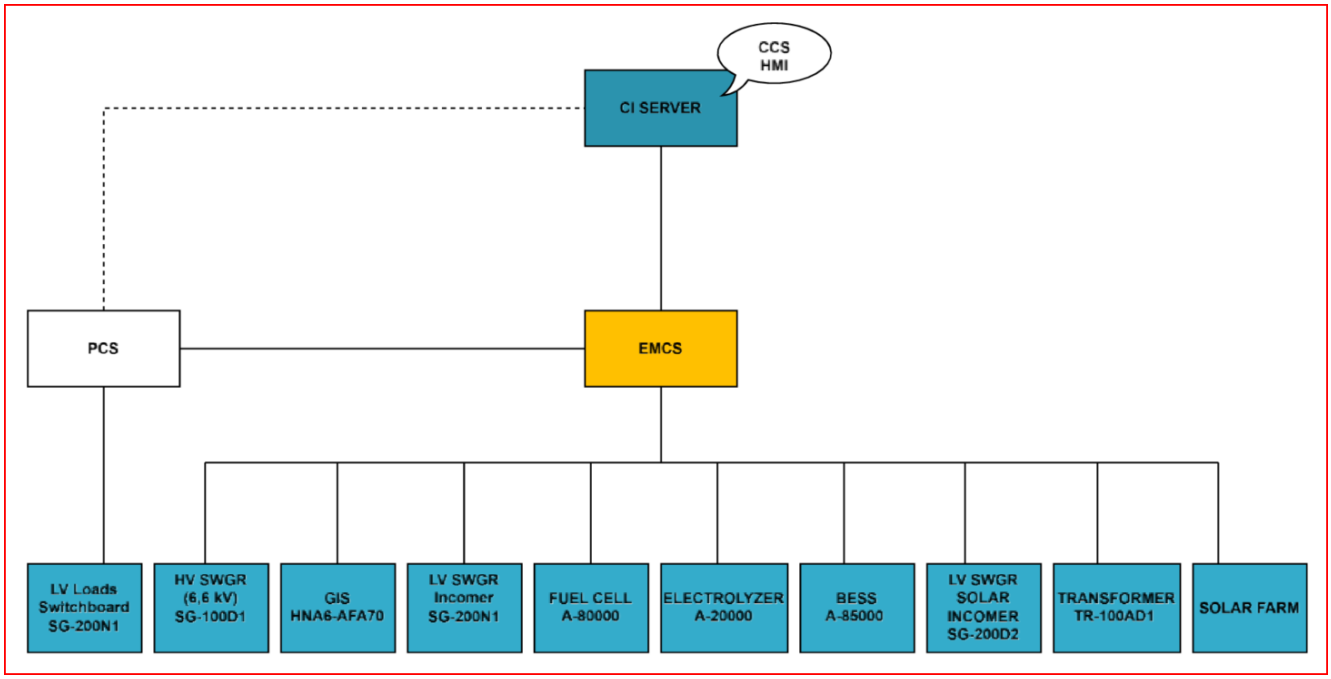


Figure 6 – CCS System Architecture

The EMCS shall receive real-time commands, concerning EMCS control functions, from the CCS HMI.

In Figure 7, the EMCS Flow Chart illustrates the transition between each Operating Mode with respect to the prevailing pre-condition.

The primary focus of the Onshore Integrated Test procedure will be to validate the logic sequences and interactions between EMCS and PCS managing the real time Operating Modes transitions.

The modes transition fixed time condition considers that all modes transitions can take up to 1 minute. On the other hand, it can be configured in the software algorithm to keep the previous mode until the 1-minute transition time is completed.

Consequently, if the system is in EMCS automatic mode, grid-tied, and with supply guarantee on, the first start/execution will be 1-minute time independent (i.e. without any intentional delay) and will immediately transition to the designated Operating Mode as per the preconditions.

Once the EMCS is in one Operating Mode (Export, Cold Stand-by, Hot Stand-by, Import 1A, or Import 1B), it will follow the 1-minute transition time to move from the current mode to another.

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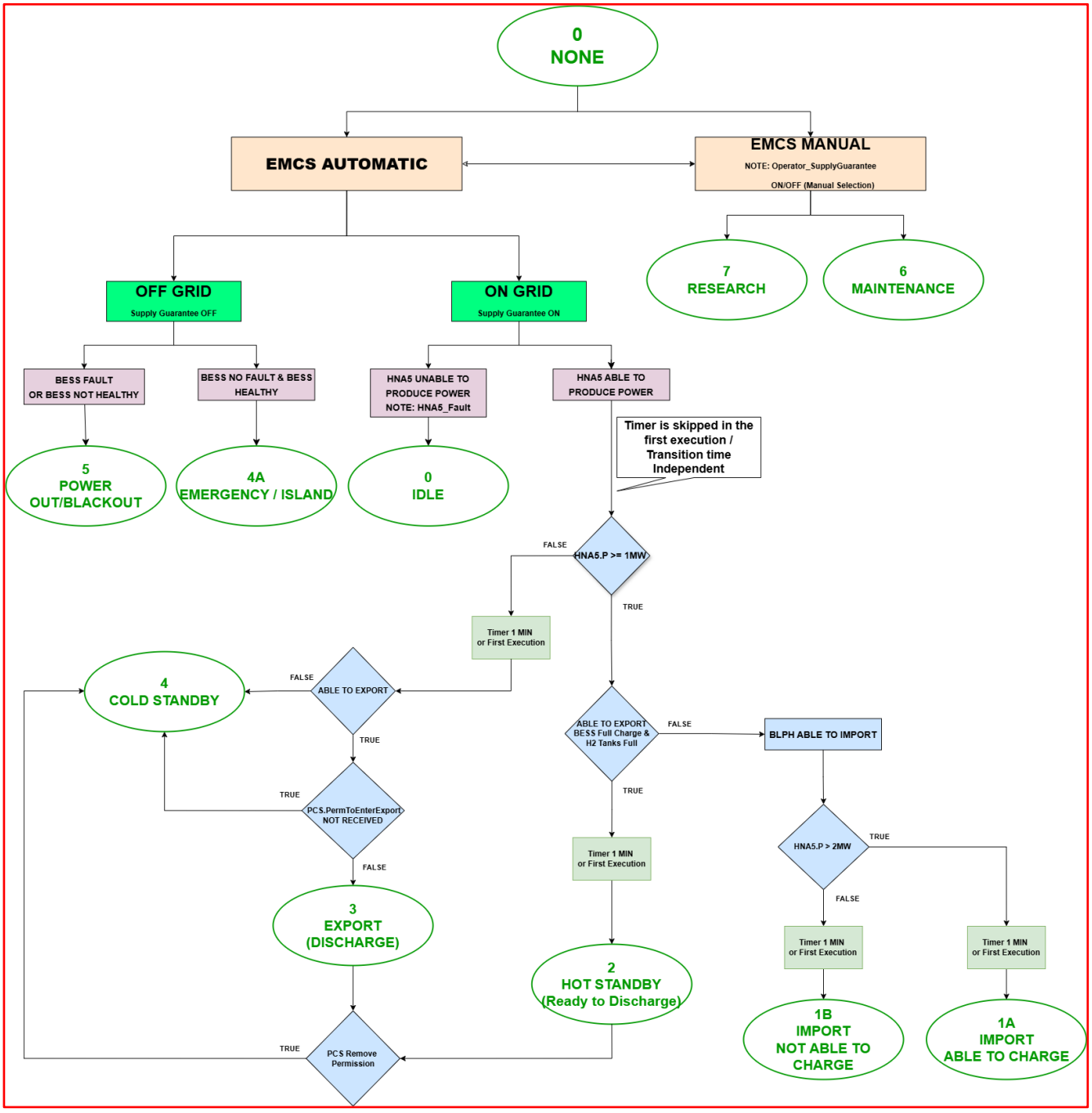


Figure 7 – EMCS Flow Chart

EMCS Interaction with PCS:

- If the PCS removes the HotStandby permission, during execution of the HotStandby MODE, the EMCS will transition to ColdStandby according to BLPH mode Transition.
- If the PCS removes the Export permission, during execution of the Export MODE, the EMCS will transition to ColdStandby according to BLPH mode Transition.
- If the EMCS is waiting for permission (according to BLPH mode transition) from PCS to enter in Export MODE and PCS does not give the permission within a defined timeout (PCS_PermissiveModeTimeout), the EMCS will transition to ColdStandby.

- If the system resets and switches to off-grid mode or EMCS manual mode, the one minute timer will restart. After the reset, the system will focus on meeting the required conditions without considering the timer at first.

5.4.2.2 Power Control and Energy Management

When HNA5 is connected / operating and generating at least 1MW to the wind farm, 'surplus' power will potentially be available for import to BLPH.

This renewable energy will be used to run the plant whilst simultaneously charging the BESS and/or running the electrolyser to produce and store hydrogen.

Conversely, when HNA5 generates less than 1MW to the wind farm, BLPH will export the energy stored in the BESS or generated by the Fuel Cell to ensure the wind farm continues to receive at least 1MW.

Basic Assumptions and Definitions:

- The BLPH is always in one single Operating Mode at a time,
- The additional NONE Mode is intended for specific conditions, such as during EMCS initialization except after the BLACK START scenario because after the black start scenario the initialization will start from RESEARCH MODE,
- The charging of the BESS while the Fuel Cell is generating power shall be considered energy inefficient in steady-state condition and be avoided,
- The EMCS shall be configured such that rapid cycling / quick switching of the BESS, Fuel Cell and Electrolyser is prevented,
- The Fuel Cell internal production balancing logic implemented by the Fuel Cell controller foresees committing Fuel Cell internal modules in sequence, according to the power set-point.
  Due to this, the raise of the set-point over specific levels produces the start of the warmup of part of the still unused modules; conversely, the decrease of the fuel cell power set-point may produce the stop of some modules in production,
- The Active Power of BLPH is calculated as the sum of BESS, Fuel Cell & HNA5 Power in EXPORT MODE,
- The Supply Guarantee is defined according to the status of the following three key signals:
  - Operator_SupplyGuarantee
  - HNA5_SupplyGuarantee
  - HV_SCADA_Connected
- "Power Surplus" definition: It refers to the HNA5 Wind Turbine producing Active Power > 1MW,
- The EMCS will drive the electrolyser as a load (ON/OFF), as a rule no partialisation will be implemented - however a limitation on the Electrolyser's maximum power rating will be temporarily imposed during the Onshore Integrated Test,
- The energy management policy implemented by the EMCS shall foresee to stop the electrolyser only if the hydrogen storage vessels are full – however during the TEST SEQUENCE 2 the Electrolyser functioning cycle will be shortened by simulating reaching the rated pressure of hydrogen storage vessel V-25001A,
- The EMCS is not in charge of implementing any electrical protection function,
- EMCS will open the CB of a package on SG-100D1 if the package does not apply control requests,
  - For example, if the EMCS will send the stop command to the Fuel Cell, and it does not stop within a timeout (parametric), the EMCS will open the related CB on the SG-100D1,
- POWER GUARANTEE is defined on the basis of the signals:
  - SUPPLY GUARANTEE,
  - HNA5_FAULT not active
- BLPH will be able to compensate the production of HNA5 and ensure, to the grid, at least 1 MW of active energy exported, regardless of the availability of wind/solar energy,

- The "BESS charge level" and the related BESS-MINIMUM-OPERATING-RESERVE (and the other parameters about "BESS charge levels") are based on absolute values of energy, expressed in MWh

Description of Requirements Priority and Evaluation Rule:

The following Figure 8 BLPH Operating Mode Transition Table illustrates the conditions under which the EMCS transitions between different Operating Modes take place.

EMCS categorizes these conditions based on the system being grid-tied or off-grid (i.e.: not grid-tied), with further distinctions depending on whether the HNA5 Fault or HNA5 No Fault, and specific power thresholds (HNA5 P < 1 MW and HNA5 P ≥ 1 MW) that determine the system's ability to export or import power.

Conditions						MODE	Specific exit contition
EMCS in automatic identification of the MODE	Grid-tied AND Supply Gurantee ACTIVE	HNA5 NO Fault	HNA5.P < 1 MW for a min time (1 minute)	Able to export		**EXPORT** (Discharge)	PCS.Remove Export Permission
				Not able to export		**COLD STANDBY** (Not Able to Discharge)	
			HNA5.P >= 1 MW for a min time (1 minute)	Not able to import	Able to export (BESS full charge & H2 Tanks full)	**HOT STANDBY** (Ready to Discharge)	When PCS.Remove Hot Standby Permission
				Able to import	HNA5.P > 2 MW for a min time (1 minute)	**IMPORT 1A** (Able to Charge)	
					HNA5.P <= 2 MW for a min time (1 minute)	**IMPORT 1B** (Not Able to Charge)	
		HNA5 Fault				**IDLE** (Power Import Only)	
	Off-grid (i.e. not grid-tied) OR Supply Guarantee INACTIVE	BESS → NO FAULT				**EMERGENCY** (ISLAND)	
		BESS → FAULT (ie. BESS problems, BESS SoC in low range, etc.)				**POWER OUT** (Black Out)	
Command to enter in RESEARCH MODE						**RESEARCH**	Command to return in automatic identification of the mode
Command to enter in MAINTENANCE MODE						**MAINTENANCE**	Command to return in automatic identification of the mode
Default / fallback						**NONE**	

Figure 8 – BLPH Mode Transition Table

For instance, when grid-tied with the Supply Guarantee on and HNA5 P < 1 MW for a minimum time (1-minute), the system enters either in EXPORT MODE 3 or COLD STANDBY MODE 4 based on its export capability.

Conversely, with HNA5 P ≥ 1 MW for a minimum time (1 minute), the system can enter HOT STANDBY MODE 2 (Ready to Discharge) if it can't import (able to export, when BESS is fully charged & H2 storage are full).

On the other hand in the similar condition if the system is being grid-tied, Supply Guarantee ON and HNA5 P ≥ 1 MW but able to Import in two conditions; first condition is if HNA5 P > 2 MW for (1-minute) the system will enter in IMPORT MODE 1A (Able to Charge), second condition is if HNA5 P ≤ 2 MW for (1-minute) the system will enter in IMPORT MODE 1B (Not able to Charge).

If the HNA5 is in Fault, the system remains in IDLE mode.

Off-grid scenarios are distinguished by the status of BESS (NO FAULT) & MV 6.6kV bars, with energized bars triggering EMERGENCY mode and non-energized bars triggering POWER OUT mode BESS (FAULT).

Special modes like RESEARCH and MAINTENANCE can be manually entered (protected by password), with specific commands to revert to automatic mode identification.

In order to ensure optimal operation and accurate mode transition, EMCS prioritises the following basic function principles:

- SAFETY (EMERGENCY and POWER OUT)
- EFFICIENCY (EXPORT and IMPORT)
- RELIABILITY (HOT STANDBY and COLD STANDBY)
- FLEXIBILITY (RESEARCH and MAINTENANCE)

For example:
If EMCS is in EXPORT MODE 3 and the PCS permission to stay in Export mode is removed, the BLPH will automatically transition to COLD STANDBY MODE 4.

If EMCS is in HOT STANDBY MODE 2 and the PCS permission to stay in Hot standby mode is removed, or if the BESS is at fault, the BLPH will automatically transition to COLD STANDBY MODE 4.

If EMCS is waiting the permission (according to BLPH mode transition) from PCS to enter in EXPORT MODE 3 and PCS does not give the permission within a timeout (PCS.PermissiveModeTimeout), then EMCS will automatically transition to COLD STANDBY MODE 4.

EMCS shall always choose an operating mode. If the conditions to enter or remain in an operating mode fail or are not met, then EMCS will transition the BLPH Mode of Operation into another Operational Mode.
While waiting for signals from other systems, BLPH will remain in the previous mode and the HMI will blink.

Ref. see 5.5.1.2 Test Steps: INTEGRATED TEST SEQUENCE N.1

5.4.2.3 General Requirements on the power Distribution Management

By default (i.e. unless required to open or keep open), EMCS shall request to close and keep closed all the 6.6 kV outgoing feeders of the BLPH distribution under the busbar SG-100D1 (including the Solar Farm).
This requirement explicitly does not apply to the incoming MV switchgear and upstream equipment.

Moreover, EMCS interacts with PCS to close and keep closed all the contactors of the BLPH LV loads (400 V Switchgear SG-200N1).

In the event an operator should manually open a circuit breaker locally (on board BLPH), EMCS system must not close it automatically, even if it is in automatic logic.

Instead, it should send an alarm signal to the HMI and HV-SCADA indicating the authorized opening of a circuit breaker. This is because the command to open the circuit breaker also functions as a STOP protection.

EMCS shall implement out-of-command timeout of the stop packages commands, EMCS shall implement the related open command on each 6.6 kV CB on SG-100D1 (even if this is due to the package being in local, see 5.5.1.2 Test Steps: INTEGRATED TEST SEQUENCE N.1 step n.105).

5.4.2.4 BESS Grid Forming Mode of Operation

The EMCS shall provide the BESS a HW permissive signal that enables the Grid Forming mode of operation.
By default, the signal shall be True.

If the BESS charge level is below the BESS-MINIMUM-OPERATING-RESERVE threshold, or BESS is not HEALTHY, then EMCS shall set to False the permissive signal that enables the grid-forming mode to the BESS.

BESS will operate in Grid forming operating mode only when HW signals (1 from EMCS and 1 from SG-100D1 [parallel of open states of CB]) are active (see 5.5.2.2 Test Steps: INTEGRATED TEST SEQUENCE N.2 step n.100).

BESS will operate in Grid forming operating mode, following the loads without any necessity to receive the set-point from EMCS, the maximum load allowed in Grid forming is 1 MVA.

5.4.2.5 Functional Considerations and Requirements Related to the BLPH Modes of Operation

1. MODE 0 = IDLE (POWER IMPORT ONLY)

BLPH will enter IDLE MODE 0 under the following conditions:
- It is GRID TIED,
- Supply Guarantee is ACTIVE,
- HNA5_Fault = True.

Note:
- In IDLE MODE there are no constraints on the power import of BLPH related to any target power exchange level with the wind farm.
- When EMCS is in IDLE MODE and the Electrolyser is running and producing H2, even if the Wind Power goes below the Power Guarantee the EMCS must stay in IDLE MODE, knowing that when the Electrolyser is started it cannot be stopped until the H2 storage vessels are full (PCS.ProcessFullyCharged).
- Due to operational constraints of the temporary yard 6.6 kV power generation facility, the Electrolyser maximum power rating will be temporarily reconfigured.

Ref. see 5.5.2.2 Test Steps: INTEGRATED TEST SEQUENCE N.2

2. MODE 1 = IMPORT

BLPH will enter IMPORT under the following general conditions:
- It is GRID TIED
- Supply Guarantee is ACTIVE
- HNA5 produces ≥ 1 MW for one minute
- Check the BESS is NOT fully charged or NOT PCS.ProcessFullyCharge (H2 storage vessels not full)

If the above conditions are satisfied, EMCS requests the PCS to enter in IMPORT MODE 1.
After receiving the permissive "PCS.PermToEnterImport", BLPH enters in IMPORT MODE 1.

BLPH is considered "able to operate in import" if it can charge the BESS or produce H2 with the electrolyser (at least one of the two) and neither the BESS nor the Fuel Cell are committed to continue producing power (according to their transition policy and any prevailing control logic).

BLPH will remain in this Mode of Operation until the condition to transition to either MODE 1A or 1B are satisfied.

3. MODE 1A = IMPORT (CHARGING)

BLPH will enter IMPORT 1A under the following condition:
- HNA5 P > 2 MW for one minute (Power surplus).

In IMPORT MODE 1A, EMCS will charge the energy storage facilities (charge the BESS and run the electrolyser to produce hydrogen), using the power surplus available in real-time (HNA5 P > 2MW), so to respect the Power Guarantee (1 MW of active power to the wind farm for 1 minute, at point Q0(QA1) of HNA6-AFA70 66kV), the system will enter in IMPORT 1A (Able to Charge).

Moreover, the system is able to import energy, which means it can charge the BESS or store energy in the hydrogen storage vessels. This state indicates surplus energy production that can be utilized for charging.

In IMPORT MODE 1A, EMCS will allow the start of the electrolyser only if the power surplus stays above a minimum value as per power management policy.

The default values of these parameters will be zero NOTE: This is to avoid untimely the start of the electrolyser.
When the Electrolyser is started it cannot be stopped until the H2 storages are full (PCS.ProcessFullyCharged).

Note:
- To load the energy storages, BLPH can only utilize the power surplus, so to respect the Power Guarantee; however, this constraint is subordinated to the electrolyser and BESS status, and any other machine transition policies. Due to this, the Power Guarantee may be not respected in power reduction conditions, as the EMCS may be not allowed to stop consumption immediately (only for the electrolyser),
- If EMCS is in IMPORT or IDLE MODE and the Electrolyser is running and producing H2, even if the Wind Power goes below the Power Guarantee the EMCS must stay in IMPORT or IDLE MODE.
- In IMPORT MODE 1A, EMCS will give priority to the charging of the BESS over the electrolyser in the use of the power surplus. This means that EMCS will start the electrolyser only when there is sufficient power surplus to run it after considering the BESS power draw. This is an energy requirement, and it does not impose that the BESS will start importing power after the electrolyser.

Ref. see 5.5.2.2 Test Steps: INTEGRATED TEST SEQUENCE N.2

4. MODE 1B = IMPORT (NOT ABLE TO CHARGE)

BLPH will enter IDLE MODE 1B under the following condition:
- HNA5 P ≤ 2 MW for one minute (Power deficit).

In IMPORT MODE 1B, EMCS shall not be able to charge the energy utilizing the power available in real-time (HNA5 P ≤ 2MW), so to respect the Power Guarantee (1 MW of active power to the wind farm for 1 minute, at point Q0(QA1) of HNA6-AFA70 66kV).

The Wind Farm will sustain the platform Balance of Plant only.

Ref. see 5.5.2.2 Test Steps: INTEGRATED TEST SEQUENCE N.2

5. MODE 2 = HOT STANDBY (READY TO EXPORT)

BLPH will enter HOT STANDBY MODE 2 under the following conditions:
- It is GRID TIED
- Supply Guarantee is ACTIVE
- HNA5 produces ≥ 1 MW for one minute
- Check the BESS is fully charged and PCS.ProcessFullyCharge (H2 storage vessels full)

EMCS requires PCS to enter in Hot Standby by "PCS.EnterMode(HOT STAND-BY)".

Once the permissive signal PCS.PermToEnterStartHOTStandby is received, EMCS transitions to the HOT STAND-BY mode.

In HOT STAND-BY, EMCS shall keep the Fuel Cell in Hot Stand-by (e.g. in the following mode neither Electrolyser nor the Fuel Cell is required to run).
The Electrolyser is stopped.

Ref. see 5.5.1.2 Test Steps: INTEGRATED TEST SEQUENCE N.1 and 5.5.2.2 Test Steps: INTEGRATED TEST SEQUENCE N.2

6. MODE 3 = EXPORT (DISCHARGING)

BLPH will enter EXPORT MODE 3 under the following conditions:
- It is GRID TIED
- Supply Guarantee is ACTIVE
- HNA5 produces < 1 MW for one minute
- BESS is Healthy

EMCS requires PCS to enter EXPORT MODE by "PCS.EnterMode(EXPORT)". Once the permissive signal PCS. PermToStartEXPORT arrives, EMCS transitions to the EXPORT MODE 3.

The BLPH is considered "able to operate in export" if it can produce power from BESS.
The Electrolyser will be stopped.

EMCS requires from PCS the permission to start the Fuel Cell.
Once the permissive signal arrives EMCS starts the Fuel Cell.

If the permission doesn't arrive, EMCS will remain in EXPORT MODE 3 and continue using the BESS energy until the minimum energy threshold is reached.

In EXPORT MODE 3, EMCS will use the BESS, Fuel Cell and HNA5 Power (if permission is received), according to their availability, to generate enough power to meet the Power Guarantee of 1 MW, or at least to reduce as much as possible the related power shortfall:

Target Power Export = BESS + FUEL CELL + HNA5 Power ≥ 1 MW

In EXPORT MODE, EMCS will give priority to the use of the fuel cell over the BESS in the generation of power to meet the Power Guarantee. This is an energy requirement, and it does not impose that the BESS will start producing power after the fuel cell.

Ref. see 5.5.1.2 Test Steps: INTEGRATED TEST SEQUENCE N.1

7. MODE 4 = COLD STANDBY (NOT ABLE TO EXPORT)

BLPH will enter COLD STANDBY MODE 4 under the following conditions:
- It is GRID TIED
- Supply Guarantee is ACTIVE
- HNA5 produces < 1 MW for one minute
- BESS is not able to operate in Export

EMCS requires PCS to transition in COLD STAND-BY MODE 4 by "PCS.EnterMode(COLD STANDBY)"
PCS sends to EMCS the "Permissive to start" for COLD STAND-BY MODE with "PermToStartCOLD STAND-BY"
In COLD STAND-BY MODE BLPH is unable to respect the Power Guarantee.

In COLD STAND-BY MODE, all relevant auxiliaries will be operational at reduced capacity due to the equipment being out of operation. Only those auxiliaries needed for the platform to remain safe will operate in this operation mode.
The BLPH auxiliaries' loads will be supported by the wind farm.

Ref. see 5.5.1.2 Test Steps: INTEGRATED TEST SEQUENCE N.1 and 5.5.2.2 Test Steps: INTEGRATED TEST SEQUENCE N.2

8. MODE 4A = EMERGENCY (ISLAND)

BLPH will enter EMERGENCY MODE 4A under the following conditions:
- It is Islanded (Off-Grid) or, Supply Guarantee is INACTIVE
- BESS is Healthy
- BESS charge level is above the BESS-MINIMUM-OPERATING-RESERVE threshold

Note:
- In EMERGENCY MODE, EMCS will command BESS to operate in Grid Forming mode of operation.
- In EMERGENCY MODE, EMCS will curtail or stop the Fuel Cell production, to prevent the overload of the system in a situation where the BESS cannot compensate for the production exceedance. This also accounts for possible sudden drops in the loads.
- In EMERGENCY MODE, EMCS will give priority to the use of the Fuel Cell over the BESS discharge, according to machines reaction times and capabilities.
- In EMERGENCY MODE, EMCS will give priority to the reduction of fuel cell use over the BESS charge, according to machines reaction times and capabilities.
- In EMERGENCY MODE, BLPH operates as an 'Island' and if Solar Farm is not in production, BESS and/or Fuel Cell will use their stored energy to support BLPH for the maximum time possible, CCS will be programmed to minimize the balance of plant (load shedding scenario) and vendor package auxiliary demand to prepare for the potential recovery from a 'black start' condition.
- There is no requirement to charge the BESS in EMERGENCY MODE; however, the BESS is allowed to charge and may be expected to charge in temporary periods.
- The "BESS charge level" will be based on the "discharge_energy" signal provided by the BESS communication interface. The value is normalized between 0% and 100% (i.e. 0 to 5MWh) to be used in the calculation of the threshold.
- In Grid Forming Mode, the BESS production is determined by the energy balance of the BLPH.
- In this mode of operation, the Load Shedding procedure will be applied.
- In EMERGENCY MODE, an algorithm will be used to estimate the remaining time before moving to POWER OUT MODE 5 (ref. EMCS FDS);

$$T_{REM} = \frac{E_{H2} + E_{BESS}}{P_{Aux} - P_{SF}}$$

Ref. see 5.5.1.2 Test Steps: INTEGRATED TEST SEQUENCE N.1

9. MODE 5 = POWER OUT (BLACK-OUT)

BLPH will enter POWER OUT MODE 5 under the following conditions:

- It is Islanded (Off-Grid) or, Supply Guarantee is INACTIVE or, EMCS is informed of ESD-1D activation,
- BESS is NOT Healthy or, BESS charge level is below the BESS-MINIMUM-OPERATING-RESERVE threshold (BESS FAULT) or, the SG-100D1 voltage measure on the BLPH 6.6kV distribution bus is absent.

Note:

- In POWER OUT MODE, EMCS will immediately open all the CBs under the busbar SG-100D1, however it shall not ensure that the CBs are held open, allowing manual closing.
- Once in POWER OUT MODE, EMCS will send a command to PCS (PCS.PowerOutMode) to trip all the valves, stop command for process items and according to their energy transition policy.
- When the ESD-1D signal (issued by SIS) is active, the EMCS goes in Power Out MODE from any mode except Research Mode.

Ref. see 5.5.1.2 Test Steps: INTEGRATED TEST SEQUENCE N.1

10. MODE 6 = MAINTENANCE

BLPH will transition to and remain in MAINTENANCE MODE 6 if EMCS receives the request to enter in this MODE from the data interface of the CCS HMI (protected under password).

The BLPH shall exit from the MAINTENANCE MODE if, and only if, EMCS receives the request to return in automatic identification of the MODE from the data interface of the CCS HMI through a software exit button.

In MAINTENANCE MODE, EMCS implements the commands arriving from the data interface of the CCS HMI, respecting permissions.

In MAINTENANCE MODE the EMCS shall not dispatch any command required by any automatic logic in the EMCS, including any open/close command, load shedding command, change in power setpoint.

Note:

- EMCS shall stop and hold stop (prevent start command) the Electrolyser.
- EMCS shall stop and hold stop (prevent start command) the Fuel Cell.
- EMCS shall stop the BESS.
- EMCS – PCS coordination shall remain in place for package permissions.
- EMCS send to PCS permissive request signal to transition to Maintenance Mode via command PCS.EnterMode(MAINTENANCE).

11. MODE 7 = RESEARCH

BLPH shall transition to and remain in RESEARCH MODE if EMCS receives the request to enter in this MODE from the data interface of the CCS HMI (protected under password).

BLPH will ignore the power output of the HNA5 wind turbine.

Warning for the operator; while in the RESEARCH MODE one the following conditions could lead to BLPH black out:

- Intentionally opening of the QA1 of HNA6-AFA70.
- Intentionally opening the INCOMER CB of SG-100D1.
- Intentionally open the CB of SG-100D1 for supply the SG-200N1.

Note:

- EMCS requests PCS to enter RESEARCH MODE by "PCS.EnterMode(RESEARCH)".
- The BLPH shall exit from the RESEARCH MODE if, and only if, EMCS receives the request to return in automatic identification of the MODE from the data interface of the CCS HMI through an exit button.
- RESEARCH MODE shall be used for First Energization and re-energization during Black Start.
- When EMCS transitions to Research Mode from any other mode, all machines must be stopped. However, this logic does not prevent the operator from manually performing machine operations.
- In RESEARCH MODE, EMCS will not dispatch any command required by default behaviour requirements, including any open/close command, load shedding command, change in power setpoint.
  This does not prevent EMCS to automatically dispatch commands that are due to specific functional requirements which are not indicated as generic defaults behaviour (e.g. it does not prevent EMCS to automatically stop the electrolyser when the hydrogen storages are full).
- Transition Conditions: BLPH will execute control commands arriving from the CCS HMI. Entrance on a command to get into the RESEARCH MODE, exit on a command to return in automation definition of the MODE.

Ref. see 5.5.1.2 Test Steps: INTEGRATED TEST SEQUENCE N.1 and 5.5.2.2 Test Steps: INTEGRATED TEST SEQUENCE N.2

12. MODE 8 = NONE MODE

EMCS shall identify NONE MODE as default BLPH MODE and during EMCS initialization.

In NONE MODE, EMCS will not dispatch any command required by default behaviour requirements, including any open/close command, load shedding command, change in power setpoint.

NOTE: This does not prevent EMCS to dispatch commands that are due to specific functional requirements which are not indicated as generic defaults behaviour (e.g. it does not prevent the EMCS to automatically stop the electrolyser when the hydrogen storage vessels are full).

EMCS shall exit from initialization status if the conditions to enter in a BLPH MODE (different from None) are met.

Ref. see 5.5.1.2 Test Steps: INTEGRATED TEST SEQUENCE N.1 and 5.5.2.2 Test Steps: INTEGRATED TEST SEQUENCE N.2

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5.4.2.6 Load Shedding

In EMERGENCY MODE 4A, EMCS will shed the loads in the list LOAD-TO-SHED-IN-EMERGENCY-MODE, by requesting the PCS "Cmd.To.LoadShed" to open the related LV contactors on the switchboard SG-200N1.
EMCS will allow to mark each load, singularly, as included or excluded in the LOAD-TO-SHED-IN-EMERGENCY-MODE from the data interface of the CCS HMI.

The default list LOAD-TO-SHED-IN-EMERGENCY-MODE(Island) "Cmd.To.LoadShed_1" immediately upon entry is the following:

- PCS Stop Electrolyzer auxiliaries
- PCS Stop Water package
- PCS Stop Sea Water Pumps

EMCS will allow to reset the default value of LOAD-TO-SHED-IN-EMERGENCY-MODE from the data interface of the CCS HMI.

In EMERGENCY MODE, if the Available Energy is below BESS-LIMIT-FOR-ADV-LOAD-SHEDDING parameter value, EMCS will shed the loads in the list LOAD-TO-SHED-IN-LOW-BESS-LEVEL, by requesting to the PCS to open the related LV contactors on the switchboard SG-200N1.
EMCS shall allow to set the value of the parameter BESS-LIMIT-FOR-ADV-LOAD-SHEDDING over the data interface with the CCS HMI.
The default value of the parameter being 25% Available Energy.

EMCS will allow to mark each load, singularly, as included or excluded in the LOAD-TO-SHED-IN-LOW-BESS-LEVEL from the data interface of the CCS HMI.

The list LOAD-TO-SHED-IN-LOW-BESS-LEVEL "Cmd.To.LoadShed_2" is the following:

- HVAC
- Welding Sockets
- BOP Distribution Panel
- Crane

During the electrical mode these systems are DISABLE to START according to Load Shedding:

- Electrolyser
- Sea Water Pumps
- Water Treatment System
- HVAC
- Welding Sockets
- BOP Distribution Panel
- Crane

The EMCS shall allow to reset the default value of LOAD-TO-SHED-IN-LOW-BESS-LEVEL from the data interface of the CCS SCADA.

EMCS removes the commands to PCS for CmdToLoadShedStage1 and CmdToLoadShedStage2 when it exits from Emergency mode of operation.

PCS manages the contactor on the LV Switchboard SG-200N1 according to the control logic.

EMCS manages the CBs on the 6.6kV Switchgear SG-100D1 and HNA6-AFA70 according to the control logic.

5.4.2.7 Management of Electrical Distribution Equipment

If IEC 61850 communication between the HV-SCADA & 66kV HNA6-AFA70 is lost, the HNA6-AFA70 will not take any automatic action.

If OPC-UA communication between the HV-SCADA and EMCS is lost, EMCS does not take any automatic action on 66kV HNA6-AFA70. In conjunction with this communication loss, EMCS will immediately command the platform in IDLE MODE "PCS.EnterMode(IDLE)".

EMCS will allow the operator to open the HNA6-AFA70 Q0(QA1) from the data interface of the CCS HMI.

EMCS will allow the operator to close the HNA6-AFA70 Q0(QA1) from the CCS HMI data interface only in presence of a permissive signal from the wind farm SCADA (and there is communication with the wind farm SCADA).
The HV-SCADA can open any time the HNA6-AFA70 Q0(QA1) through the direct link (IEC-61850), while simultaneously removing the permissive signal to close.

Note: The exiting from any island mode (RESEARCH or EMERGENCY), once the voltage is back on the Wind Farm up to the BLPH 66 kV HNA6-AFA70, will require reconnection to the grid by means of a manual procedure.

The operator first of all has to close the line switches and the circuit breaker of the 66 kV HNA6-AFA70 in order to energize the step-up transformer, to be ready to take the load from the 6.6 kV system.

Once the step-up transformer is energized, the operator will request from the CCS HMI to close the incoming breaker on the 6.6 kV switchgear (only after black start scenario or first energization).
The closure of the breaker will be managed by the BESS system (only in EMERGENCY mode), which has the capabilities necessary to synchronize the isolated 6.6 kV system with the grid.

With the closure of the 6.6 kV incoming breaker, the 6.6 kV system will be connected back to the grid and the BLPH platform will return in the operating mode requested in that moment.

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5.5 OTP Test Steps – Onshore WORKSITE – TEST SEQUENCE 1 AND TEST SEQUENCE 2

The following sections will describe the test steps to be followed for execution of both Onshore Integrated Test sequences.

5.5.1 OTP Steps WORKSITE – SEQUENCE 1

In order to facilitate comprehension of the following sequence test steps, it is recommended to review the Work Flow Diagram detailed on the following sheet (**Figure 9** – Integrated Test Sequence – WORK FLOW n.1).

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INTEGRATED TEST SEQUENCE

WORK FLOW N.1

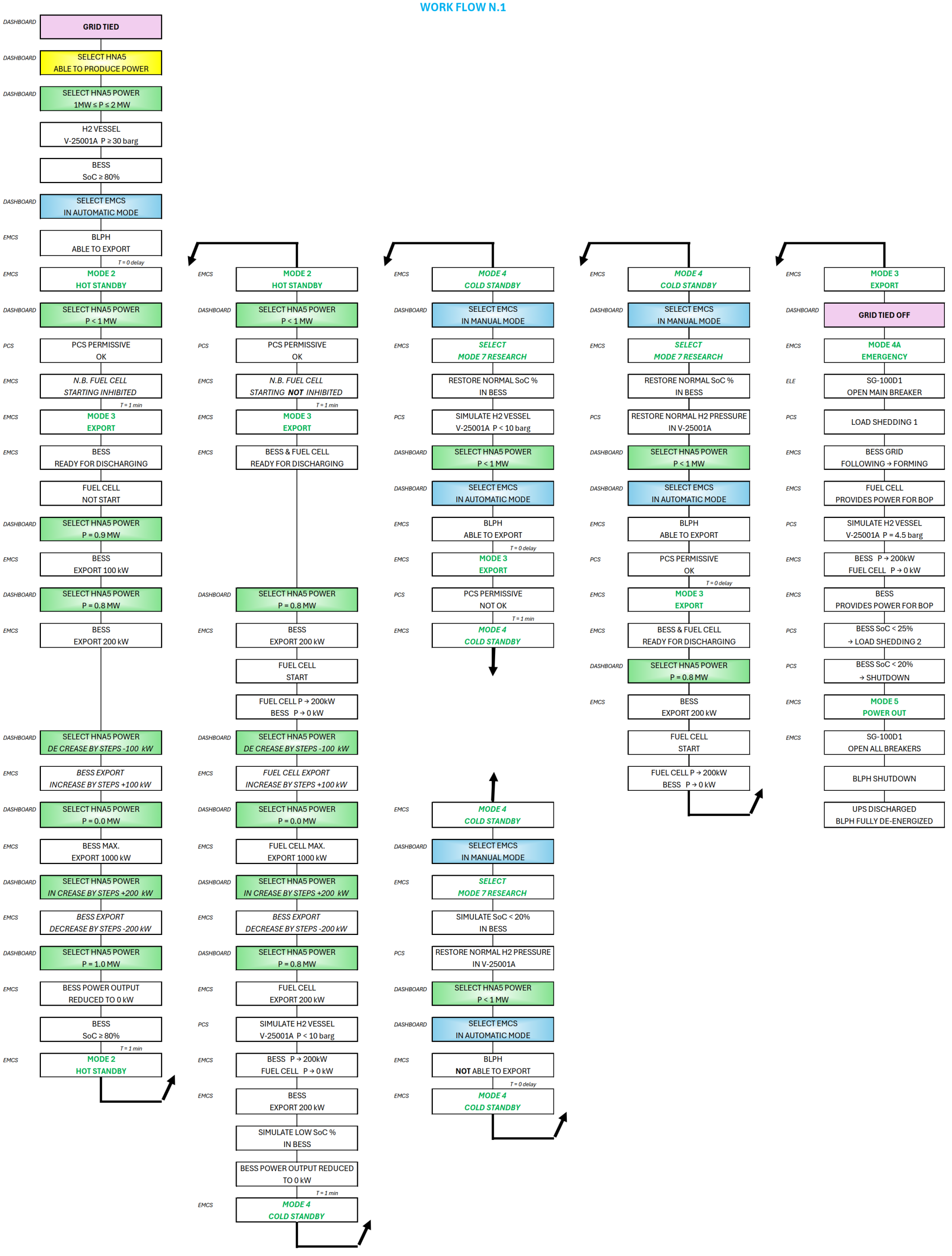


Figure 9 – Integrated Test Sequence – WORK FLOW n.1

5.5.1.1 Test Preparation

Need to Verify:

- Temporary Yard facilities are available
- All systems and subsystems involved in this procedure must be certified Ready for Operation and available
- Confirm successful completion of Electrolyser performance test run for 72hrs, related SAT / OTP, Hydrogen gas produced with 99,999% purity.
- Confirm successful completion of BESS performance test and related SAT / OTP.
- Confirm successful completion of FUEL CELL performance test and related SAT / OTP.
- Confirm availability of pressurized Hydrogen at 30 barg inside Storage Vessel V-25001A.
- Confirm BLPH Integrated Control and Safety Systems (ICSS) online with no blocking alarms present.
- Confirm BLPH Energy Management and Control System (EMCS) online with no blocking alarms present.
- Confirm filling of Hydraulic Seal (Glycol / Water mix) on vent drum.

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5.5.1.2 Test Steps: INTEGRATED TEST SEQUENCE N.1

Further to completion of the Electrolyser 72hrs Performance Test, Hydrogen gas is already available for use.
This testing sequence will detail the automatic Operating Mode transitions, starting with BPLH fully charged until BLPH will be fully discharged.
HNA5 POWER SIMULATOR SELECTOR P ≥ 1MW, ≤ 2MW
→ Set to 1,50 MW
Set EMCS Operation Mode Selector in MODE 7 RESEARCH
Set HNA5 Able to produce Power in Testing Dashboard
Set EMCS Operating Condition to GRID TIED

MODE 2 - HOT STANDBY

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
1	On OWS confirm H2 pressure inside V-25001A, ref. 25-PT-035, (required ≥ 20.0 barg). P = ……. barg			
2	On OWS confirm BESS SoC, ref. Signal BESS_HIGH_OPERATING_RESERVE, (required between 80% and 100% full charge). SoC = ……. %			
3	On EMCS: - set Operation Mode Selector to AUTOMATIC - confirm that EMCS stays in NONE 8 MODE until it engages MODE 2 HOT STANDBY - confirm that the transition happens without delay			
4	Prepare to change BLPH Mode of Operation from HOT STANDBY to EXPORT; → On temporary yard 6.6kV Power Station, start n.1 diesel generator, → Start resistive load bank and set to 250 kW.			
5	Confirm status of EMCS and PCS active system overrides.			

MODE 3 - EXPORT

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
6	On EMCS: - simulate unavailability of Fuel Cell			
7	On EMCS: - set HNA5 POWER SIMULATOR SELECTOR to 0.90 MW - confirm that EMCS engages MODE 3 EXPORT - confirm that the transition happens with 1 min delay - confirm receiving of permissive from PCS - confirm automatic start of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = …..... kW (Expected value ~ 100 kW including losses) Confirm total load BOP = …..... kW			
8	Prepare to simulate reduction of power generated by HNA5 from 0.90 MW to 0.80 MW (equiv. 200 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 350 kW.			
9	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.80 MW and confirm automatic step-up of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = …..... kW (Expected value ~ 200 kW including losses) Confirm total load BOP = …..... kW			
10	Prepare to simulate reduction of power generated by HNA5 from 0.80 MW to 0.70 MW (equiv. 300 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 450 kW.			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
11	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.70 MW and confirm automatic step-up of BESS (the Fuel Cell does not initiate at this point).Confirm active power generated = …..... kW(Expected value ~ 300 kW including losses)Confirm total load BOP = …..... kW			
12	Prepare to simulate reduction of power generated by HNA5 from 0.70 MW to 0.60 MW (equiv. 400 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 550 kW.			
13	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.60 MW and confirm automatic step-up of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = …..... kW (Expected value ~ 400 kW including losses) Confirm total load BOP = …..... kW			
14	Prepare to simulate reduction of power generated by HNA5 from 0.60 MW to 0.50 MW (equiv. 500 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 650 kW.			
15	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.50 MW and confirm automatic step-up of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = …..... kW (Expected value ~ 500 kW including losses) Confirm total load BOP = …..... kW			
16	Prepare to simulate reduction of power generated by HNA5 from 0.50 MW to 0.40 MW (equiv. 600 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 750 kW.			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
17	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.40 MW and confirm automatic step-up of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = …..... kW (Expected value ~ 600 kW including losses) Confirm total load BOP = …..... kW			
18	Prepare to simulate reduction of power generated by HNA5 from 0.40 MW to 0.30 MW (equiv. 700 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 850 kW.			
19	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.30 MW and confirm automatic step-up of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = …..... kW (Expected value ~ 700 kW including losses) Confirm total load BOP = …..... kW			
20	Prepare to simulate reduction of power generated by HNA5 from 0.30 MW to 0.20 MW (equiv. 800 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 950 kW.			
21	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.20 MW and confirm automatic step-up of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = …..... kW (Expected value ~ 800 kW including losses) Confirm total load BOP = …..... kW			

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Step	*Test Step Description*	*Result*	*Verified By*	*Date*
22	Prepare to simulate reduction of power generated by HNA5 from 0.20 MW to 0.10 MW (equiv. 900 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 1050 kW.			
23	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.10 MW and confirm automatic step-up of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = …..... kW (Expected value ~ 900 kW including losses) Confirm total load BOP = …..... kW			
24	Prepare to simulate reduction of power generated by HNA5 from 0.10 MW to 0.00 MW (equiv. 1000 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 1150 kW.			
25	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.00 MW and confirm automatic step-up of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = …..... kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = …..... kW			
26	N.B. IN ORDER TO DEMONSTRATE THE COMPLETE FUNCTIONALITY BETWEEN BESS AND FUEL CELL, THE BLPH MODE OF OPERATION WILL BE GRADUALLY TRANSITIONED TO MODE 2 HOT STANDBY			
27	Prepare to simulate increase of power generated by HNA5 from 0.00 MW to 0.20 MW (equiv. 800 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 950 kW.			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
28	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.20 MW and confirm automatic step-down of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = ……. kW (Expected value ~ 800 kW including losses)			
29	Prepare to simulate increase of power generated by HNA5 from 0.20 MW to 0.40 MW (equiv. 600 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 750 kW.			
30	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.40 MW and confirm automatic step-down of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = ……. kW (Expected value ~ 600 kW including losses)			
31	Prepare to simulate increase of power generated by HNA5 from 0.40 MW to 0.60 MW (equiv. 400 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 550 kW.			
32	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.60 MW and confirm automatic step-down of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = ……. kW (Expected value ~ 400 kW including losses)			
33	Prepare to simulate increase of power generated by HNA5 from 0.60 MW to 0.80 MW (equiv. 200 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 350 kW.			

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Step	*Test Step Description*	*Result*	*Verified By*	*Date*
34	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.80 MW and confirm automatic step-down of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = …..... kW (Expected value ~ 200 kW including losses)			
35	Prepare to simulate increase of power generated by HNA5 from 0.80 MW to 1.00 MW (equiv. 0 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 150 kW.			
36	Due to the fact that the BESS has only been partially discharged, there will be sufficient residual charge to proceed with another EXPORT scenario.			
37	On EMCS: - adjust HNA5 POWER SIMULATOR SELECTOR to 1.0 MW - confirm automatic step-down of BESS - confirm receiving of permissive from PCS - confirm that EMCS engages MODE 2 HOT STANDBY - confirm that the transition happens with 1 min delay Confirm active power generated = …..... kW (Expected value ~ 0 kW including losses) Confirm total load BOP = …..... kW			
38	THE FUEL CELL INHIBIT WILL NOW BE REMOVED IN ORDER TO GENERATE AND EXPORT POWER UP TO 1.0 MW. THE PREVIOUS STEPS WILL BE REPEATED IN ORDER TO TEST THE COMBINED FUNCTIONALITY OF BESS TOGETHER WITH FUEL CELL.			
39	On EMCS: - restore availability of Fuel Cell			

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Step	*Test Step Description*	*Result*	*Verified By*	*Date*
40	Prepare to simulate reduction of power generated by HNA5 from 1.00 MW to 0.80 MW (equiv. 200 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 350 kW.			
41	On EMCS: - set HNA5 POWER SIMULATOR SELECTOR to 0.80 MW - confirm that EMCS engages MODE 3 EXPORT - confirm that the transition happens with 1 min delay - confirm receiving of permissive from PCS - confirm automatic start of BESS - confirm Fuel Cell initiates START-UP Confirm active power generated = ……. kW (Expected value ~ 200 kW including losses) Confirm total load BOP = ……. kW			
42	Confirm automatic start-up of Fuel Cell with ramp-up of power generated up to a maximum of 200 kW, at the same time, the power generated by the BESS will reduce to 0 kW; FUEL CELL … 0 kW ---→ 200 kW BESS ……. 200 kW ---→ 0 kW			
43	Prepare to simulate reduction of power generated by HNA5 from 0.80 MW to 0.70 MW (equiv. 300 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 450 kW.			
44	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.70 MW and confirm automatic step-up of Fuel Cell. Confirm active power generated = ……. kW (Expected value ~ 300 kW including losses) Confirm total load BOP = ……. kW			

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Step	*Test Step Description*	*Result*	*Verified By*	*Date*
45	Prepare to simulate reduction of power generated by HNA5 from 0.70 MW to 0.60 MW (equiv. 400 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 550 kW.			
46	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.60 MW and confirm automatic step-up of Fuel Cell. Confirm active power generated = …..... kW (Expected value ~ 400 kW including losses) Confirm total load BOP = …..... kW			
47	Prepare to simulate reduction of power generated by HNA5 from 0.60 MW to 0.50 MW (equiv. 500 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 650 kW.			
48	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.50 MW and confirm automatic step-up of Fuel Cell. Confirm active power generated = …..... kW (Expected value ~ 500 kW including losses) Confirm total load BOP = …..... kW			
49	Prepare to simulate reduction of power generated by HNA5 from 0.50 MW to 0.40 MW (equiv. 600 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 750 kW.			

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Step	*Test Step Description*	*Result*	*Verified By*	*Date*
50	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.40 MW and confirm automatic step-up of Fuel Cell. Confirm active power generated = …..... kW (Expected value ~ 600 kW including losses) Confirm total load BOP = …..... kW			
51	Prepare to simulate reduction of power generated by HNA5 from 0.40 MW to 0.30 MW (equiv. 700 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 850 kW.			
52	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.30 MW and confirm automatic step-up of Fuel Cell. Confirm active power generated = …..... kW (Expected value ~ 700 kW including losses) Confirm total load BOP = …..... kW			
53	Prepare to simulate reduction of power generated by HNA5 from 0.30 MW to 0.20 MW (equiv. 800 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 950 kW.			
54	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.20 MW and confirm automatic step-up of Fuel Cell. Confirm active power generated = …..... kW (Expected value ~ 800 kW including losses) Confirm total load BOP = …..... kW			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
55	Prepare to simulate reduction of power generated by HNA5 from 0.20 MW to 0.10 MW (equiv. 900 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 1050 kW.			
56	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.10 MW and confirm automatic step-up of Fuel Cell. Confirm active power generated = …..... kW (Expected value ~ 900 kW including losses) Confirm total load BOP = …..... kW			
57	Prepare to simulate reduction of power generated by HNA5 from 0.10 MW to 0.00 MW (equiv. 1000 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 1150 kW.			
58	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.00 MW and confirm automatic step-up of Fuel Cell. Confirm active power generated = …..... kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = …..... kW			
59	N.B. IN ORDER TO DEMONSTRATE THE COMPLETE FUNCTIONALITY BETWEEN BESS AND FUEL CELL, THE BLPH MODE OF OPERATION WILL BE GRADUALLY TRANSITIONED TO MODE 4 COLD STANDBY			
60	Prepare to simulate increase of power generated by HNA5 from 0.00 MW to 0.20 MW (equiv. 800 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 950 kW.			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
61	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.20 MW and confirm automatic step-down of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = ……. kW (Expected value ~ 800 kW including losses)			
62	Prepare to simulate increase of power generated by HNA5 from 0.20 MW to 0.40 MW (equiv. 600 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 750 kW.			
63	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.40 MW and confirm automatic step-down of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = ……. kW (Expected value ~ 600 kW including losses)			
64	Prepare to simulate increase of power generated by HNA5 from 0.40 MW to 0.60 MW (equiv. 400 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 550 kW.			
65	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.60 MW and confirm automatic step-down of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = ……. kW (Expected value ~ 400 kW including losses)			
66	Prepare to simulate increase of power generated by HNA5 from 0.60 MW to 0.80 MW (equiv. 200 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 350 kW.			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
67	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 0.80 MW and confirm automatic step-down of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = …..... kW (Expected value ~ 200 kW including losses)			
68	N.B. THE FOLLOWING TEST STEPS MAINTAIN THE BLPH OPERATING CONDITION GRID TIED, AND CONSEQUENTLY DEMONSTRATE THE CONTINUED GENERATION OF POWER FROM FUEL CELL TO THE GRID. HOWEVER, IT IS NOT CONSIDERED A MANDATORY REQUIREMENT TO FULLY DISCHARGE THE HYDROGEN VESSEL V-25001A TO CLEARLY VALIDATE THE LOGIC SEQUENCE; PROCESS VARIABLE 25-PT-035 WILL BE FORCED TO THE LOW PRESSURE THRESHOLD UTILIZING A HART COMMUNICATOR DIRECTLY ON THE APPROPRIATE MARSHALLING CABINET INPUT CHANNEL. For the purposes of this test, Hydrogen Vessels V-25001B-1F will actually be depressurized and without any Hydrogen gas.			
69	Proceed with HART Communicator to force input process variable < 10 barg and confirm activation of process alarm and automatic stop of Fuel Cell power generation. 25-PT-035 …..... barg			
70	Confirm initiation of BESS with ramp-up of power generated up to a maximum of 200 kW, at the same time, the power generated by the FUEL CELL will reduce to 0 kW; BESS ….....… 0 kW ---→ 200 kW FUEL CELL …..... 200 kW ---→ 0 kW			
71	Confirm Fuel Cell ramp-down then stopped, auxiliary power remains available for internal services, protection systems, HVAC, etc.			
72	Confirm BESS is operational with power generated in EXPORT = 200 kW. BESS …..... kW			

Step	Test Step Description	Result	Verified By	Date
73	Confirm on EMCS actual BESS SoC: BESS State of Charge …..... %			

MODE 4 - COLD STANDBY

Step	Test Step Description	Result	Verified By	Date
74	N.B. THE FOLLOWING TEST STEPS MAINTAIN THE BLPH OPERATING CONDITION GRID TIED, AND CONSEQUENTLY DEMONSTRATE THE CONTINUED GENERATION OF POWER FROM BESS TO THE GRID. HOWEVER, IT IS NOT CONSIDERED A MANDATORY REQUIREMENT TO FULLY DISCHARGE THE BESS BATTERIES TO CLEARLY VALIDATE THE LOGIC SEQUENCE; BESS CONTROL SYSTEM TO OVERRIDE PROCESS VARIABLE "BESS_MINIMUM_OPERATING_RESERVE" TRANSMITTED VIA MODBUS TO EMCS, CONSEQUENTLY SET TO 20% LOW-LOW SoC.			
75	Confirm on EMCS new BESS SoC override: BESS State of Charge …..... %			
76	On EMCS: - confirm that EMCS engages MODE 4 COLD STANDBY - confirm that the transition happens without delay - confirm receiving of permissive from PCS - confirm automatic stop of BESS Confirm total load BOP = …..... kW			
77	N.B: EMCS WILL BE SET TO MODE 7 RESEARCH, THEN THE BESS OVVERRIDE STATUS SIGNALS WILL BE RESTORED TO NORMAL OPERATING CONDITIONS WHILST THE H2 STORAGE WILL BE SIMULATED TO BE UNAVAILABLE. EMCS WILL THEN BE SET TO AUTOMATIC MODE AND BLPH WILL ABORT THE TENTATIVE TO ENGAGE MODE 3 EXPORT (AFTER SOME DELAY ALLOWED TO RECEIVE PERMISSIVE FROM PCS). AS THE PCS PERMISSIVE IS NOT RECEIVED WITHIN THE ALLOWED TIMEFRAME, EMCS WILL ENGAGE MODE 4 COLD STANDBY.			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
78	Set EMCS Operation Mode Selector in MODE 7 RESEARCH			
79	Restore process variable BESS_MINIMUM_OPERATING_RESERVE without override. Confirm on EMCS actual BESS SoC: BESS State of Charge …..... %			
80	Confirm forced input process variable < 10 barg. 25-PT-035 …..... barg			
81	Confirm simulated power generated by HNA5 equal to 0.80 MW (equiv. 200 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Resistive load bank set to 350 kW.			
82	On EMCS: - set Operation Mode Selector to AUTOMATIC - confirm that EMCS engages MODE 3 EXPORT - confirm that the transition happens without delay			
83	On EMCS: - confirm automatic start of BESS (the Fuel Cell does not initiate at this point). Confirm active power generated = …..... kW (Expected value ~ 200 kW including losses) Confirm total load BOP = …..... kW			
84	On EMCS: - confirm permissive to enter MODE 3 EXPORT from PCS not received - confirm that EMCS engages MODE 4 COLD STANDBY - confirm automatic stop of BESS			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
85	N.B: EMCS WILL BE SET TO MODE 7 RESEARCH, THEN THE BESS OVVERRIDE STATUS SIGNALS WILL BE SIMULATED TO BE UNAVAILABLE WHILST THE H2 STORAGE WILL BE RESTORED TO NORMAL OPERATING CONDITIONS. EMCS WILL THEN BE SET TO AUTOMATIC MODE AND BLPH WILL ABORT THE TENTATIVE TO ENGAGE MODE 3 EXPORT. EMCS THEN WILL ENGAGE MODE 4 COLD STANDBY.			
86	Set EMCS Operation Mode Selector in MODE 7 RESEARCH			
87	On OWS confirm BESS SoC, ref. Signal BESS_MINIMUM_OPERATING_RESERVE, (required below 20% full charge). SoC = …..... %			
88	Proceed to restore normal operation of pressure transmitter. Confirm on PCS actual measured value of Vessel pressure: (required ≥ 20 barg). 25-PT-035 …..... barg			
89	Confirm simulated power generated by HNA5 equal to 0.80 MW (equiv. 200 kW Export); → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Resistive load bank set to 350 kW.			
90	On EMCS: - set Operation Mode Selector to AUTOMATIC - confirm fail to engage ABLE TO EXPORT status - confirm that EMCS engages MODE 4 COLD STANDBY - confirm that the transition happens with 1 min delay			

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MODE 3 - EXPORT

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
91	N.B. THE FOLLOWING TEST STEPS MAINTAIN THE BLPH OPERATING CONDITION GRID TIED, AND CONSEQUENTLY DEMONSTRATE THE CONTINUED GENERATION OF POWER FROM BESS TO THE GRID. EMCS WILL BE PUT IN MODE 3 EXPORT, THEN THE GRID TIED SIGNAL WILL BE SIMULATED TO BE UNAVAILABLE. EMCS WILL THEN TRANSITION TO MODE 4A EMERGENCY AND ADOPT MEASURES OF LOAD SHEDDING TO PROLONG THE DURATION OF THE ENERGY RESERVES. WHEN THE ENERGY RESERVES DROP BELOW A THRESHOLD, EMCS WILL ENGAGE MODE 5 POWER OUT.			
92	Set EMCS Operation Mode Selector in MODE 7 RESEARCH			
93	Restore process variable BESS_MINIMUM_OPERATING_RESERVE without override. Confirm on EMCS actual BESS Soc: BESS State of Charge …..... %			
94	Proceed to restore normal operation of pressure transmitter. Confirm on PCS actual measured value of Vessel pressure: (required ≥ 10 barg). 25-PT-035 …..... barg			
95	On EMCS: - set Operation Mode Selector to AUTOMATIC - confirm that EMCS engages MODE 3 EXPORT - confirm that the transition happens with 1 min delay - confirm receiving of permissive from PCS - confirm automatic start of BESS - confirm Fuel Cell initiates START-UP Confirm active power generated = …..... kW (Expected value ~ 200 kW including losses) Confirm total load BOP = …..... kW			

Step	Test Step Description	Result	Verified By	Date
96	Confirm automatic start-up of Fuel Cell with ramp-up of power generated up to a maximum of 200 kW, at the same time, the power generated by the BESS will reduce to 0 kW; FUEL CELL … 0 kW ---→ 200 kW BESS ……..... 200 kW ---→ 0 kW			
97	Prepare to simulate disconnection from the Grid; → On temporary yard 6.6kV Power Station, maintain operation of n.1 diesel generator, → Set resistive load bank to new value 200 kW.			

N.B. THE FOLLOWING TEST STEPS START BY MAINTAINING THE BLPH OPERATING CONDITION GRID TIED, WITH BOTH BESS AND FUEL CELL IN NORMAL EXPORT OPERATION.

HOWEVER, BEFORE HYDROGEN GAS AND BATTERY CHARGES WILL BE DEPLETED, BLPH WILL MOVE TO OFF-GRID (NOT GRID-TIED) OPERATING CONDITION.

CONSEQUENTLY, THE HYDROGEN GAS AND BATTERY CHARGES WILL GRADUALLY BECOME DEPLETED, BLPH WILL AUTOMATICALLY TRANSITION TO MODE 4A EMERGENCY AND ULTIMATELY MODE 5 POWER OUT

MODE 4A - EMERGENCY

Step	Test Step Description	Result	Verified By	Date
98	Set EMCS Operating Condition to OFF-GRID (NOT GRID-TIED) by opening the breaker in temporary yard 6.6kV Power Station.			
99	Confirm that EMCS automatically enters MODE 4A EMERGENCY. Confirm that incoming breaker in SG-100D1 opens automatically. PCS will command the LOAD SHEDDING 1 to limit BOP auxiliary power consumption. Consequently, Fuel Cell and BESS shall export power just to sustain BLPH.			
100	Confirm that EMCS commands BESS to go in Grid Forming mode. Confirm that BESS is in Grid Forming mode.			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
101	BOP Auxiliary Systems power will be provided by Fuel Cell until there's enough Hydrogen in Vessel V-25001A and then by BESS. Confirm that Fuel Cell export power is limited to the BOP auxiliary power consumption Confirm active power generated = …..... kW (Expected value ~ 200 kW including losses)			
102	Proceed with Hydrogen Vessel V-25001A discharge until pressure reaches 4.5 barg and confirm activation of process alarm and automatic stop of Fuel Cell power generation. 25-PT-035 …..... barg			
103	Confirm initiation of BESS with ramp-up of power generated up to a maximum of 200 kW, at the same time, the power generated by the FUEL CELL will reduce to 0 kW; BESS ……..… 0 kW ---⟶ 200 kW FUEL CELL ……..... 200 kW ---⟶ 0 kW (the above power values are taken in to account assuming that the BOP power consumption is equal to 200 kW; actual values may differ and will be adjusted accordingly) Confirm active power generated = …..... kW			
104	When the actual BESS State of Charge reaches the BESS_LOW_OPERATING_RESERVE, PCS will command the LOAD SHEDDING 2 to further limit BOP auxiliary power consumption. Confirm on EMCS actual BESS Soc: BESS State of Charge …..... %			

MODE 5 - POWER OUT

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
105	When the actual BESS State of Charge reaches the BESS_MINIMUM_OPERATING_RESERVE, BLPH will automatically transition to MODE 5 POWER OUT. Confirm on EMCS actual BESS Soc: BESS State of Charge …..... %			
106	Confirm that EMCS automatically enters MODE 5 POWER OUT.			
107	Confirm that EMCS opens all the CBs under the busbar SG-100D1, immediately. Confirm that SIS trips all the valves and stops process (ESD-1D).			
108	Confirm that UPS will sustain power to ICSS cabinets until charge is available			

5.5.1.3 OTP Worksite SEQUENCE 1 - Tests Notes and Remarks

5.5.1.4 OTP Worksite SEQUENCE 1 - Tests Certifying Authority Table of Attendances

Name and Surname	Certifying Authority	Position	Signature

5.5.1.5 OTP WORKSITE SEQUENCE 1 - Tests Final Signatures and Company Acceptance

Name and Surname	Company Representative	Position	Signature

5.5.2 OTP Steps WORKSITE – SEQUENCE 2

In order to facilitate comprehension of the following sequence test steps, it is recommended to review the Work Flow Diagram detailed on the following sheet (**Figure 10** – Integrated Test Sequence – WORK FLOW n.2).

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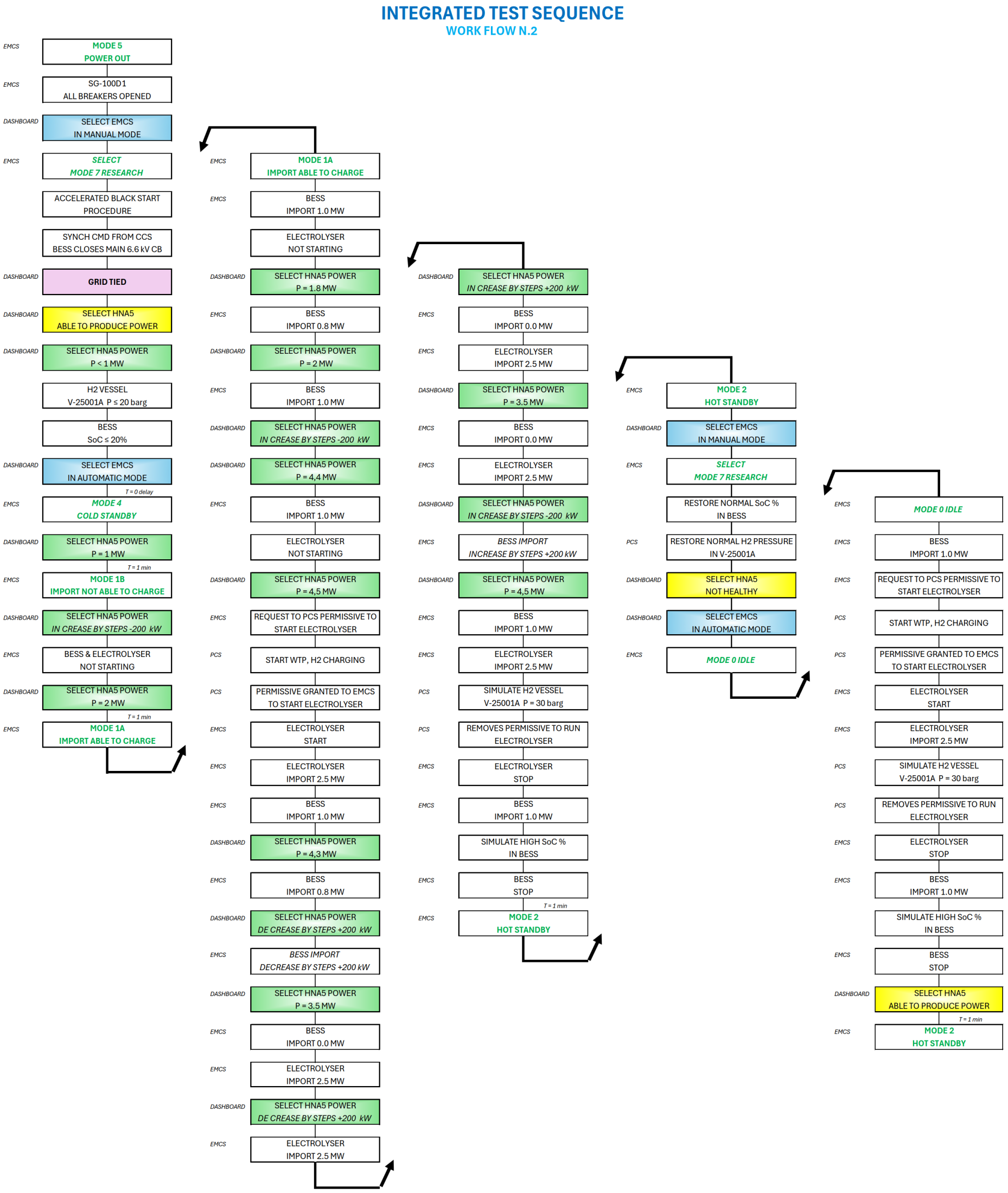


Figure 10 – *Integrated Test Sequence – WORK FLOW n.2*

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5.5.2.1 Test Preparation

Need to Verify:

- Temporary Yard facilities are available
- All systems and subsystems involved in this procedure must be certified Ready for Operation and available
- Confirm successful completion of Electrolyser performance test run for 72hrs, related SAT / OTP, Hydrogen gas produced with 99,999% purity.
- Confirm successful completion of BESS performance test and related SAT / OTP.
- Confirm successful completion of ELECTROLYSER performance test and related SAT / OTP.
- Confirm availability of low pressurized Hydrogen inside Storage Vessel V-25001A.
- Confirm BLPH Integrated Control and Safety Systems (ICSS) online with no blocking alarms present.
- Confirm BLPH Energy Management and Control System (EMCS) online with no blocking alarms present.
- Confirm filling of Hydraulic Seal (Glycol / Water mix) on vent drum.
- Maximum Input Power to Electrolyser will be reduced to 50%.

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5.5.2.2 Test Steps: INTEGRATED TEST SEQUENCE N.2

Further to completion of the Electrolyser 72hrs Performance Test, Hydrogen gas is already available for use. This testing sequence will detail the automatic Operating Mode transitions, starting with BPLH fully charged until BLPH will be fully discharged.
HNA5 POWER SIMULATOR SELECTOR P ≥ 1MW, ≤ 2MW
→ Set to 1,50 MW
Set EMCS Operation Mode Selector in MODE 7 RESEARCH
Set HNA5 Able to produce Power in Testing Dashboard
Set EMCS Operating Condition to GRID TIED

MODE 4 – COLD STANDBY

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
1	On OWS confirm low H2 pressure inside V-25001A, ref. 25-PT-035, (required between 2.0 barg and 20.0 barg). P = …..... barg			
2	On OWS confirm BESS SoC, ref. Signal BESS_MINIMUM_OPERATING_RESERVE, (required below 20% full charge). SoC = …..... %			
3	On EMCS: - set Operation Mode Selector to AUTOMATIC - confirm that EMCS stays in NONE 8 MODE until it engages MODE 4 COLD STANDBY - confirm that the transition happens without delay			
4	Prepare to change BLPH Mode of Operation from COLD STANDBY to IMPORT; → On temporary yard 6.6kV Power Station, start n.2 diesel generators, → Start resistive load bank and set to 200 kW.			
5	Confirm status of EMCS and PCS active system overrides.			

MODE 1 - IMPORT

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
6	N.B. THE FOLLOWING TEST STEPS MAINTAIN THE BLPH OPERATING CONDITION GRID TIED, AND CONSEQUENTLY DEMONSTRATE THE CONTINUOUS STORAGE OF SURPLUS OF POWER FROM HNA5.			
7	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 1 MW and confirm no automatic start of BESS. On EMCS: - set HNA5 POWER SIMULATOR SELECTOR to 1.0 MW - confirm that EMCS engages MODE 1B IMPORT NOT ABLE TO CHARGE - confirm that the transition happens with 1 min delay - confirm receiving of permissive from PCS - confirm no automatic start of BESS - confirm no automatic start of Electrolyser Confirm total load BOP = ……. kW			
8	Prepare to simulate increasing of power generated by HNA5 from 1.0 MW to 1.2 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generator, → Reduce resistive load bank to new value 0 kW.			
9	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 1.2 MW and confirm no automatic start of BESS/Electrolyser. Confirm total load BOP = ……. kW			
10	Prepare to simulate increasing of power generated by HNA5 from 1.2 MW to 1.4 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generator, → Maintain resistive load bank to 0 kW.			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
11	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 1.4 MW and confirm no automatic start of BESS/Electrolyser. Confirm total load BOP = …..... kW			
12	Prepare to simulate increasing of power generated by HNA5 from 1.4 MW to 1.6 MW;→ On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generator,→ Maintain resistive load bank to 0 kW.			
13	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 1.6 MW and confirm no automatic start of BESS/Electrolyser. Confirm total load BOP = …..... kW			
14	Prepare to simulate increasing of power generated by HNA5 from 1.6 MW to 1.8 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generator, → Maintain resistive load bank to 0 kW.			
15	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 1.8 MW and confirm no automatic start of BESS/Electrolyser. Confirm total load BOP = …..... kW			
16	Prepare to simulate increasing of power generated by HNA5 from 1.8 MW to 2.0 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generator, → Maintain resistive load bank to 0 kW.			

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Step	*Test Step Description*	*Result*	*Verified By*	*Date*
17	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 2.0 MW and: - confirm that EMCS engages MODE 1A IMPORT ABLE TO CHARGE - confirm that the transition happens with 1 min delay - confirm automatic start of BESS - confirm no automatic start of Electrolyser. Confirm active power absorbed = ... kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ... kW			
18	Prepare to simulate reduction of power generated by HNA5 from 2.0 MW to 1.8 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generator, → Maintain resistive load bank to 0 kW.			
19	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 1.8 MW and confirm automatic step-down of BESS (the Electrolyser does not initiate at this point). Confirm active power absorbed = ... kW (Expected value ~ 800 kW including losses) Confirm total load BOP = ... kW			
20	Prepare to simulate increasing of power generated by HNA5 from 1.8 MW to 2.0 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generator, → Maintain resistive load bank to 0 kW.			
21	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 2.0 MW and confirm automatic step-up of BESS (the Electrolyser does not initiate at this point). Confirm active power absorbed = ... kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ... kW			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
22	Prepare to simulate increasing of power generated by HNA5 from 2.0 MW to 2.2 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators.			
23	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 2.2 MW. Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			
24	Prepare to simulate increasing of power generated by HNA5 from 2.2 MW to 2.4 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators.			
25	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 2.4 MW. Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			
26	Prepare to simulate increasing of power generated by HNA5 from 2.4 MW to 2.6 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators.			
27	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 2.6 MW. Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			

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Step	*Test Step Description*	*Result*	*Verified By*	*Date*
28	Prepare to simulate increasing of power generated by HNA5 from 2.6 MW to 2.8 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators.			
29	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 2.8 MW. Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			
30	Prepare to simulate increasing of power generated by HNA5 from 2.8 MW to 3.0 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators.			
31	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 3.0 MW. Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			
32	Prepare to simulate increasing of power generated by HNA5 from 3.0 MW to 3.2 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators.			
33	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 3.2 MW. Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			

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Step	*Test Step Description*	*Result*	*Verified By*	*Date*
34	Prepare to simulate increasing of power generated by HNA5 from 3.2 MW to 3.4 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators.			
35	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 3.4 MW. Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			
36	Prepare to simulate increasing of power generated by HNA5 from 3.4 MW to 3.6 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators.			
37	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 3.6 MW. Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			
38	Prepare to simulate increasing of power generated by HNA5 from 3.6 MW to 3.8 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators.			
39	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 3.8 MW. Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			

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Step	*Test Step Description*	*Result*	*Verified By*	*Date*
40	Prepare to simulate increasing of power generated by HNA5 from 3.8 MW to 4.0 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators.			
41	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 4.0 MW. Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			
42	Prepare to simulate increasing of power generated by HNA5 from 4.0 MW to 4.2 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators.			
43	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 4.2 MW. Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			
44	Prepare to simulate increasing of power generated by HNA5 from 4.2 MW to 4.4 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators.			
45	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 4.4 MW.The Electrolyser does not initiate at this point. Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
46	N.B. DUE TO TEMPORARY YARD 6.6kV POWER STATION CAPACITY, IT WILL ONLY BE DEMONSTRATED THE POWER TRANSFER TO THE ELECTROLYSER WITH MAXIMUM POWER @ 50% EQUIVALENT TO 1250 kW.			
47	Prepare to simulate increasing of power generated by HNA5 from 4.4 MW to 4.5 MW; → On temporary yard 6.6kV Power Station, start n.4 diesel generators.			
48	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 4.5 MW and confirm automatic start of Electrolyser. Confirm active power absorbed = ……. kW (Expected value ~ 2250 kW including losses) Confirm total load BOP = ……. kW			
49	Confirm PCS start of charging sequence: → open valve 25-XV-004 → start timer T7A = 7 hours Confirm total charging time to reach 30 barg: t = ……. h			
50	Confirm PCS start Water Treatment package			
51	Prepare to simulate reduction of power generated by HNA5 from 4.5 MW to 4.3 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
52	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 4.3 MW and confirm automatic step-down of BESS. Confirm active power absorbed = ……. kW (Expected value ~ 2050 kW including losses) Confirm total load BOP = ……. kW			

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Step	*Test Step Description*	*Result*	*Verified By*	*Date*
53	Prepare to simulate reduction of power generated by HNA5 from 4.3 MW to 4.1 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
54	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 4.1 MW and confirm automatic step-down of BESS. Confirm active power absorbed = ……. kW (Expected value ~ 1850 kW including losses) Confirm total load BOP = ……. kW			
55	Prepare to simulate reduction of power generated by HNA5 from 4.1 MW to 3.9 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
56	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 3.9 MW and confirm automatic step-down of BESS. Confirm active power absorbed = ……. kW (Expected value ~ 1650 kW including losses) Confirm total load BOP = ……. kW			
57	Prepare to simulate reduction of power generated by HNA5 from 3.9 MW to 3.7 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
58	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 3.7 MW and confirm automatic step-down of BESS. Confirm active power absorbed = ……. kW (Expected value ~ 1450 kW including losses) Confirm total load BOP = ……. kW			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
59	Prepare to simulate reduction of power generated by HNA5 from 3.7 MW to 3.5 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
60	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 3.5 MW and confirm automatic stop of BESS. Confirm active power absorbed = ……. kW (Expected value ~ 1250 kW including losses) Confirm total load BOP = ……. kW			
61	Prepare to simulate reduction of power generated by HNA5 from 3.5 MW to 3.3 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
62	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 3.3 MW and confirm no change in power absorbed by Electrolyser. Confirm active power absorbed = ……. kW (Expected value ~ 1250 kW including losses) Confirm total load BOP = ……. kW			
63	Prepare to simulate increasing of power generated by HNA5 from 3.3 MW to 3.5 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
64	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 3.5 MW. Confirm active power absorbed = ……. kW (Expected value ~ 1250 kW including losses) Confirm total load BOP = ……. kW			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
65	Prepare to simulate increasing of power generated by HNA5 from 3.5 MW to 3.7 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
66	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 3.7 MW and confirm automatic step-up of BESS. Confirm active power absorbed = ……. kW (Expected value ~ 1450 kW including losses) Confirm total load BOP = ……. kW			
67	Prepare to simulate increasing of power generated by HNA5 from 3.7 MW to 3.9 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
68	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 3.9 MW and confirm automatic step-up of BESS. Confirm active power absorbed = ……. kW (Expected value ~ 1650 kW including losses) Confirm total load BOP = ……. kW			
69	Prepare to simulate increasing of power generated by HNA5 from 3.9 MW to 4.1 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
70	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 4.1 MW and confirm automatic step-up of BESS. Confirm active power absorbed = ……. kW (Expected value ~ 1850 kW including losses) Confirm total load BOP = ……. kW			

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Step	*Test Step Description*	*Result*	*Verified By*	*Date*
71	Prepare to simulate increasing of power generated by HNA5 from 4.1 MW to 4.3 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
72	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 4.3 MW and confirm automatic step-up of BESS. Confirm active power absorbed = ……. kW (Expected value ~ 2050 kW including losses) Confirm total load BOP = ……. kW			
73	Prepare to simulate increasing of power generated by HNA5 from 4.3 MW to 4.5 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
74	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 4.5 MW and confirm automatic step-up of BESS. Confirm active power absorbed = ……. kW (Expected value ~ 2250 kW including losses) Confirm total load BOP = ……. kW			
75	Prepare to simulate Hydrogen vessel V-25001A charging complete; → On temporary yard 6.6kV Power Station, maintain operation of n.4 diesel generators.			
76	Proceed with HART Communicator to force input process variable = 30 barg and confirm activation of process alarm and automatic stop of Electrolyser. 25-PT-035 ……. barg Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			

Step	Test Step Description	Result	Verified By	Date
77	Confirm PCS stop of charging sequence: → close valve 25-XV-004			
78	Confirm PCS stop Water Treatment package			
79	Confirm on EMCS new BESS Soc override: BESS State of Charge …..... %			
80	When the actual BESS State of Charge reaches the BESS_MAXIMUM_OPERATING_RESERVE, BLPH will automatically transition to MODE 2 HOT STANDBY.			
81	Confirm that EMCS automatically enters MODE 2 HOT STANDBY.			

MODE 0 - IDLE

Step	Test Step Description	Result	Verified By	Date
82	N.B. THE HNA5 HEALTHY STATUS SIGNAL WILL BE SIMULATED TO BE OFF. EMCS WILL THEN TRANSITION TO MODE 0 IDLE AND ABSORB POWER AS MUCH AS POSSIBLE FROM THE GRID.			
83	Set EMCS Operation Mode Selector in MODE 7 RESEARCH			
84	Restore process variable BESS_MAXIMUM_OPERATING_RESERVE without override. Confirm on EMCS actual BESS SoC: BESS State of Charge …..... %			
85	Proceed to restore normal operation of pressure transmitter. Confirm on PCS actual measured value of Vessel pressure: 25-PT-035 …..... barg			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
86	On EMCS: - set HNA5 HEALTHY = OFF - confirm that EMCS engages MODE 0 IDLE - confirm that the transition happens without delay - confirm receiving of permissive from PCS - confirm automatic start of BESS - confirm automatic start of Electrolyser Confirm active power absorbed = ……. kW (Expected value ~ 2250 kW including losses) Confirm total load BOP = ……. kW			
87	Confirm PCS start of charging sequence: → open valve 25-XV-004 → start timer T7A = 7 hours Confirm total charging time to reach 30 barg: t = ……. h			
88	Confirm PCS start Water Treatment package			
89	Proceed with HART Communicator to force input process variable = 30 barg and confirm activation of process alarm and automatic stop of Electrolyser. 25-PT-035 ……. barg Confirm active power absorbed = ……. kW (Expected value ~ 1000 kW including losses) Confirm total load BOP = ……. kW			
90	Confirm PCS stop of charging sequence: → close valve 25-XV-004			
91	Confirm PCS stop Water Treatment package			

Step	*Test Step Description*	*Result*	*Verified By*	*Date*
92	Confirm on EMCS new BESS Soc override: BESS State of Charge …..... %			
93	When the actual BESS State of Charge reaches the BESS_MAXIMUM_OPERATING_RESERVE, the BESS will stop charging.			
94	Confirm that EMCS remains in MODE 0 IDLE.			
95	Prepare to simulate reduction of power generated by HNA5 from 4.5 MW to 1.0 MW; → On temporary yard 6.6kV Power Station, maintain operation of n.2 diesel generators and stop operation of n.2 diesel generators.			
96	On EMCS, proceed to adjust HNA5 POWER SIMULATOR SELECTOR to 1 MW. Confirm total load BOP = …..... kW			
97	On EMCS set HNA5 HEALTHY = ON			
98	On EMCS: - confirm that EMCS engages MODE 2 HOT STANDBY - confirm that the transition happens without delay			

5.5.2.3 OTP Worksite SEQUENCE 2 Tests Notes and Remarks

5.5.2.4 OTP Worksite SEQUENCE 2 - Tests Certifying Authority Table of Attendances

Name and Surname	Certifying Authority	Position	Signature

5.5.2.5 OTP WORKSITE SEQUENCE 2 - Tests Final Signatures and Company Acceptance

Name and Surname	Company Representative	Position	Signature

6 OTP TEST STEPS – OFFSHORE SITE

NOT APPLICABLE.

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7 APPENDICES

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7.1 Vendor SAT Procedure

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7.2 Proverlis Summary System Reports

7.3 Equipment Related Technical Queries

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7.4 As Built Documentation

7.5 Management of Change – Summary Table of Tasks and Details of Affected Related Documentation

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