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NON STOP POWER

Battery Energy Storage System (BESS)
BASE LOAD POWER HUB

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Site Acceptance Test (SAT) Procedure J99

for Base Load Power Hub (BLPH) Project

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Document name	Site Acceptance Test (SAT) Procedure
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Version	Date	Name	Description
1.0	2024-12-06	C. Palenzuela	First version

Table 1: Version overview

	Date	Name
Editor	2024-12-06	C. Palenzuela
Checked by	2024-12-06	M. Müller
Approved by	2024-12-06	C. Palenzuela

Table 2: Approval overview

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Identification

Product Version / Document Version

Product version
Prototype

Document release date
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K559-2254-CWIWP4202201-J99-001

Name and Address of Manufacturer

Manufacturer of the product
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Original document

This document is an original document of FREQCON GmbH.

1 Introduction

1.1 About this Document

This document is part of the documentation for the Base Load Power Hub (BLPH) Project (K559-2254). In case of any contradiction resulting by the information or specification given in this document, phase 2 or later documents supersede the information provided in this document.

1.2 Display Elements

Symbol	Meaning
➜	Action with one or several steps for which the sequence is irrelevant.
Step 1 : **Step 2 :**	Action with several steps for which the sequence is relevant.
•	First level of list.
-	Second level of list.

Table 1: Display Elements

1.3 Other Applicable Documents

The following documents are applicable:

Document type	Document Name
SAT Protocol (final version v2.2)	23A2007_241030_SAT_BESS_EN_v2.2

Table 2: Other applicable documents

1.4 Generic Terms and Abbreviations Used

This following list should help you understand some of the abbreviations used in this document.

Generic Term and Abbreviation	Description
BESS	Battery Energy Storage System
BLPH	Base Load Power Hub
FEED	Front End Engineering Design
IGBT	Insulated Gate Bipolar Transistor
PCS	Power Conversion System

Table 3: Generic terms and abbreviations used

2 General

This document provides information about the Site Acceptance Test Procedure conducted on the BESS system during and after commissioning of the system.

The Site Acceptance Test was worked out in close collaboration with the customer and several revisions were made. The final version of the SAT Report is attached to this document and provides detailed information about the SAT procedure (*see section 3*).

3 Appendix

FREQCON

SAT Protocol

Converter & BESS

(Site Acceptance Test)

Version	date	Name	Description of the
Draft	2024-03-26	J. Nitsch C. Palenzuela	First, preliminary version
1.0	2024-10-08	J. Nitsch C. Palenzuela	First, final version
1.1	2024-10-21	J. Nitsch C. Palenzuela	Updated tables
2.0	2024-10-30	M. Jahns C. Palenzuela	Updated document structure
2.1	2024-11-01	C. Palenzuela	Comments implementation and corrections
2.2	2024-11-21		Comments implementation and corrections

Table 1Version overview

	Date	Name
Created by	2024-03-26	J. Nitsch C. Palenzuela
Checked by	2024-03-26	J. Nitsch
Approved by	2024-03-26	C. Palenzuela

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You can also visit our website **at http://www.freqcon.com for** more information on our products and solutions.

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Identification

Product and type designation

Device type
BESS 1 MW / 5MWh

Document number
23A2007_241030_SAT_BESS_EN_v2.0

Name and Address of Manufacturer

Manufacturer of the product
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Original document

This document is an original document of FREQCON GmbH.

1 About this Document

The test report for site acceptance test (SAT) is intended to qualify whether the system fulfils the design requirements and the customer's requirements.

The site acceptance test (SAT) is carried out by specialised personnel after delivery of the system at customer site and the result is checked by the customer.

2 Responsibility

2.1 Responsibility of FREQCON GmbH

- Preparation and review of the acceptance report
- Carrying out the acceptance test (SAT), documentation of the results
- Elimination of identified deviations
- Preparation and review of the acceptance report

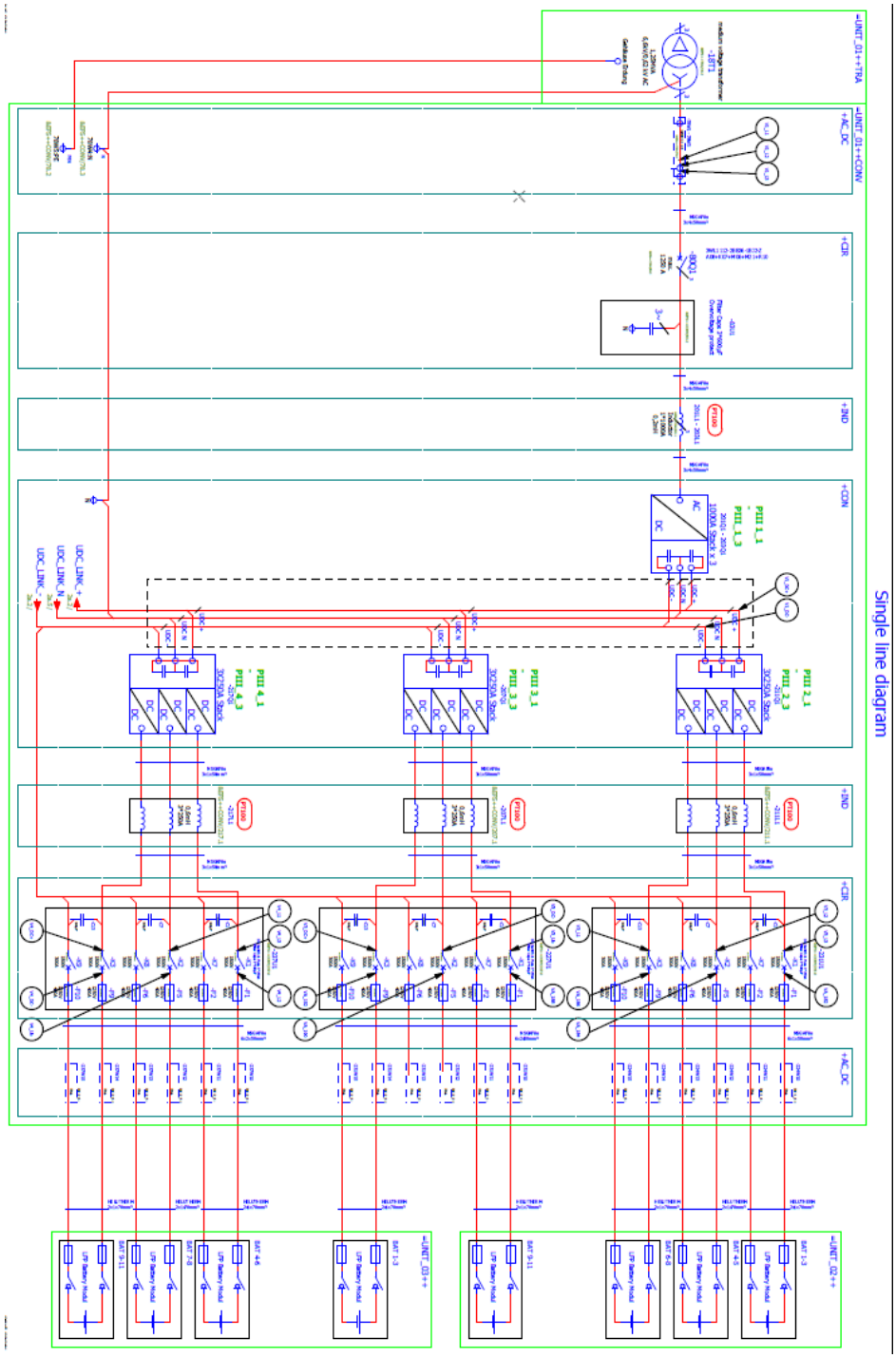
2.2 Responsibility of the customer

- Sending personnel to site, checking the test result and the data
- Approve the SAT protocol

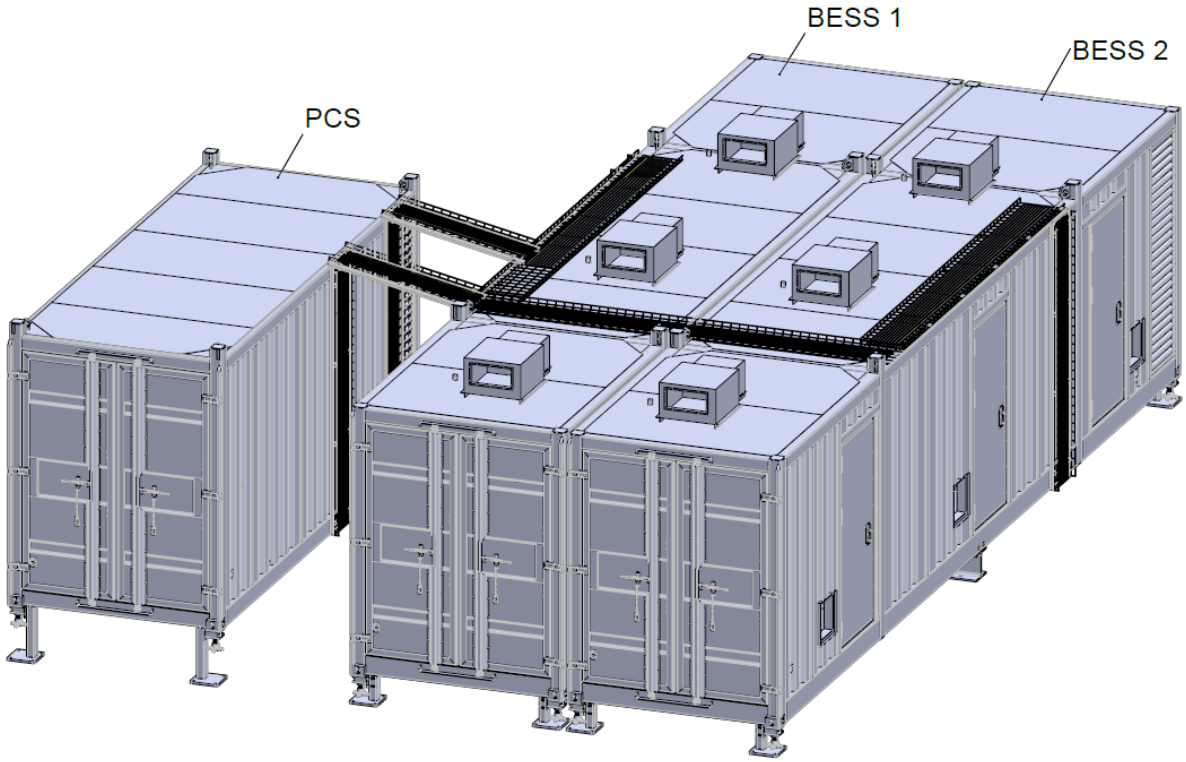
3 Device Description

3.1 Single Line Diagram

Extract from overall schematics “10354_23A2007_CAE_Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_20241105_V1.2”



3.2 General Arrangement



4 PCS (Converter System)

4.1 Reference Documents

These documents are not physically included in this report but are externally available.

Document Title	Document Name
Overall Schematics (print out)	10354_23A2007_CAE_Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_20241105_V1.2
GA drawing as build (print out)	23A2007 BLPH BESS complete system
Operating and maintenance manual (print out)	10354_23A2007_240911_Operating_Manual_BESS_1MW_5 MWh_6.6kV_EN_v0.87
FAT report (external)	23A2007_240708_FAT_BESS_Converter_EN_v2.0_Signed
Profinet interface list	23A2007_240628_PROFINET_Register BESS_V1_0_0_3
FAT punchlist tracker	20240828 - punchlist - FRQ comments v2.4

4.2 PCS Prerequisites

Carefully qualify that this SAT protocol has been approved and the equipment has been inspected by the quality control department. Ensure that all requirements for the SAT are met. And then record the qualification results in the TR01 test report.

The following documents must be available in electronic form or as a printout for the SAT:

1. Circuit diagram of the system
2. Manual in the current version
3. General arrangement overview
4. Interface documentation (if available)

No category A open punch list items are outstanding.

The following power sources are required to perform the activities listed in the following paragraphs. Please ensure the main power source is LOTO before starting operation and follow the correct procedures to power up any circuit.

- 400VAC aux PCS – *auxiliary load BESS B-200 <> 84W2*

Remarks:

4.3 Visual inspection of Control Cabinet 1

Check all system components, including external ones, to ensure that they are in perfect condition. Document the qualification results in the following table.

TR01	Test		Result
4.3.1	**Cleanliness**	**Test Layout:** Check covers and cabinet interior for cleanliness and rust. **Pass Fail Criteria:** Covers and interior are clean, without dirt or rust.	☐ OK ☐ Defects ☐ N/A
4.3.2	**Metal sheets**	**Test Layout:** Check metal sheets for sharp edges and damages **Pass Fail Criteria:** No sharp edges or recognisable damage present.	☐ OK ☐ Defects ☐ N/A
4.3.3	**Wires and cables**	**Test Layout:** Visually inspect cable connections and wires inside the converter cabinets for perfect condition and loose parts. **Pass Fail Criteria:** Cable connections are in perfect condition, no loose parts present.	☐ OK ☐ Defects ☐ N/A
4.3.4	**Compliance with circuit diagram**	**Test Layout:** • Check if main components of the control cabinet are installed in accordance with the circuit diagram. • Check if labelling of the components in the control cabinet corresponds to the circuit diagram (exemplary test of some components). **Pass Fail Criteria:** • Essential parts of the control cabinet are available in accordance with the circuit diagram. • Labelling of the components in the control cabinet corresponds to the circuit diagram. **Reference document:** 10354_23A2007_YYMMDD_Operating_Manual_ Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_EN_vx.x	☐ OK ☐ Defects ☐ N/A
4.3.5	**Touch panel**	**Test Layout:** Check if touch panel of HMI user interface is clean and without damage **Pass Fail Criteria:** The user interface of the touch panel is clean without damage	☐ OK ☐ Defects ☐ N/A
4.3.6	**Punch List Items Closed**	**Test Layout:** Review and confirm no category A open punch list items are outstanding. **Pass Fail Criteria:** No category A open punch list items are outstanding.	☐ OK ☐ Defects ☐ N/A
4.3.7	**LOTO**	**Apply LOTO as required.**	☐ OK ☐ Defects ☐ N/A

Completed by	Witnessed by	Date
Remarks:		

4.4 Visual inspection of Control Cabinet 2

Check all system components, including external ones, to ensure that they are in perfect condition. Document the qualification results in the following table.

TR02	Test		Result
4.4.1	**Cleanliness**	**Test Layout:** Check covers and cabinet interior for cleanliness and rust. **Pass Fail Criteria:** Covers and interior are clean, without dirt or rust.	☐ OK ☐ Defects ☐ N/A
4.4.2	**Metal sheets**	**Test Layout:** Check metal sheets for sharp edges and damages **Pass Fail Criteria:** No sharp edges or recognisable damage present.	☐ OK ☐ Defects ☐ N/A
4.4.3	**Wires and cables**	**Test Layout:** Visually inspect cable connections and wires inside the converter cabinets for perfect condition and loose parts. **Pass Fail Criteria:** Cable connections are in perfect condition, no loose parts present.	☐ OK ☐ Defects ☐ N/A
4.4.4	**Compliance with circuit diagram**	**Test Layout:** • Check if main components of the control cabinet are installed in accordance with the circuit diagram. • Check if labelling of the components in the control cabinet corresponds to the circuit diagram (exemplary test of some components). **Pass Fail Criteria:** • Essential parts of the control cabinet are available in accordance with the circuit diagram. • Labelling of the components in the control cabinet corresponds to the circuit diagram. **Reference document:** 10354_23A2007_YYMMDD_Operating_Manual_Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_EN_vx.x	☐ OK ☐ Defects ☐ N/A
4.4.5	**Punch List Items Closed**	**Test Layout:** Review and confirm no category A open punch list items are outstanding. **Pass Fail Criteria:** No category A open punch list items are outstanding.	☐ OK ☐ Defects ☐ N/A
4.4.6	**LOTO**	**Apply LOTO as required.**	☐ OK ☐ Defects ☐ N/A

Completed by	Witnessed by	Date
Remarks:		

4.5 Visual inspection of Converter Cabinets

Check all system components, including external ones, to ensure that they are in perfect condition. Document the qualification results in the following table.

TR03	Test		Result
4.5.1	Cleanliness	**Test Layout:** **Check covers and cabinet interior for cleanliness and rust.** **Pass Fail Criteria:** **Covers and interior are clean, without dirt or rust.**	**☐ OK** **☐ Defects** **☐ N/A**
4.5.2	Metal sheets	**Test Layout:** **Check metal sheets for sharp edges and damages** **Pass Fail Criteria:** **No sharp edges or recognisable damage present.**	☐ OK ☐ Defects ☐ N/A
4.5.3	Wires and cables	**Test Layout:** **Visually inspect cable connections and wires inside the converter cabinets for perfect condition and loose parts.** **Pass Fail Criteria:** **Cable connections are in perfect condition, no loose parts present.**	☐ OK ☐ Defects ☐ N/A
4.5.4	Control elements description	**Test Layout:** **Check if the operating elements are explained in the operating manual.** **Pass Fail Criteria:** **The operating elements are explained in the operating manual.** **Reference document:** **10354_23A2007_YYMMDD_Operating_Manual_ Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_EN_vx.x**	☐ OK ☐ Defects ☐ N/A
4.5.5	Punch List Items Closed	**Test Layout:** **Review and confirm no category A open punch list items are outstanding.** **Pass Fail Criteria:** **No category A open punch list items are outstanding.**	☐ OK ☐ Defects ☐ N/A
4.5.6	LOTO	**Apply LOTO as required.**	☐ OK ☐ Defects ☐ N/A

Completed by	Witnessed by	Date
Remarks:		

4.6 Visual Inspection of Converter Cooling System and Heat Exchanger

Check the correct installation and connection of the cooling system. Document the qualification results in the following table.

TR04	Test		Result
4.6.1	**Water drop check**	**Test Layout:** Check that no drops of water can be seen at the connection points of the coolant hoses. **Pass Fail Criteria:** No water on the connection points of coolant hoses.	☐ OK ☐ Defects ☐ N/A
4.6.2	**Heat exchanger visual inspection**	**Test Layout:** Check the external heat exchanger for proper connection and mechanical stability. **Pass Fail Criteria:** Heat exchanger is properly mechanically installed	☐ OK ☐ Defects ☐ N/A
4.6.3	**I/O check**	**Test Layout:** Check the electrical connection to the Heat exchanger unit **Pass Fail Criteria:** Heat exchanger is properly connected	☐ OK ☐ Defects ☐ N/A

Completed by	Witnessed by	Date
Remarks:		

4.7 Power On

Sequentially power on all the subsystems. Document the qualification results in the following table.

Please refer to the SLD on page 1a and 2a of the overall schematics for PCS:
10354_23A2007_CAE_Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_20241105_V1.2

Note:
Prior to carrying out any work, the commissioning engineer to check the current version of the reference document is available.

TR05	Test		Result
4.7.1	**Check LOTO of subsystem**	**Test Layout:** Check that all breakers feeding subsystems are turned to OFF position and LOTO **Pass Fail Criteria:** LOTO confirmed	☐ OK ☐ Defects ☐ N/A
4.7.2	**Remove LOTO from main feeding source (RM board)**	**Test Layout:** Remove LOTO from main feeding source and measure voltage across incoming cable. **Pass Fail Criteria:** Voltage is read at incoming feeding terminals.	☐ OK ☐ Defects ☐ N/A
4.7.3	**Supply voltage control cabinet**	**Test Layout:** Switch on 190F3 **Pass Fail Criteria:** Cabinet lights and socket power up	☐ OK ☐ Defects ☐ N/A
4.7.4	**Supply voltage control cabinet**	**Test Layout:** Switch on 191F1 **Pass Fail Criteria:** Clima 1 power up	☐ OK ☐ Defects ☐ N/A
4.7.5	**Supply voltage control cabinet**	**Test Layout:** Switch on 191F2 **Pass Fail Criteria:** Clima 2 power up	☐ OK ☐ Defects ☐ N/A
4.7.6	**Supply voltage control cabinet**	**Test Layout:** Switch on 101Q1. The control unit starts up properly. **Pass Fail Criteria:** Pass: - Simotion turns on - HMI turns on properly and WebVisualization (WebVisu) access is active Access to Simotion WebVisu is established and “Run” state of Simotion can be confirmed	☐ OK ☐ Defects ☐ N/A
4.7.7	**Supply voltage control cabinet**	**Test Layout:** Remove LOTO and switch on 84F2 **Pass Fail Criteria:** Voltage read at feeding terminals	☐ OK ☐ Defects ☐ N/A
4.7.8	**Supply voltage control cabinet**	**Test Layout:** Switch on 183F1	

TR05	Test		Result
		Pass Fail Criteria: No breaker trip or issue and Relative circuit power up	☐ OK ☐ Defects ☐ N/A
4.7.9	**Supply voltage control cabinet**	**Test Layout:** Switch on 183F2 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up	☐ OK ☐ Defects ☐ N/A
4.7.10	**Supply voltage control cabinet**	**Test Layout:** Switch on 185F1 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up	☐ OK ☐ Defects ☐ N/A
4.7.11	**Supply voltage control cabinet**	**Test Layout:** switch on 185F2 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up	☐ OK ☐ Defects ☐ N/A
4.7.12	**Supply voltage control cabinet**	**Test Layout:** Switch on 187F1 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up	☐ OK ☐ Defects ☐ N/A
4.7.13	**Supply voltage control cabinet**	**Test Layout:** Switch on 181Q1 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up	☐ OK ☐ Defects ☐ N/A
4.7.14	**Supply voltage control cabinet**	**Test Layout:** Switch on 181Q2 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up	☐ OK ☐ Defects ☐ N/A
4.7.15	**Supply voltage control cabinet**	**Test Layout:** Switch on 182Q1 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up	☐ OK ☐ Defects ☐ N/A

Completed by	Witnessed by	Date
Remarks:		

4.8 Software and Function Tests

Check the following software functions. Document the qualification results in the following table.

TR06	Test		Result	Completed by	Witnessed by	Date
4.8.1	**Leakage and connections check**	**Test Layout:** Check the converter water cooling system for proper connection and leaks. Run cooling system and perform visual check of connections and check for leaks **Pass Fail Criteria:** All connections are properly connected and no leakage present.	☐ OK ☐ Defects ☐ N/A			
4.8.2	**Pressure check**	**Test Layout:** Check whether the pressure of the cooling system is above 3 bar. Check on the manometer of the converter cooling system cabinet (COSY) and verify value on HMI/WebVisu. **Pass Fail Criteria:** Manometer and HMI/WebVisu indicate a pressure of 3 bar.	☐ OK ☐ Defects ☐ N/A			
4.8.3	**Check pre-heating** **4.5 FAT**	**Test Layout:** Connecting the converter via interface: • Check the pre-heating of the converter for proper functionality • Check the pre-charge and DC link control for proper functionality **Pass Fail Criteria:** - Heat exchanger switches on and off correctly (visual check) - Preheating status is correctly indicated by the HMI/WebVisu. - Pump is running (visual check) - Heater is heating up the coolant (check coolant temperature on HMI/WebVisu)	☐ OK ☐ Defects ☐ N/A			
4.8.4	**UPS** **4.13 FAT**	**Test Layout:** Checking the UPS functionality. If the auxiliary supply fails (e.g. by activating the fuse of the AC power supply unit), the control cabinet continues to be supplied by the UPS. **Pass Fail Criteria:** After the defined time, the control cabinet is switched off completely. When the voltage returns, the control unit starts up again and the UPS battery is charged.	☐ OK ☐ Defects ☐ N/A			
4.8.5	**Smoke detectors**	**Test Layout:** Test the smoke detector in PCS CON-cabinet with test spray.				

TR06	Test		Result	Completed by	Witnessed by	Date
		Pass Fail Criteria: The smoke detectors trigger accordingly and an error (Error level 4) is generated.	☐ OK ☐ Defects ☐ N/A			
4.8.6	**Communication test interface signals FREQCON->Customers**	**Test Layout:** Connecting communication interface to customer higher level controller. Transferring status signals to customer via comm interface. Check all signals listed in the comm interface list. **Reference document:** 23A2007_240628_PROFINET_Register BESS_V1_0_0_3	☐ OK ☐ Defects ☐ N/A			
		Pass Fail Criteria: The transmitted signals received via Profinet interface is plausible and correct.				
4.8.7	**Communication test interface signals Customer->Freqcon**	**Test Layout:** Connecting Profinet interface to customer higher level controller. Transferring control signals from customer higher level controller to BESS main controller via Profinet interface. Check all signals listed in the comm interface list. **Reference document:** 23A2007_240628_PROFINET_Register BESS_V1_0_0_3	☐ OK ☐ Defects ☐ N/A			
		Pass Fail Criteria: The transmitted signals received via Profinet interface are plausible and lead to foreseen behaviour.				

Remarks:

5 BESS 1 and 2

5.1 Reference Documents

These documents are not physically included in this report but are externally available.

Document Title	Document Name
Overall Schematics (print out)	10354_23A2007_CAE_Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_20241105_V1.2
GA drawing as build (print out)	23A2007 BLPH BESS complete system
Operating and maintenance manual (print out)	10354_23A2007_240911_Operating_Manual_BESS_1MW_5 MWh_6.6kV_EN_v0.87
FAT report (external)	23A2007_240708_FAT_BESS_Converter_EN_v2.0_Signed
Profinet interface list	23A2007_240628_PROFINET_Register BESS_V1_0_0_3
FAT punchlist tracker	20240828 - punchlist - FRQ comments v2.4

5.2 BESS Prerequisites

Carefully qualify that this SAT protocol has been approved and the equipment has been inspected by the quality control department. Ensure that all requirements for the SAT are met. And then record the qualification results in the TR0x test report.

The following documents must be available in electronic form or as a printout for the SAT:

1. Circuit diagram of the system
2. Manual in the current version
3. General arrangement overview
4. Interface documentation (if available)

No category A open punch list items are outstanding. Any re-work on the electrical installation is completed.

- LOTO equipment
- Gas test spray equipment

The following power sources are required to perform the activities listed in the following paragraphs. Please ensure the main power source is LOTO before starting operation and follow the correct procedures to power up any circuit.

- 400 VAC Aux BESS – auxiliary load BESS B-200 <> 84W2
- Temporary 230 V AC Multiple socket outlet (e.g. to supply Laptop, temporary lights etc.)

Remarks:

5.3 Container Visual Inspection BESS 1

Check all system parts, including external and internal parts, to ensure that they are in perfect condition. Document the qualification results in the following table.

TR07	Examination		Result
5.3.1	**Damage**	The container is free of dents and unusual rust (minor rust spots, e.g. on crane eyes, are unavoidable)	☐ OK ☐ Defects ☐ N/A
5.3.2	**Earthing connections**	The earthing lugs are in the correct position (compare CAD) and are not painted	☐ OK ☐ Defects ☐ N/A
5.3.3	**Warnings**	The required warning signs are located on the personnel doors	☐ OK ☐ Defects ☐ N/A
5.3.4	**Accessibility**	The clearances in the container correspond to the CAD. All enclosure doors are in the correct position and accessible	☐ OK ☐ Defects ☐ N/A
5.3.5	**Installation of components and cables in the container**	All components such as switch cabinets, cable trays, air conditioning units, etc. are properly installed and cannot fall or tip over.	☐ OK ☐ Defects ☐ N/A
5.3.6	**Cable bushings**	All cable ducts are present (possibly not fitted) and comply with the client's specification. Covers, cable bushings or similar are available for all openings in the container	☐ OK ☐ Defects ☐ N/A
5.3.7	**LOTO**	**Apply LOTO as required.**	☐ OK ☐ Defects ☐ N/A

5.4 Container Visual Inspection BESS 2

Check all system parts, including external and internal parts, to ensure that they are in perfect condition. Document the qualification results in the following table.

TR08	Examination		Result
5.4.1	**Damage**	The container is free of dents and unusual rust (minor rust spots, e.g. on crane eyes, are unavoidable)	☐ OK ☐ Defects ☐ N/A
5.4.2	**Earthing connections**	The earthing lugs are in the correct position (compare CAD) and are not painted	☐ OK ☐ Defects ☐ N/A
5.4.3	**Warnings**	The required warning signs are located on the personnel doors	☐ OK ☐ Defects ☐ N/A
5.4.4	**Accessibility**	The clearances in the container correspond to the CAD. All enclosure doors are in the correct position and accessible	☐ OK ☐ Defects ☐ N/A
5.4.5	**Installation of components and cables in the container**	All components such as switch cabinets, cable trays, air conditioning units, etc. are properly installed and cannot fall or tip over.	☐ OK ☐ Defects ☐ N/A
5.4.6	**Cable bushings**	All cable ducts are present (possibly not fitted) and comply with the client's specification. Covers, cable bushings or similar are available for all openings in the container	☐ OK ☐ Defects ☐ N/A
5.4.7	**LOTO**	Apply LOTO as required.	☐ OK ☐ Defects ☐ N/A

Completed by	Witnessed by	Date
Remarks:		

5.5 Power On BESS 1

Sequentially power on all the subsystems. Document the qualification results in the following table.

Please refer to the SLD on page 1a and 2a of the overall schematics for battery container 1:
10354_23A2007_CAE_Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_20241105_V1.2

Note:
Prior to carrying out any works, the commissioning engineer to check the current version of the reference document is available.

TR09	Test		Result
5.5.1	**Compliance with circuit diagram**	**Test Layout:** • Check if main components of the control cabinet are installed in accordance with the circuit diagram. Check if labelling of the components in the control cabinet corresponds to the circuit diagram (exemplary test of some components). **Pass Fail Criteria:** • Essential parts of the control cabinet are available in accordance with the circuit diagram. • Labelling of the components in the control cabinet corresponds to the circuit diagram. **Reference document:** 10354_23A2007_CAE_Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_20241105_V1.2	☐ OK ☐ Defects ☐ N/A
5.5.2	**Check LOTO of subsystem**	**Test Layout:** Check that all breakers feeding subsystems are turned to OFF position and LOTO **Pass Fail Criteria:** LOTO confirmed	☐ OK ☐ Defects ☐ N/A
5.5.3	**Remove LOTO from main feeding source (RM Board)**	**Test Layout:** Remove LOTO from main feeding source and measure voltage across incoming cable. **Pass Fail Criteria:** Voltage is read at incoming feeding terminals.	☐ OK ☐ Defects ☐ N/A
5.5.4	**Remove LOTO from main feeding source**	**Test Layout:** Remove LOTO and switch on 684F1. **Pass Fail Criteria:** Voltage read at downstream feeding terminals.	☐ OK ☐ Defects ☐ N/A
5.5.5	**Supply voltage**	**Test Layout:** Switch on 690F1 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up (container lights)	☐ OK ☐ Defects ☐ N/A
5.5.6	**Supply voltage**	**Test Layout:** Switch on 690F2	

TR09	Test		Result
		Pass Fail Criteria: No breaker trip or issue and Relative circuit power up (sockets)	☐ OK ☐ Defects ☐ N/A
5.5.7	**Supply voltage**	**Test Layout:** Switch on 690F3, 690F4, 690F5 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up (cranes)	☐ OK ☐ Defects ☐ N/A
5.5.8	**Supply voltage**	**Test Layout:** Switch on 101Q1. The control unit starts up properly. **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up (DC power supply)	☐ OK ☐ Defects ☐ N/A
5.5.9	**Supply voltage**	**Test Layout:** Switch on 691F4 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up (cooling units)	☐ OK ☐ Defects ☐ N/A
5.5.10	**Supply voltage**	**Test Layout:** Remove LOTO and switch on 684F3 **Pass Fail Criteria:** Voltage read at downstream feeding terminals	☐ OK ☐ Defects ☐ N/A
5.5.11	**Supply voltage**	**Test Layout:** Switch on 691F1, 691F2, 691F3 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up (emergency ventilation and louvers)	☐ OK ☐ Defects ☐ N/A
5.5.12	**Supply voltage**	**Test Layout:** Remove LOTO and switch on 684F4 **Pass Fail Criteria:** Voltage read at downstream feeding terminals	☐ OK ☐ Defects ☐ N/A
5.5.13	**Supply voltage**	**Test Layout:** Sequentially switch on 687F1, 687F2, 687F3, 687F4, 687F5, 687F6, 688F1, 688F2, 688F3, 688F4, 688F5 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up	☐ OK ☐ Defects ☐ N/A

Completed by	Witnessed by	Date
Remarks:		

5.6 Power On BESS 2

Sequentially power on all the subsystem. Document the qualification results in the following table.

Please refer to the SLD on page 1a and 2a of the overall schematics for Battery Container 2:
10354_23A2007_CAE_Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_20241105_V1.2

Note:
Prior to carrying out any works, the commissioning engineer to check the current version of the reference document is available.

TR10	Test		Result
5.6.1	**Compliance with circuit diagram**	**Test Layout:** • Check if main components of the control cabinet are installed in accordance with the circuit diagram. Check if labelling of the components in the control cabinet corresponds to the circuit diagram (exemplary test of some components). **Pass Fail Criteria:** • Essential parts of the control cabinet are available in accordance with the circuit diagram. • Labelling of the components in the control cabinet corresponds to the circuit diagram. **Reference document:** 10354_23A2007_CAE_Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_20241105_V1.2	☐ OK ☐ Defects ☐ N/A
5.6.2	**Check LOTO of subsystem**	**Test Layout:** Check that all breakers feeding subsystems are turned to OFF position and LOTO **Pass Fail Criteria:** LOTO confirmed	☐ OK ☐ Defects ☐ N/A
5.6.3	**Remove LOTO from main feeding source (RM Board)**	**Test Layout:** Remove LOTO from main feeding source and measure voltage across incoming cable. **Pass Fail Criteria:** Voltage is read at incoming feeding terminals.	☐ OK ☐ Defects ☐ N/A
5.6.4	**Remove LOTO from main feeding source**	**Test Layout:** Remove LOTO and switch on 684F1. **Pass Fail Criteria:** Voltage read at downstream feeding terminals.	☐ OK ☐ Defects ☐ N/A
5.6.5	**Supply voltage**	**Test Layout:** Switch on 690F1 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up (container lights)	☐ OK ☐ Defects ☐ N/A
5.6.6	**Supply voltage**	**Test Layout:** Switch on 690F2	

TR10	Test		Result
		Pass Fail Criteria: No breaker trip or issue and Relative circuit power up (sockets)	☐ OK ☐ Defects ☐ N/A
5.6.7	**Supply voltage**	**Test Layout:** Switch on 690F3, 690F4, 690F5 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up (cranes)	☐ OK ☐ Defects ☐ N/A
5.6.8	**Supply voltage**	**Test Layout:** Switch on 101Q1. The control unit starts up properly. **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up (DC power supply)	☐ OK ☐ Defects ☐ N/A
5.6.9	**Supply voltage**	**Test Layout:** Switch on 691F4 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up (cooling units)	☐ OK ☐ Defects ☐ N/A
5.6.10	**Supply voltage**	**Test Layout:** Remove LOTO and switch on 684F3 **Pass Fail Criteria:** Voltage read at downstream feeding terminals	☐ OK ☐ Defects ☐ N/A
5.6.11	**Supply voltage**	**Test Layout:** Switch on 691F1, 691F2, 691F3 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up (emergency ventilation and louvers)	☐ OK ☐ Defects ☐ N/A
5.6.12	**Supply voltage**	**Test Layout:** Remove LOTO and switch on 684F4 **Pass Fail Criteria:** Voltage read at downstream feeding terminals	☐ OK ☐ Defects ☐ N/A
5.6.13	**Supply voltage**	**Test Layout:** Sequentially switch on 687F1, 687F2, 687F3, 687F4, 687F5, 687F6, 688F1, 688F2, 688F3, 688F4, 688F5 **Pass Fail Criteria:** No breaker trip or issue and Relative circuit power up	☐ OK ☐ Defects ☐ N/A

Completed by	Witnessed by	Date
Remarks:		

5.7 Function and Safety Critical Tests BESS 1, BESS 2 and PCS

Check system components of all battery cabinets (one cabinet in each container section) inside BESS 1 and 2 container and the following software functions. Document the qualification results in the following table.

Please refer to Appendix for the cause and effect description for the different detectors/sensors.

TR11	Test		Result	Completed by	Witnessed by	Date
5.7.1	**Check smoke detectors BESS 1**	**Test Layout:** Use test spray to trigger the sensor. **Pass Fail Criteria:** TR/gas event was simulated and - All battery cabinets decoupled from PCS - 80Q1 (Main AC breaker) opened - Air dampers are working - All exhaust system units in container roofs are operating - TR successfully transmitted to higher level controller via hard wired signal	☐ OK ☐ Defects ☐ N/A			
5.7.2	**Check CO detectors BESS 1**	**Test Layout:** Use test spray to trigger the sensor. **Pass Fail Criteria:** TR/gas event was simulated and - All battery cabinets decoupled from PCS - 80Q1 (Main AC breaker) opened - Air dampers are working - All exhaust system units in container roofs are operating - TR successfully transmitted to higher level controller via hard wired signal	☐ OK ☐ Defects ☐ N/A			
5.7.3	**Check H2 BESS 1**	**Test Layout:** Check the correct functionality of the H2 exhaust system (detection and gas removal) in case of TR/gas event. Sample gas trigger. Check correct behaviour of the BESS: - All battery cabinets decouple from PCS DC side - 80Q1 (Main AC breaker) opens - Air dampers are working - All exhaust system units in container roofs are operating - Fire&Gas is transmitted to higher level controller via hard wired signal	☐ OK ☐ Defects ☐ N/A			

TR11	Test		Result	Completed by	Witnessed by	Date
		Pass Fail Criteria: TR/gas event was simulated and - All battery cabinets decoupled from PCS - 80Q1 (Main AC breaker) opened - Air dampers are working - All exhaust system units in container roofs are operating - F&G successfully transmitted to higher level controller via hard wired signal				
5.7.4	**Check smoke detectors BESS 2**	**Test Layout:** Use test spray to trigger the sensor. **Pass Fail Criteria:** TR/gas event was simulated and - All battery cabinets decoupled from PCS - 80Q1 (Main AC breaker) opened - Air dampers are working - All exhaust system units in container roofs are operating - TR successfully transmitted to higher level controller via hard wired signal	☐ OK ☐ Defects ☐ N/A			
5.7.5	**Check CO detectors BESS 2**	**Test Layout:** Use test spray to trigger the sensor. **Pass Fail Criteria:** TR/gas event was simulated and - All battery cabinets decoupled from PCS - 80Q1 (Main AC breaker) opened - Air dampers are working - All exhaust system units in container roofs are operating - TR successfully transmitted to higher level controller via hard wired signal	☐ OK ☐ Defects ☐ N/A			

TR11	Test		Result	Completed by	Witnessed by	Date
5.7.6	**Check H2 BESS 2**	**Test Layout:** Check the correct functionality of the H2 exhaust system (detection and gas removal) in case of TR/gas event. Sample gas trigger. Check correct behaviour of the BESS: - All battery cabinets decouple from PCS DC side - 80Q1 (Main AC breaker) opens - Air dampers are working - All exhaust system units in container roofs are operating - Fire&Gas is transmitted to higher level controller via hard wired signal	☐ OK ☐ Defects ☐ N/A			
		Pass Fail Criteria: TR/gas event was simulated and - All battery cabinets decoupled from PCS - 80Q1 (Main AC breaker) opened - Air dampers are working - All exhaust system units in container roofs are operating - F&G successfully transmitted to higher level controller via hard wired signal				

6 Battery Modules

6.1 Reference Documents

These documents are not physically included in this report but are externally available.

Document Title	Document Name
Overall Schematics (print out)	10354_23A2007_CAE_Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_20241105_V1.2
GA drawing as build (print out)	23A2007 BLPH BESS complete system
Operating and maintenance manual (print out)	10354_23A2007_240911_Operating_Manual_BESS_1MW_5 MWh_6.6kV_EN_v0.87
FAT report (external)	23A2007_240708_FAT_BESS_Converter_EN_v2.0_Signed
Profinet interface list	23A2007_240628_PROFINET_Register BESS_V1_0_0_3

6.2 Prerequisites

Carefully qualify that this SAT protocol has been approved and the equipment has been inspected by the quality control department. Ensure that all requirements for the SAT are met. And then record the qualification results in the TR12 test report.

The following documents must be available in electronic form or as a printout for the SAT:

1. Circuit diagram of the system
2. Manual in the current version
3. General arrangement overview
4. Interface documentation (if available)

No category A open punch list items are outstanding. Any re-work on the electrical installation is completed.

The following power sources are required to perform the activities listed in the following paragraphs. Please ensure the main power source is LOTO before starting operation and follow the correct procedures to power up any circuit.

- 400 VAC aux BESS – *auxiliary load BESS B-200 <> 84W2*

Note – the battery modules have been tested after assembly for quality assessment (reports available) and have been tested for functionality and capacity prior to shipping (reports available).

Remarks:

6.3 Installation Report

Check the correct installation and connection of the battery modules in the BESS 1 and BESS 2 containers. Document the qualification results in the following table.

TR12	Test		Result	Completed by	Witnessed by	Date
6.3.1	**Installation report for cabinets**	**Test Layout:** Report issued for the following racks: BESS 1 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 BESS 2 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 **Pass Fail Criteria:** All cabinets have been checked and report is available	☐ OK ☐ Defects ☐ N/A			
6.3.2	**LOTO**	Check DC fused are disconnected.	☐ OK ☐ Defects ☐ N/A			

7 System Tests

7.1 Reference Documents

These documents are not physically included in this report but are externally available.

Document Title	Document Name
Overall Schematics (print out)	10354_23A2007_CAE_Statron_Shell Crosswind BESS FQ 1MW 5MWh Offshore_20241105_V1.2
GA drawing as build (print out)	23A2007 BLPH BESS complete system
Operating and maintenance manual (print out)	10354_23A2007_240911_Operating_Manual_BESS_1MW_5 MWh_6.6kV_EN_v0.87
FAT report (external)	23A2007_240708_FAT_BESS_Converter_EN_v2.0_Signed
Profinet interface list	23A2007_240628_PROFINET_Register BESS_V1_0_0_3

7.2 Prerequisites

Carefully qualify that this SAT protocol has been approved and the equipment has been inspected by the quality control department. Ensure that all requirements for the SAT are met. And then record the qualification results in the TR0x test report.

The following documents must be available in electronic form or as a printout for the SAT:

1. Circuit diagram of the system
2. Manual in the current version
3. General arrangement overview
4. Interface documentation (if available)

No category A open punch list items are outstanding. Any re-work on the electrical installation is completed.

The following power sources are required to perform the activities listed in the following paragraphs. Please ensure the main power source is LOTO before starting operation and follow the correct procedures to power up any circuit.

- 400VAC aux BESS – *auxiliary load BESS B-200 <> 84W2*
- 6.6 kV AC
- (FREQCON) power meter needs to be connected to AC busbars for voltage measurement before energization

Remarks:

7.1 Software and Function Tests

Check the following software functions. Document the qualification results in the following table.

Note – in the event that BLPH control system connections are not available at this time, consideration must be given to implement temporary safety measures e.g. use of local temporary pushbutton in lieu of no trip signal from BLPH control system. To be fully risk assessed at site prior to any implementation.

TR13	Test		Result	Completed by	Witnessed by	Date
7.1.1	**LOTO main connection and electro mechanical lock in place**	**Test Layout:** Confirm BESS AC connection is LOTO and captive key to earth the transformer is available before energizing the system. Confirm all system mains (80Q1) is open. **Pass Fail Criteria:** Transformer connections are correct. Captive key is retrieved, transformer is grounded. 80Q1 open.	☐ OK ☐ Defects ☐ N/A			
7.1.2	**Transformer inspection**	**Test Layout:** MV and LV connections are completed and according to as built electrical drawings. After visual inspection, lock the door and extract the captive key for energization. **Pass Fail Criteria:** Transformer connections are correct. Key is available for energization	☐ OK ☐ Defects ☐ N/A			
7.1.3	**Energize AC connection**	**Test Layout:** Energize main AC connection. - Transformer is energized - Turn on mains (80Q1). **Pass Fail Criteria:** Inverter units energized, no unexpected trips.	☐ OK ☐ Defects ☐ N/A			
7.1.4	**Check pre-charging and DC link control** **4.7 FAT**	**Test Layout:** Connecting the converter via interface: • Check the pre-charge and DC link control for proper functionality **Pass Fail Criteria:** **Precharge:** - Precharging process is indicated by HMI/WebVisu. - After precharging process is done, the green “Ready for Operation” is indicated by HMI/WebVisu. **DC Link Control:** - Verify correct DC-link voltage level was successfully reached and held via HMI/WebVisu.	☐ OK ☐ Defects ☐ N/A			

TR13	Test		Result	Completed by	Witnessed by	Date
7.1.5	Check IGBTs	**Test Layout:** Check IGBT activation. **Pass Fail Criteria:** - IGBTs can be switched without any problems - Operating status is indicated by by HMI/WebVisu.	☐ OK ☐ Defects ☐ N/A			
7.1.6	Check DC ports	**Duration: After reaching 250 A test duration is 10 min.** **Test Layout:** **<u>DC ports:</u>** Connection to customer AC mains is performed in order to work AC power. Each port will be charged with 250 kW which corresponds to a current of 250 A. DC ports connection Increase the DC current setpoint slowly to 250 A and keep this value for 10 minutes. **<u>Heat run:</u>** Check if temperatures of - IGBTs - Inductors - Coolant of converter cooling system are within the permissible ranges by verifying the temperature values displayed on the HMI/WebVisu. **Pass Fail Criteria:** **<u>DC Ports:</u>** DC current output of 250 A is displayed on the HMI/WebVisu according to setpoint. **<u>Heat Run:</u>** IGBT, inductor and converter cooling system coolant temperatures are below the temperature thresholds set in the control system.	☐ OK ☐ Defects ☐ N/A			

TR13	Test		Result	Completed by	Witnessed by	Date
7.1.7	**Check DC port current/offset control**	**Test Layout:** Check the DC port current control / offset control and check for oscillations.	☐ OK ☐ Defects ☐ N/A			
		Pass Fail Criteria: Oscillations are within the permissible range of +/- 10% of 250A.				
7.1.8	**Check temperature values**	**Test Layout:** Check all temperature values displayed on the HMI/WebVisu for plausibility.	☐ OK ☐ Defects ☐ N/A			
		Pass Fail Criteria: The temperature values indicated on the HMI/WebVisu are plausible. IGBTs: 30 … 65 °C Inductors: 30 … 120°C Cooling water: 27 … 55 °C				
7.1.9	**Measurements** **4.11 FAT**	**Test Layout:** Check if the measured values (voltages and currents) are properly collected by the Simotion (PCS main controller) and verify by using a multimeter or current clamp at DC and AC side.	☐ OK ☐ Defects ☐ N/A			
		Pass Fail Criteria: Values measured with multimeter correspond +/-5% to the values displayed on the HMI/WebVisu.				
7.1.10	**Check temperature derating functionality**	**Test Layout:** Check the temperature derating for proper functionality. For this purpose, lower the temperature setpoints.	☐ OK ☐ Defects ☐ N/A			
		Pass Fail Criteria: PCS lowers power according to the set derating thresholds.				
7.1.11	**Switching-off** **4.12 FAT**	**Test Layout:** Switching off the inverter. The inverter is properly switched off by removing the control bits.	☐ OK ☐ Defects ☐ N/A			
		Pass Fail Criteria: “OFF” state is indicated by the HMI/WebVisu.				

TR13	Test		Result	Completed by	Witnessed by	Date
7.1.12	**Battery capacity test**	**Test Layout:** Capacity test / load test as required. Check the temperature behavior of the converter system during the test. Make sure plots include: - Power AC - Power DC - Voltage DC - Cell voltage max and min - Cell temp max and min - Room temperatures - Filter temperature - SOC **Pass Fail Criteria:** Capacity was successfully reached without power derating and all temperatures in acceptable ranges.	☐ OK ☐ Defects ☐ N/A			
7.1.13	**Performance Test** **AC output**	**Test Layout:** **Duration: After reaching 1000 A duration test of 10 min.** **Test Layout:** Increase the AC current setpoint value slowly to 1000 A output and keep this value for 10 minutes. **Pass Fail Criteria:** AC current output of 1000 A is displayed correctly on the HMI/WebVisu according to setpoint.	☐ OK ☐ Defects ☐ N/A			

8 Employees Present

Identify each employee involved in the execution of this protocol. Document the employee 's name, signature, name abbreviation and date in the following table:

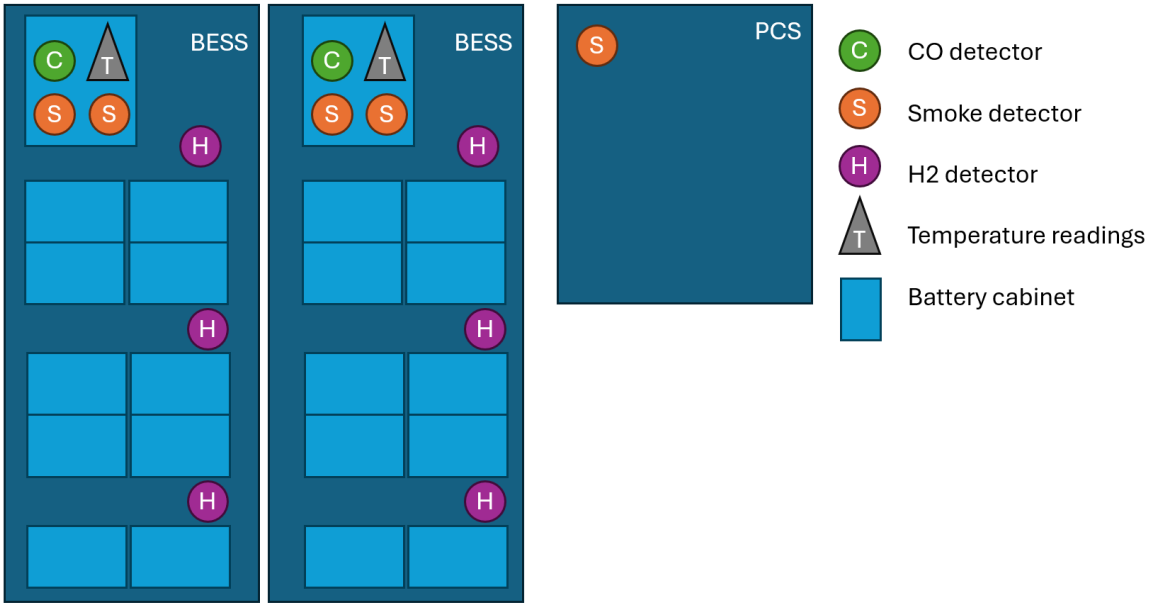
Company Name	Employee Name	Employee Signature	Abbreviation	Date

	Yes/No
All persons involved in the SAT were documented.	☐ Y ☐ N

Remarks:

9 Appendix

9.1 Fire and Gas Cause and Effect



Simplified representation of the location of different components within the BESS system.

9.1.1 PCS container

1x smoke detector – trigger 1-out-of-1 – it can be reset remotely.
Once triggered it sends 85-XA-002 (confirmed smoke) hardwired signal to EMCS.
PCS Control Cabinet XT1-3&4

9.1.2 BESS container

3x H2 detectors – trigger is 2-out-of-3.
It generates 85-XA-001 (confirmed gas) hardwired signal to EMCS.
PCS Control Cabinet XT1-1&2

9.1.3 BESS cabinets (1 to 11 in each container) - independent reaction

1x CO detector – trigger is 1-out-of-1
2x Smoke detectors – trigger is 2-out-of-2
Module Temperature reading (from BMS) – trigger is > 60°C
They generate 85-XA-004 (Confirmed Thermal Runaway) hardwired signal to EMCS
Note: each detector type works independently. The first one to reach the triggers conditions will activate the HW signal to EMCS.

10 Check and Approval

The SAT protocol becomes the SAT report when it has been completed as the individual test reports have been completed and labelled with a test date. The SAT report is submitted to the customer for confirmation and the results must be documented in TR14.

TR14	**Examination and authorisation of execution**
Check the test results and the original data. Final assessment for SAT	
□ PASS	□ NOT PASSED
If there are any unresolved discrepancies, please fill in the following “remarks” table.	
Specify whether or not these unresolved discrepancies may affect the completion of the SAT.	
□ YES	□ NO

Remarks:

Carried out by:		Date:	
	FREQCON GmbH		YYYY/MM/DD
Authorised by:		Date:	
	Customer		YYYY/MM/DD