Ballard Power Systems Europe A/S
Majsmarken 1
9500 Hobro
Denmark

Revision history		
Rev.	**Date.**	**Description**
001	16/01/2025	First Issue

Document Title:	**BLPH Project -EN 60204 Electrical safety test 40ft**
Document Number:	K559-2254-CWIWP4202202-J99-7-007
Revision:	Rev001
Sequence Number:	007
File Name:	K559-2254-CWIWP4202202-J99-7-007Rev001
Purchaser Job:	K559-2254
Purchase Order:	CWIWP4202202
Code:	J99-7
Requsition Number:	n/a
Customer:	CrossWind C.V., Rotterdam, The Netherlands

Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

1. Introduction

The Megablock system contains many components utilizing potentially dangerous voltages and currents. It is a safety requirement that the electrical safety is tested before a product is shipped.

The testing is done according to the standard EN60204-1 Chapter 18, from which the tests in this document are described with room to note test results.

2. Revision Record

Rev #	Author	Description	Revised By	Date
1.0	PBL	Initial Release		09/11-2023
2.0	PBL	Adapted from 40ft Coolant Skid document		04/07-2024
3.0	CJA	Adapted from 10ft power converter container document		15/10-2024
4.0	RKN	General review		09/01-2025

3. List of Figures

Figure 1 – Excerpt from EN60204-1:2018, Chapter 18.1 3
Figure 2 – EN60204-1:2018, Chapter 18.1 5
Figure 3 – EN60204-1:2018, Chapter 18.2.2 6
Figure 4 – EN60204-1:2018, Chapter 18.2 7
Figure 5 – EN60204-1:2018, Chapter 18.3 9
Figure 6 – EN60204-1:2018, Chapter 18.4 10
Figure 7 – EN60204-1:2018, Chapter 18.5 11
Figure 8 – EN60204-1:2018, Chapter 6.2.4 11
Figure 9 – EN60204-1:2018, Chapter 8.2.6 12

4. List of Tables

Table 1 – References 2
Table 2 – Requirement headlines, chapter, and ID mapping 3
Table 3 – Bonding Resistance Test point and expected resistance values. 7
Table 4 – Megablock Component Power Circuit Insulation Resistance Requirements 9

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.

Table 5 – Voltage Test Requirements 10
Table 6 – Summary Table 13

5. Purpose and structure of this document

As Megablock is a large system, containing several parts assembled individually and brought together to fulfill the customer requirements, the components are tested individually.

With each component tested before final assembly, the interconnect must be tested, both before initial operation and after any disassembly, e.g. after shipping.

The purpose of this document is to compare the requirements outlined in EN60204-1 Chapter 18 against following testing performed Megablock components.

This is required for the CE approval of the Megablock Fuel Cell Power Plant.

This document is structured as follows:

1. The requirements from EN60204-1 are outlined:
    a. Section 7
2. Test Specifications to comply with the requirement outlined above.
    a. Sections 10 to 16
3. Summary table
    a. Section 17

6. References

Document	Title	Author
DS/EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General Requirements	CENELEC

Table 1 – References

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.

7. Requirements from EN60204-1 Ch 18

Figure 1 is reproduced from the EN60204-1 Ch18.1:

18.1 General

The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no dedicated product standard for the machine, the verifications shall always include the items a), b), c) and h) and may include one or more of the items d) to g):

a) verification that the electrical equipment complies with its technical documentation;
b) verification of continuity of the protective bonding circuit (Test 1 of 18.2.2);
c) in case of fault protection by automatic disconnection of supply, conditions for protection by automatic disconnection shall be verified according to 18.2;
d) insulation resistance test (see 18.3);
e) voltage test (see 18.4);
f) protection against residual voltage (see 18.5);
g) verification that the relevant requirements of 8.2.6 are met;
h) functional tests (see 18.6).

Figure 1 – Excerpt from EN60204-1:2018, Chapter 18.1

The mapping between the headlines from the standard and the requirement ID used in this document is listed in Table 2.

Requirement headline	EN60204-1 Chapter 18.1	EN60204-1 Chapter	Requirement ID
Verification that the electrical equipment complies with its technical documentation	A	n/a	A1
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	B	18.2.2 – Test #1	A2
Verification of conditions for protection by automatic disconnection of supply	C	18.2	A3
Insulation resistance tests	D	18.3	A4
Voltage tests	E	18.4	A5
Protection against residual voltages	F	18.5	A6
Verification that the relevant requirements of 8.2.6 are met	G	8.2.6	A7

Table 2 – Requirement headlines, chapter, and ID mapping

Functional testing of the equipment is outside the scope of this document.

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.

Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

8. Test Equipment.

The test equipment is a CE MultiTester, manufactured by Metrel.

Test Equipment	Ballard Equipment ID	Calibration valid until:

9. Device Under Test

The device to be tested is the 40ft Fuel Cell Container for the Megablock project.

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.

Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

10. A1 – Verification that the electrical equipment complies with its technical documentation

EN60204-1 requirements:

a) verification that the electrical equipment complies with its technical documentation;

Figure 2 – EN60204-1:2018, Chapter 18.1

Megablock Component requirements:

Inspection of the electrical equipment and cabinets to ensure congruence between documentation and equipment/cabinet.

Megablock Component validation:

Component	40ft Container
Result (pass/fail)	
Date and Initials	

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.

11. A2 – Verification of continuity of the protective bonding circuit

EN60204-1 requirements:

18.2.2 Test 1 – Verification of the continuity of the protective bonding circuit

The resistance between the PE terminal (see 5.2 and Figure 4) and relevant points that are part of the protective bonding circuit shall be measured with a current between at least 0,2 A and approximately 10 A derived from an electrically separated supply source (for example SELV, see 414 of IEC 60364-4-41:2005) having a maximum no-load voltage of 24 V AC or DC.

The resistance measured shall be in the expected range according to the length, the cross sectional area and the material of the related protective conductors and protective bonding conductor(s).

Earthed PELV supplies can produce misleading results in this test and therefore shall not be used.

Figure 3 – EN60204-1:2018, Chapter 18.2.2

Megablock Component requirements:

The EN60204-1 Chapter 18.2.2, Test #1 specifies a current of 10A.

Megablock Component bonding resistance test is performed with a current of 10A and a test period of 10 seconds.

Megablock Component validation:

The primary earthing point for the 40ft Fuel Cell Container is the main ground bar located in +UC50.

Each component is verified and compared to expected values for the following locations.

ID	Test Point	Expected Value	Recorded Value
1	Busbar to busbar	<100mΩ	
2	Module 1		
3	DC/DC cabinet 1		
4	Module 2		
5	DC/DC cabinet 2		
6	Module 3		
7	DC/DC cabinet 3		
8	Module 4		
9	DC/DC cabinet 4		
10	Module 5		
11	DC/DC cabinet 5		

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.

12	Module 6		
13	DC/DC cabinet 6		
14	Control cabinet		
15	Control cabinet right door		
16	Lifting crane track, dolly		
17	LT piping		
18	Isolation transformer cover		
19	Cable tray		

Table 3 – Bonding Resistance Test point and expected resistance values.

When performing the test, ensure the connection between the test leads and the equipment is not contributing to inaccurate measurements.

12. A3 - Verification of conditions for protection by automatic disconnection of supply

EN60204-1 requirements:

18.2 Verification of conditions for protection by automatic disconnection of supply

18.2.1 General

The conditions for automatic disconnection of supply (see 6.3.3) shall be verified by tests.

Test 1 verifies the continuity of the protective bonding circuit.

Figure 4 – EN60204-1:2018, Chapter 18.2

Megablock Component requirements:

As specified in chapter 18.2.1, Test #1 is performed (see section 11).

Chapter 18.2.1 further specifies testing of Residual Current Devices (RCD) according to manufacturer specifications.

Megablock RCD Testing:

All RCD (Residual Current Device) in the Megablock system is equipped with self-test functionality from the manufacturer. This takes the shape of a push button, which must cause the RCD device to trip when actuated.

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.

Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

For the test, first enable all RCD circuits, and then actuate the self-test button on the devices. The devices must trip within 1 second. After the trip, use a multimeter to verify that the output of the device has no voltage (<10VAC)

Component	RCD Devices in UC20 (40ft Control Cabinet)
Result – 3ph RCD	
Result – 1ph RCD/MCCB	
Date and Initials	

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.

13. A4 - Insulation resistance tests

EN60204-1 requirements:

18.3 Insulation resistance tests

When insulation resistance tests are performed, the insulation resistance measured at 500 V DC between the power circuit conductors and the protective bonding circuit shall be not less than 1 MΩ. The test may be made on individual sections of the complete electrical installation.

Figure 5 – EN60204-1:2018, Chapter 18.3

Megablock Component requirements:

Before performing this test, isolate all fuel cell DCDC converters from the DC bus (Cabinets UC01 to UC05)

Use a set of test leads and alligator clips to create a single AC node (3 phases shorted together)

The Megablock Component insulation requirements are higher than as specified chapter 18.3. The test is specified in Table 4):

Test point	Pass criteria	Test Voltage [VDC]
Internal side of the output breaker	>1MΩ	500

Table 4 – Megablock Component Power Circuit Insulation Resistance Requirements

Megablock Component validation:

Each component is verified and compared to pass criteria in Table 4.

Component	Fuel Cell Container
Result – AC Node (value and pass/fail)	
Date and Initials	

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.

Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

14. A5 – Voltage tests

EN60204-1 requirements:

18.4 Voltage tests

When voltage tests are performed, test equipment in accordance with IEC 61180-2 should be used.

The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz.

The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1 000 V, whichever is the greater. The maximum test voltage shall be applied between the power circuit conductors and the protective bonding circuit for at least 1 s. The requirements are satisfied if no disruptive discharge occurs.

Components and devices that are not rated to withstand the test voltage and surge protection devices which are likely to operate during the test shall be disconnected during testing.

Components and devices that have been voltage tested in accordance with their product standards may be disconnected during testing.

Figure 6 – EN60204-1:2018, Chapter 18.4

Megablock Component requirements:

The requirements from EN 60204-1:2018, Chapter 18.4 is compared in Table 5.
AC Voltage for Megablock Components is at most 480V, so twice the supply voltage is 960Vac.

Parameter	EN 60204-1:2018, Chapter 18.4	Megablock Component Testing
Voltage [VAC]	960	2500
Frequency [Hz]	50 or 60	50
Duration [sec]	1	10
Maximum Current [mA]	No arcing	5

Table 5 – Voltage Test Requirements

Megablock Component validation:

Connection point is internal side of main output breaker.

Component	Fuel Cell Container
Voltage Test – L1 (value and pass/fail)	
Voltage Test – L2 (value and pass/fail)	
Voltage Test – L3 (value and pass/fail)	
Date and Initials	

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.

Megablock		40ft Container Electrical Safety Checklist	
Document type	*Author*	*Revision date*	*Revision*
Test Specification	RKN	09-01-2025	4.0.0

15. A6 – Protection against residual voltages

EN60204-1 requirements:

18.5 Protection against residual voltages

Where appropriate, tests shall be performed to ensure compliance with 6.2.4.

Figure 7 – EN60204-1:2018, Chapter 18.5

6.2.4 Protection against residual voltages

Live parts having a residual voltage greater than 60 V when the supply is disconnected shall be discharged to 60 V or less within a time period of 5 s provided that this rate of discharge does not interfere with the proper functioning of the equipment. Exempted from this requirement are components having a stored charge of 60 μC or less. Where this specified rate of discharge would interfere with the proper functioning of the equipment, a durable warning notice drawing attention to the hazard and stating the delay required before the enclosure may be opened shall be displayed at an easily visible location on or immediately adjacent to the enclosure that contains the live parts.

In the case of plugs or similar devices, the withdrawal of which results in the exposure of conductors (for example pins), the discharge time to 60 V shall not exceed 1 s, otherwise such conductors shall be protected to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved (for example in the case of removable collectors on conductor wires, conductor bars, or slip-ring assemblies, see 12.7.4), additional switching devices or an appropriate warning, for example a warning sign drawing attention to the hazard and stating the delay required shall be provided. When the equipment is located in places open to all persons, which can include children, warnings are not sufficient and therefore a minimum degree of protection against contact with live parts to IP4X or IPXXD is required.

Figure 8 – EN60204-1:2018, Chapter 6.2.4

Megablock Component requirements:

Identical to EN60204-1 requirements.

Megablock Component validation:

No live parts of the Megablock Component system are accessible without disassembling barriers or accessing electrical cabinets. All connectors are IP2X or higher in unmated state in applications higher than 60V (power system)

Frequency converters and motor drives are marked with applicable durations before internal capacitors are discharged.

Maintenance procedures for the Megablock Component module include a manual verification before any work on exposed components is permitted.

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.

16. A7 – Verification that the relevant requirements of 8.2.6 are met

EN60204-1 requirements:

8.2.6 Additional requirements for electrical equipment having earth leakage currents higher than 10 mA

Where electrical equipment has an earth leakage current that is greater than 10 mA AC or DC in any protective conductor, one or more of the following conditions for the integrity of each section of the associated protective bonding circuit that carries the earth leakage current shall be satisfied:

a) the protective conductor is completely enclosed within electrical equipment enclosures or otherwise protected throughout its length against mechanical damage;

b) the protective conductor has a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al;

c) where the protective conductor has a cross-sectional area of less than 10 mm^2 Cu or 16 mm^2 Al, a second protective conductor of at least the same cross-sectional area is provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm^2 Cu or 16 mm^2 Al. This can require that the electrical equipment has a separate terminal for a second protective conductor.

d) the supply is automatically disconnected in case of loss of continuity of the protective conductor;

e) where a plug-socket combination is used, an industrial connector in accordance with IEC 60309 series, with adequate strain relief and a minimum protective earthing conductor cross-section of 2,5 mm^2 as part of a multi-conductor power cable is provided.

A statement shall be given in the instructions for installation that the equipment shall be installed as described in this 8.2.6.

Figure 9 – EN60204-1:2018, Chapter 8.2.6

Megablock Component requirements:

The Megablock Component does not have a leakage current higher than 10mA.

Megablock Component validation:

The protection against excessive leakage current is twofold:

- Ground fault detection is installed with a proven component (Bender Isometer). Detection of ground fault causes system shutdown and service technician is dispatched.
- Conductivity measurement of internal coolant is a part of the regular maintenance procedures (see N01-003 Service and Maintenance Manual)

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.

17. Summary Table

The requirements from sections 10 to 16, together with results are summarized below in Table 6:

Requirement headline	EN60204-1 Chapter	Req ID	Pass/Fail?
Verification that the electrical equipment complies with its technical documentation	n/a	A1	
Verification of continuity of the protective bonding circuit (Test 1 of 18.2.2)	18.2.2 – Test #1	A2	
Verification of conditions for protection by automatic disconnection of supply	18.2	A3	
Insulation resistance tests	18.3	A4	
Voltage tests	18.4	A5	
Protection against residual voltages	18.5	A6	
Verification that the relevant requirements of 8.2.6 are met	8.2.6	A7	

Table 6 – Summary Table

Commercial Confidential
The information contained in this document is confidential and/or proprietary business or technical data.
Unauthorized copying, distribution or use of this manual is strictly prohibited.