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FC

Part no.: 601456B-7002362
Document ID: K559-2254-CWIWP4202202-N01-005
Configuration: 40ft Fuel Cell Container w. 6 FCwave™
10ft Converter Container, 6,6 kVAC

PowerGen 1000kW

Lockout Tagout (LOTO)



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1.0 General information

1.1 Lock-out-tag-out

Always open/disconnect applicable connections and perform lock-out-tag-out, using relevant locking-methods and tagging-signage to reduce the risk of accidents.

Figure 1: ABB SA1



Example log-out-tag-out kit for MCB's and others



Always measure for voltages



Emergency buttons are NOT for Lock-out-tag-out.

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2.0 Site Requirements and Permission to work systems

2.1 Site Requirements

When the FC system is installed on a customer or other site, rules governing the applicable site may be in place, which must be complied with. These rules may concern hot work, live work, work at heights or other activities.

If Ballard personnel observe any unsafe activity, by Ballard personnel or other workers, they are required to report this to site supervisor and Ballard management.

2.2 Permission to Work management

When the FC system is installed on a customer or other site, it is expected that there exists a system governing permission to work, covering scopes such as area, activities, time slot and responsible person.

Ballard personnel is required to participate and comply with relevant policies and procedures for Permission to Work management.

3.0 Fuel Cell Container

3.1 Interface connections (Externals)

3.1.1 Auxiliary power supply (=HKN70-XB01)

 The auxiliary power supply is outside Ballard scope. Responsible entity must either provide a procedure for their end (Upstream) or perform the procedure when needed.

If work on the supply-side of the switch disconnector is to be done, follow that procedure.

 When disconnecting the Auxiliary Power supply, the UPS inside may engage.

3.1.2 Hydrogen supply (=HKN70)

 The Hydrogen Supply is outside Ballard scope. Responsible entity must provide a procedure for their end (Upstream) or perform the procedure when needed.

If work on the supply side of the interface is to be done, follow that procedure.

LOTO from the interface and downstream on is normally in correlation with service tasks on an FCwave™ (see section electrical LOTO in section 3.2.3)

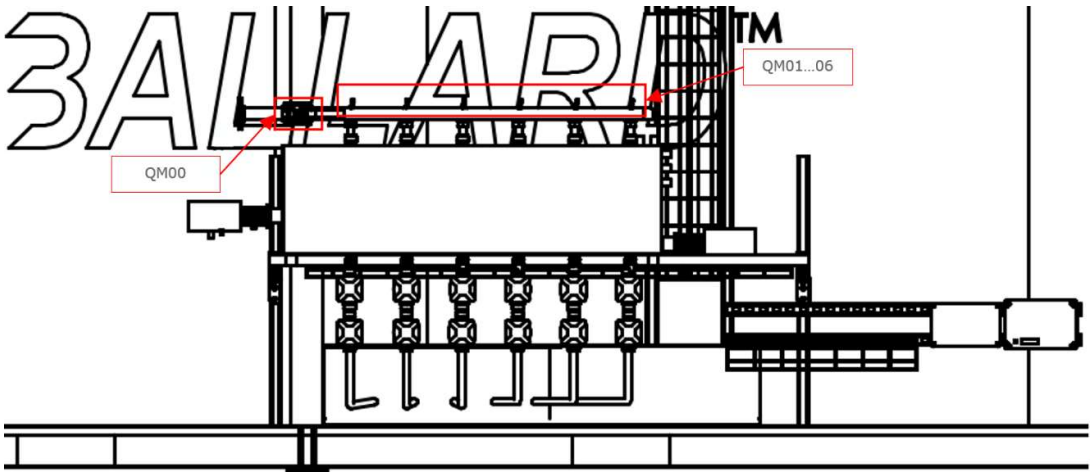
Typical hydrogen supply LOTO:

- Locate applicable manual isolation valve by the hydrogen heater (=HA01+DA02-QM01…06)
  alternatively, supply to all FCwave's can be done with the main shutoff valve (HA01+DA02-QM00)
- Turn off
- Lock-out-tag-out with padlock and sign

 Hydrogen remains in the piping from the manual isolation valve, downstream to the hydrogen supply interface of the FCwave. Refer to section 3.2.3 for bleeding.

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Figure 2: Manual H2 isolation valves



All valves are lockable, enabling LOTO

3.2 Internals

3.2.1 Auxiliary power supply (-SG01)

LOTO of auxiliary power supply to the internal of the container

Auxiliary power supply may be live

1. Locate +UC50
2. Open +UC50 (The bigger cabinet door on the left)
3. Open switch disconnector (-SG01)
4. Lock-out-tag-out with padlock and sign
5. Verify absence of voltage with applicable voltmeter

When disconnecting the Auxiliary Power supply, the UPS may engage.

Re-connect

1. Ensure that work is finished, and that cabinet is clean
2. Ensure that fuses downstream of auxiliary supply switch disconnector is off
3. Re-engage switch disconnector
4. Re-engage fuses downstream one at a time
5. Remove tag-out

3.2.2 DCDC cabinet (+UC01…06)

LOTO and De-energization

1. Shut down the FCwave applicable to the DCDC cabinet through the HMI/ModBus.
   e.g.: Fuel Cell Module 1 (+GB01) if working on DCDC Cabinet #1 (+UC01)
2. Open the top-left door of the applicable DCDC cabinet with Double-bit key no. 5 cabinet key.

Do not open any other doors of the DCDC cabinet yet.

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Figure 3: Top-left door on DCDC cabinet (left)



Cabinet door marked with "Switch disconnector inside"

3. Open the switch disconnector
4. Lock-out-tag-out switch disconnector with padlock and sign

RESIDUAL POWER – In DCDC's - Wait at least 5 minutes

5. Open cabinet doors

DC-link is most likely LIVE

6. Remove pre-charge fuses (4pcs - right top)
   This ensures that accidental activation of pre-charge turn-knop next to the switch disconnector handle does not introduce electrical hazard.
7. Optional: Unplug the 4 DC-connections in the bottom of the FCwave (beneath the floor).
8. Verify absence of voltage with applicable voltmeter (between top of DCDC's B+ and B-)

Re-connect

1. Ensure that work is finished, and that cabinet is clean
2. Re-apply pre-charge fuses
3. Close the two cabinet doors without the switch disconnector and turn-knop for pre-charge behind
4. Pre-charge the components of the cabinet using the turn-knop
5. Verify voltage by measuring with voltmeter in the two available plugs (530-750VDC)
6. Re-engage switch disconnector and close cabinet door.
7. Remove tag-out

3.2.3 FCwave™ (+GB01…06)

LOTO and De-energization (External to the FCwave™)

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Electrical power

1. Set FCwave state to "Prepare for service" in HMI/ModBus and wait for it to transition.
2. Electrical supply LOTO:
    a. Open the top-left door of the applicable DCDC cabinet.

    Do not open any other doors of the DCDC cabinet yet.

    b. Open switch disconnector
    c. Lock-out-tag-out switch disconnector with padlock and sign

    RESIDUAL POWER – In DCDC's - Wait at least 5 minutes

    d. Open cabinet doors

    DC-link is most likely LIVE

    e. Remove pre-charge fuses (4pcs - right top)
    This ensures that accidental activation of pre-charge turn-knop next to the switch disconnector handle does not introduce electrical hazard.
    f. Verify absence of voltage with applicable voltmeter (between top of DCDC's B+ and B-)
    g. Optional: Unplug the 4 DC-connections in the bottom of the FCwave (beneath the floor).

Re-connect

1. Ensure that work is finished, and that areas are clean
2. Close the doors on the FCwave™
3. Re-apply pre-charge fuses in DCDC cabinet
4. Close the two cabinet doors in the DCDC cabinet without the switch disconnector and turn-knop for pre-charge behind
5. Pre-charge the components of the cabinet using the turn-knop
6. Verify voltage by measuring with voltmeter in the two available plugs (530-750VDC)
7. Re-engage switch disconnector and close cabinet door.
8. Remove tag-out
9. Take FCwave™ out of service state through HMI/ModBus

Gas

1. Typically, as described in section 3.1.1

Hydrogen remains in the piping from the manual isolation valve, downstream to the hydrogen supply interface of the FCwave

2. Continue de-energization of FCwave internals as described it's in manual

Re-connect

Typically reverse

24VDC Supply and control

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1. Disconnect plug from the bottom of the FCwave (beneath the floor)
2. Verify absence of voltage with applicable voltmeter

Re-connect

1. Ensure that work is finished, and that areas are clean
2. Reconnect

3.2.4 MCU cabinet (+UC20)

 MCU cabinet contains foreign control voltages – e.g. safety signals from customer

 UPS batteries supply energy to the MCU cabinet. These are located under floor by door (24VDC) and disconnected as described in section 3.2.5

The MCU cabinet is powered from +UC50

1. Ensure low-to-no power consumption in the MCU cabinet by opening fuses inside
2. Locate +UC50
3. Open +UC50 Right-lower door with Double-bit key no. 5 cabinet key
4. Open -FC04
5. Lock-out-tag-out -FC04 with ABB SA1, padlock and sign
6. Verify absence of voltage with applicable voltmeter

Alternative:

1. Ensure low-to-no power consumption in the MCU cabinet by opening fuses inside
2. Locate switch disconnector on the right side of the cabinet (-QB01)
3. Open -QB01

 The power supply (upstream from switch disconnector) remains live

4. Lock-out-tag out -QB01with padlock and sign
5. Verify absence of voltage with applicable voltmeter

Re-connect

1. Ensure that work is finished, and that cabinets are clean
2. Re-engage chosen switch disconnector
3. Re-engage fuses inside MCU cabinet
4. Remove LOTO

3.2.5 UPS

Access the UPS(s) by removing the floor-panel marked “Batteries”.

Power source:

1. Locate and turn off applicable fuse in +UC20
2. Lock-out-tag-out applicable fuse with ABB SA1, padlock and sign
3. Verify absence of voltage on UPS interface with applicable voltmeter

 Energy in UPS batteries remain

Outgoing power:

1. Ensure no power is drawn from UPS
2. Remove the 2x spade-fuses on applicable UPS unit(s)

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3. Tag-out
4. Verify absence of voltage with applicable voltmeter

Re-connect

1. Ensure that work is finished, and that area is clean
2. Ensure no energy-draw from the UPS when reconnecting the spade-fuses by opening the applicable fuses
3. Reconnect spade connectors
4. Close the earlier opened fuses

3.2.6 LT pump drive

1. Locate and turn off the fuse in the MCU cabinet (+UC20)
2. Lock-out-tag-out of fuse with ABB SA1, padlock and sign

 RESIDUAL POWER – In Frequency Converter - Wait at least 5 minutes

3. Verify absence of voltage with applicable voltmeter

 The 24VDC control and supply remains active

Re-connect

1. Ensure that work is finished, and that area is clean
2. Reconnect in reverse order

3.2.7 Intake fans

1. Locate and turn off the fuse in the MCU cabinet (+UC20)
2. Lock-out-tag-out fuse(s) with ABB SA1, padlock and sign
3. Turn lock-function of plug on the fan and remove by pulling

Re-connect

1. Ensure that work is finished, and that area is clean
2. Reconnect plug on fan
3. Close fuse(s)

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4.0 Converter Container

	**The internals of the Converter Container are not accessible when the system is running.**
	**Internals are IP00 area**
	**Never force entry, never de-activate safeguards.**

Entering the 10ft Converter Container

1. Remove the on the padlock on the container door with applicable key
2. Open the container door
3. Mount the padlock to the locking handle (like in Figure 4), ensuring that the container doors cannot be closed and locked by anyone with no knowledge of the work being done.

Figure 4: Mounted padlock on open container door



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4.1 Interface connections

4.1.1 Grid connection (=HKN70-XB02)

 – The Grid connection is outside Ballard scope. The responsible entity must provide a procedure for their end of the cable(s). If work downstream of the 1250KVA Transformer (-TA30) is to be done, follow that procedure.

4.1.2 DC bus (DC1)

 The DC bus in the Converter Container may be supplied both from the DC interconnection from the Fuel Cell Container and the grid connection.

If work is to be done inside the Converter Container, the DC bus must be fully de-energized.

4.1.3 AC Power Supply (BP2)

AC is supplied from the Fuel Cell Container to the Control Cabinet (+UC31) in the Converter Container. It can be shut-off locally or externally (locally – refer to section 4.2.1)

 UPS batteries supply energy to the Control cabinet. – refer to section 4.2.5.

Externally to Power Converter Container:

1. Locate +UC50 in the Fuel Cell Container
2. Open door with Double-bit key no. 5 cabinet key
3. Open switch disconnector -FC05
4. Lock-out-tag-out with padlock and sign

 RESIDUAL POWER – In converters - Wait at least 5 minutes

5. Verify absence of voltage with applicable Voltmeter

4.2 Internals

4.2.1 AC Power Supply (-QB01)

AC is supplied from the Fuel Cell Container to the Control Cabinet in the Power Converter Container. It can be shut-off locally or externally (Externally - refer to section 4.1.3).

Locally:

1. Access the Control Cabinet (+UC31) on the Converter Container by opening the door on the backside of the container (Key needed).
2. Open the control cabinet (+UC31) with a Double-bit key no. 5 cabinet key.
3. Turn off the fused switch disconnector (-QB01) in the cabinet (+UC31)

 The power-supply remains active upstream from -QB01. If work is to be done upstream, follow the procedure in section 4.1.3.

 RESIDUAL POWER – In converters - Wait at least 5 minutes before proceeding

4. Verify absence of voltage with applicable voltmeter

 When disconnecting the Auxiliary Power supply, the UPS may engage.

4.2.2 Grid connection (-FC30)

Actuating/ Lock-out-tag-out is performed as defined by the manual for ABB SACE Emax 2.

 – Live parts may be present

Description of Disconnection of the Customer-end of the connected cable(s) is provided by customer

4.2.3 Transformer

Voltage to the Transformer is removed by the safety-system, when opening a door.

Make sure that the grid connection, described in section 4.2.2, is disconnected.

4.2.4 Capacitors

Voltage to the capacitors is removed by the safety system, when opening a door.

Make sure that the grid connection, described in section 4.2.2, is disconnected.

 RESIDUAL POWER – In capacitors - Wait at least 5 minutes

4.2.5 UPS

The UPS(s) is located in +UC31 which is accessed by opening the container doors that face away the Fuel Cell Container.

Power source:

1. Locate and turn off applicable fuse in +UC31
2. Lock-out-tag-out applicable fuse with ABB SA1, padlock and sign
3. Verify absence of voltage on UPS interface with applicable voltmeter

 Energy in UPS batteries remain present

Outgoing power of UPS:

4. Stop machine through HMI/ModBus
5. Locate the container doors that face away from the Fuel Cell Container.
6. Open the door with applicable key
7. Access the UPS that is located inside +UC41
8. Ensure no power is drawn from UPS
9. Remove the 2x spade-fuses on applicable UPS unit(s)
10. Tag-out
11. Verify absence of voltage with applicable voltmeter

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Re-connect

1. Ensure that work is finished, and that area is clean
2. Ensure no energy-draw from the UPS when reconnecting the spade-fuses by opening the applicable fuses
3. Reconnect spade connectors
4. Close the earlier opened fuses

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5.0 HT Cooling Platform

5.1.1 Control cabinet (+UC30)

The power supply of the HT Cooling Platform can be shut off locally on the Control Cabinet, or in +UC50 inside the Fuel Cell Container.



A 24VDC UPS is in the cabinet.

Converters: DCDC for the UPS and Frequency converters for the pumps.

Foreign control signals.

Locally:

1. Turn off switch disconnector on the cabinet (-QB01)

 RESIDUAL POWER – In converters - Wait at least 5 minutes

2. Verify absence of voltage with applicable voltmeter

 The power-supply remains active upstream from -QB01. If work is to be done upstream, follow the procedure below.

Externally to HT Cooling Platform:

1. Locate +UC50 in the Fuel Cell Container
2. Open +UC50 with a Double-bit key no. 5 cabinet key.
3. Open switch disconnector -FC04
4. Lock-out-tag-out with padlock and sign

 RESIDUAL POWER – In converters - Wait at least 5 minutes

5. Access the Control Cabinet (+UC30) on the HT Cooling Platform with a Double-bit key no. 5 cabinet key.
6. Verify absence of voltage with applicable voltmeter

5.1.2 UPS

The UPS is in the Control Cabinet.

Using MCCB:

1. Locate applicable fuse (MCCB) in +UC30
2. Open the fuse
3. Lock-out-tag-out fuse with ABB SA1, padlock and sign
4. Verify absence of voltage on UPS interface with applicable voltmeter

 Energy in UPS batteries remain present

Using fuses on UPS:

1. Ensure no power is drawn from UPS by opening applicable fuses
2. Remove the 2x spade-fuses on UPS unit

 Energy in UPS batteries remain present

3. Tag-out with sign
4. Verify absence of voltage with applicable voltmeter

Re-connect

1. Ensure that work is finished, and that the cabinet is clean
2. Open the applicable fuses to ensure no energy-draw from the UPS when reconnecting the spade connectors
3. Reconnect spade connectors or turn on fuse
4. Close the earlier opened fuses

5.1.3 HT Coolant pump

1. Locate and turn off the applicable fuse in the Control cabinet (+UC30)
2. Lock-out-tag-out fuse with ABB SA1, padlock and sign

 RESIDUAL POWER – In Frequency Converter - Wait at least 5 minutes

3. Verify absence of voltage with applicable voltmeter

Re-connect

1. Ensure that work is finished, and that area is clean
2. Close fuse

5.1.4 Cooling fan / VFD

This section applies to the cooling fans -GQ11…16, -GQ21…16, and -QG31, as well as their applicable Variable Frequency Drive (VFD)

 Foreign control signals

1. Locate and turn off the applicable fuse in the Control cabinet (+UC30)

 RESIDUAL POWER – In Frequency Converter - Wait at least 5 minutes

2. Lock-out-tag-out fuse with ABB SA1, padlock and sign
3. Turn lock-function of plug on the fan and remove by pulling

Re-connect

1. Ensure that work is finished, and that area is clean
2. Reconnect any disconnected plugs on fan
3. Close fuse

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5.1.5 VFD Cabinet chiller

1. Locate and turn off -FC40 in the Control cabinet (+UC30)
2. Lock-out-tag-out fuse with ABB SA1, padlock and sign

Re-connect

1. Ensure that work is finished, and that area is clean
2. Close fuse

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