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Short Title	Alarm System Introduction
Full Title	Crosswind BLPH Project – FC Package Alarm System Introduction and Explanation
Abstract	*This document presents the details and reading guide for the FC Package Alarm System for the Crosswind BLPH project.*

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1.0 Purpose and Scope

This document presents the details and reading guide for the FC Package Alarm System for the Crosswind BLPH project.

2.0 Terminology

Table 1: List of Terminology

Abbreviation	Full Name
OT	Operational Technology
IACS	Industrial Automation and Control Systems
BLPH	Crosswind Hollandse Kust Noord Baseload Power Hub
HT	High Temperature
LT	Low Temperature
H2	Hydrogen
IsoMon	Isolation Monitor
CoolBreak	Coolant Breaker
P&ID	Process and Instrumentation Diagram
PSU	Power Supply Unit
SLD	Single Line Diagram (Electrical)
HV	High Voltage

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3.0 Operator Expectations

The following is expected of the operator, which will be notified of the alarms and is responsible for reacting to the alarm codes

- Access to relevant documentation:
  - Fuel Cell Package P&ID
  - Fuel Cell Package SLD
  - Platform Safety Plan
- Understanding of the following:
  - Reading and understanding a P&ID
  - Reading and understanding a Single Line Diagram
  - Basic understanding of fuel cell package operation
  - Basic understanding of fuel cell fundamentals
  - Basic understanding of industrial control systems and electrical systems
  - Basic electrical troubleshooting knowledge is recommended.

4.0 Alarm System Introduction

An alarm is set up of several logical steps, to determine if an alarm is Active. The alarm is set up around a basic equation called the *Alarm Test*, where a process value is compared to a limit, with basic mathematical comparison-operators. An example below is shown with the Greater Than operator:

$$pv > limit$$

Here, *pv* is the Process Value – either a sensor value or a calculated value. If the equation yields True, the Alarm Test is True.

Please note that the pv and limit can be Boolean values. The operator will then always be the equality operator ('='). If the operator field is left blank, the equality operator is implicit.

When the Alarm Test is True, a timer denoted the Delay Time is started. If the Delay Time elapses, the alarm becomes Active. If the Alarm Test becomes False during the Delay Time, the Delay Time is reset. In other words, the Alarm Test must be true for the consecutive number of seconds denoted by the delay time.

An alarm can be Inactive in certain states. This means the Alarm Test is not evaluated. After the system transitions from a state where the alarm is Inactive to a state where the alarm is Active, the State Enable Delay must elapse before the Alarm Test is evaluated (and thus, before the Delay Time is started). Note that the State Enable Delay does not apply to a state transition where the alarm was Active in both states.

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5.0 Severities

The Severity has no effect on whether an alarm is Active or not, only how the system reacts to the alarm if it becomes Active. There are five different severities, from 0 to 4:

Severity 0 – Info: An information of a parameter being outside an optimal range but will not impair the system from running at full capacity. Action may be taken to restore optimal running conditions.

Severity 1 – Warning: A parameter is outside normal operating limits. System can still run, but possibly in a derated mode. Action should be planned to rectify the problem, as this parameter will likely lead to a shutdown of the system

Severity 2 – Delayed shutdown: A parameter is outside acceptable operating limits, but safe to operate for a short period. System will run normally for this short period, then perform a controlled shutdown. Problem must be rectified before a restart can be attempted.

Severity 3 – Controlled Shutdown: A parameter is outside safe operating limits. System will perform a controlled shutdown. Problem must be rectified before a restart can be attempted.

Severity 4 – Emergency Shutdown: A parameter is outside safe operating limits. This parameter would not allow a safe, controlled shutdown. Thus, the system will perform an immediate shutdown. Problem must be rectified before a restart can be attempted.

6.0 Corrective Action

The alarm list includes a column with a brief description of the suggested corrective action for each alarm. A column is also included with a yes/no indication of if the corrective action is plausible from a remote monitoring control station.

E.g., a high temperature warning might suggest reducing power requested from the FC package, which should be possible from a remote-operator station.

Another alarm might suggest inspection of a coolant system, which is not plausible from a remote-operator station.

Some alarms direct the operator to contact Ballard, either on occurrence or recurrence

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Alarm Examples

6.1 Example 1

As an example, we take alarm ID 22038. This has the following definition:

Table 2 - Alarm Example 1

ID	Sub-system	Alarm Name	Tagname	Unit	Oper-ator	Limit	Sev	Delay Time	State Enable Delay	Corrective Action	Remote Friendly
22038	LT Cooling	Return Temp High-High	=HE03+DA01-BT01	°C	>	55	3	20	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes

This alarm belongs to the LT Cooling subsystem and is activated if the Return Temperature becomes too high. The sensor which measures this is called =HE03+DA01-BT01. If this temperature is above 55 °C for 20 consecutive seconds, the alarm becomes Active. As it is a Severity 3 alarm, it would trigger a controlled shutdown of the LT Cooling subsystem. The Corrective action is a text for the operator, indicating what is possible to mitigate the issue – in this case waiting until the ambient temperature is reduced. The remote friendly text indicates if the alarm is plausibly fixed by a remote operator, in this case no action on the platform is needed.

6.2 Example 2

For another example, let's look at alarm 1014:

Table 3 - Alarm Example 2

ID	Sub-system	Alarm Name	Tagname	Unit	Oper-ator	Limit	Sev	Delay Time	State Enable Delay	Corrective Action	Remote Fiendly
1015	Main Control	Smoke Detector OutletB	=JA01+DA01-BQ06		=	TRUE	4	3	3	Remove the cause of smoke. Reset sensor by disconnecting from base and reconnect.	No

This alarm belongs to the Main Control System. It is activated if Smoke Detector B in the 40 ft container is activated. The detector is called =JA01+DA01-BQ06. When this detector returns TRUE (high) for 3 consecutive seconds, the alarm becomes Active. As it is a Severity 4 alarm, it will trigger an emergency shutdown of the Main Control System.

This alarm is reset by removing and reseating the smoke detector, which is not feasible by a remote operator.

AlarmID	ID Prefix	ID Suffix	SubSystem	Alarm Name	Tagname	Unit	Operator	Limit	Severity	Description	Delay Time	State Enable Delay	Corrective Action	Remote Friendly
1001	1	1	MainControl	MainSafetyOK	=LA01+UC20-KE10			FALSE	4	Main Safety needs Reset	3	3	Reset Main Safety Controller once it is safe to do so	No
1002	1	2	MainControl	SafetymodbusCommsDriverError				TRUE	4	Safety Controller - Com Error	3	3	Inspect network connection between Safety Controllers and main controller, and fix loose cables, replace broken cables and check network switches	No
1003	1	3	MainControl	ESTOPCustomer	<RM/BLPH Scope>			FALSE	4	E STOP BLPH Platform	3	3	ESTOP from BLPH - Correct BLPH error and reset safety system	No
1004	1	4	MainControl	ESTOPcontrolCabinet	=LA01+UC20-SG10			FALSE	4	E STOP Control Cabinet	3	3	Release the safety button once it is safe to do so	No
1005	1	5	MainControl	ESTOPContainerDoor	=LB02+DA01-SG23			FALSE	4	ESTOP Container Door	3	3	Release the safety button once it is safe to do so	No
1006	1	6	MainControl	ESTOPcoolantSkid	=LB02+DA04-SG4			FALSE	4	E STOP Coolant Skid	3	3	Release the safety button once it is safe to do so	No
1007	1	7	MainControl	EFIBusStatus1	=LA01+UC20-KE10			FALSE	4	Safety Controller - 40/10ft Com Ch 1	3	3	Inspect CANBus cables between Safety Controllers in UC20 and UC30, and fix loose cables or replace broken cables	
1008	1	8	MainControl	EFIBusStatus2	=LA01+UC20-KE10			FALSE	4	Safety Controller - 40/10ft Com Ch 2	3	3	Inspect CANBus cables between Safety Controllers in UC20 and UC30, and fix loose cables or replace broken cables	
1009	1	9	MainControl	ESTOP10ft	n/a			FALSE	4	Not Applicable	3	3	Not Applicable	
1010	1	10	MainControl	DoorRight_10ft	=LB02+DA03-BG01			FALSE	4	10ft Container - Door Right Open	3	3	Close door and check safety switch	No
1011	1	11	MainControl	DoorLeft_10ft	=LB02+DA03-BG02			FALSE	4	10ft Container - Door Left Open	3	3	Close door and check safety switch	No
1012	1	12	MainControl	smokeDetectorIntake	=JA01+DA01-BQ04			FALSE	4	Smoke Detector, 40ft Middle	3	3	Remove the cause of smoke. Reset sensor by disconnecting from base and reconnect.	No
1013	1	13	MainControl	smokeDetectorOutletA	=JA01+DA01-BQ05			FALSE	4	Smoke Detector, 40ft Left	3	3	Remove the cause of smoke. Reset sensor by disconnecting from base and reconnect.	No
1014	1	14	MainControl	smokeDetectorOutletB	=JA01+DA01-BQ06			FALSE	4	Smoke Detector, 40ft Right	3	3	Remove the cause of smoke. Reset sensor by disconnecting from base and reconnect.	No
1015	1	15	MainControl	smokeDetector10ft	=JA01+DA03-BQ01			FALSE	4	Smoke Detector, 10ft	3	3	Remove the cause of smoke. Reset sensor by disconnecting from base and reconnect.	No
1016	1	16	MainControl	hydrogenSensorVentIntakeok	=JA01+DA01-BQ01			FALSE	4	Hydrogen Detector, 40ft Middle	3	3	Check and fix any hydrogen leak.	No
1017	1	17	MainControl	hydrogenSensorOutletAok	=JA01+DA01-BQ02			FALSE	4	Hydrogen Detector, 40ft Left	3	3	Check and fix any hydrogen leak.	No
1018	1	18	MainControl	hydrogenSensorOutletBok	=JA01+DA01-BQ03			FALSE	4	Hydrogen Detector, 40ft Right	3	3	Check and fix any hydrogen leak.	No
1019	1	19	MainControl	FCwave 1 Error				TRUE	1	FCwave 1 Control Error	0	0	Mitigate alarms in relevant subsystem	
1020	1	20	MainControl	FCwave 2 Error				TRUE	1	FCwave 2 Control Error	0	0	Mitigate alarms in relevant subsystem	
1021	1	21	MainControl	FCwave 3 Error				TRUE	1	FCwave 3 Control Error	0	0	Mitigate alarms in relevant subsystem	
1022	1	22	MainControl	FCwave 4 Error				TRUE	1	FCwave 4 Control Error	0	0	Mitigate alarms in relevant subsystem	
1023	1	23	MainControl	FCwave 5 Error				TRUE	1	FCwave 5 Control Error	0	0	Mitigate alarms in relevant subsystem	
1024	1	24	MainControl	FCwave 6 Error				TRUE	1	FCwave 6 Control Error	0	0	Mitigate alarms in relevant subsystem	
1025	1	25	MainControl	HT Cool 1 Error				TRUE	1	HT Coolant System 1 Error	0	0	Mitigate alarms in relevant subsystem	
1026	1	26	MainControl	HT Cool 2 Error				TRUE	1	HT Coolant System 2 Error	0	0	Mitigate alarms in relevant subsystem	
1027	1	27	MainControl	LT Cool Error				TRUE	3	LT Coolant System Error	0	0	Mitigate alarms in relevant subsystem	
1028	1	28	MainControl	Microgrid Error				TRUE	3	Microgrid Error	0	0	Mitigate alarms in relevant subsystem	
1029	1	29	MainControl	Nanogrid Error				TRUE	3	Nanogrid Error	0	0	Mitigate alarms in relevant subsystem	
1030	1	30	MainControl	Ventilation Error				TRUE	3	Ventilation Error	0	0	Mitigate alarms in relevant subsystem	
1031	1	31	MainControl	Climate 40ft Error				TRUE	3	40ft Climate Control Error	0	0	Mitigate alarms in relevant subsystem	
1032	1	32	MainControl	Climate 10ft Error				TRUE	3	10ft Climate Control Error	0	0	Mitigate alarms in relevant subsystem	
1033	1	33	MainControl	H2 Heating Error				TRUE	3	Hydrogen Heating System Error	0	0	Mitigate alarms in relevant subsystem	
1034	1	34	MainControl	FCwave 1 Warning				TRUE	1	FCwave 1 Control Warning	0	0	Mitigate alarms in relevant subsystem	
1035	1	35	MainControl	FCwave 2 Warning				TRUE	1	FCwave 2 Control Warning	0	0	Mitigate alarms in relevant subsystem	
1036	1	36	MainControl	FCwave 3 Warning				TRUE	1	FCwave 3 Control Warning	0	0	Mitigate alarms in relevant subsystem	
1037	1	37	MainControl	FCwave 4 Warning				TRUE	1	FCwave 4 Control Warning	0	0	Mitigate alarms in relevant subsystem	
1038	1	38	MainControl	FCwave 5 Warning				TRUE	1	FCwave 5 Control Warning	0	0	Mitigate alarms in relevant subsystem	
1039	1	39	MainControl	FCwave 6 Warning				TRUE	1	FCwave 6 Control Warning	0	0	Mitigate alarms in relevant subsystem	
1040	1	40	MainControl	HT Cool 1 Warning				TRUE	1	HT Coolant System 1 Warning	0	0	Mitigate alarms in relevant subsystem	
1041	1	41	MainControl	HT Cool 2 Warning				TRUE	1	HT Coolant System 2 Warning	0	0	Mitigate alarms in relevant subsystem	
1042	1	42	MainControl	LT Cool Warning				TRUE	1	LT Coolant System Warning	0	0	Mitigate alarms in relevant subsystem	
1043	1	43	MainControl	Microgrid Warning				TRUE	1	Microgrid Warning	0	0	Mitigate alarms in relevant subsystem	
1044	1	44	MainControl	Nanogrid Warning				TRUE	1	Nanogrid Warning	0	0	Mitigate alarms in relevant subsystem	
1045	1	45	MainControl	Ventilation Warning				TRUE	1	Ventilation Warning	0	0	Mitigate alarms in relevant subsystem	
1046	1	46	MainControl	Climate 40ft Warning				TRUE	1	40ft Climate Control Warning	0	0	Mitigate alarms in relevant subsystem	
1047	1	47	MainControl	Climate 10ft Warning				TRUE	1	20ft Climate Control Warning	0	0	Mitigate alarms in relevant subsystem	
1048	1	48	MainControl	H2 Heating Warning				TRUE	1	Hydrogen Heating System Warning	0	0	Mitigate alarms in relevant subsystem	
1049	1	49	MainControl	IsoMonModbusCommsDriverError	=LA01+UC31-BB01			TRUE	3	Isolation monitor - Com Error	3	3	Inspect network connection between Isolation Monitor and main controller, and fix loose cables, replace broken cables and check network switches	No
1050	1	50	MainControl	CoolBreakModbusCommsDriverError	=BA30+UC50-FC04			TRUE	3	Coolant Breaker - Com Error	3	3	Inspect network connection between Coolant Breaker and main controller, and fix loose cables, replace broken cables and check network switches	No
1051	1	51	MainControl	fuseTrip_PSU	=LA01+UC20-FC110..FC115			FALSE	3	400V/24V PSU - Fuse Trip	3	3	Inspect and reset listed MCCBs. Inspect wiring and continue troubleshooting if issue persists	No
1052	1	52	MainControl	Isolation Resistance LowLow	=LA01+UC31-BB01	kOhm	<	30	3	Isolation Resistance Low Alarm	3	0	Isolation resistance on internal DC grid critically low - Discontinue operation and contact Ballard Serivce	No
1053	1	53	MainControl	Isolation Resistance Low	=LA01+UC31-BB01	kOhm	<	70	1	Isolation Resistance Low Warning	5	0	Isolation resistance on internal DC grid low - Contact Ballard and schedule maintenance	Yes
1054	1	54	MainControl	Fuse 24VDC 80percent	=LA01+UC20-FC110..FC115			FALSE	0	24VDC Fuse above 80% load	3	3	24V Load exceeds 80% of PSU rating. Disable unneeded loads such as lighting	Yes
1055	1	55	MainControl	FuseTrip400230V	=LA01+UC20-FC10..FC20			FALSE	3	400V Fuse Trip 40ft Control Cabinet	3	3	Inspect and reset listed MCCBs. Inspect wiring and continue troubleshooting if issue persists	No
1056	1	56	MainControl	EtherCAT Alarm				TRUE	3	Ethercat Communication Failure	10	3	Inspect network cables between Extension Racks and main controller, and fix loose cables and replace broken cables	No
1057	1	57	MainControl	All FCwaves Error				TRUE	3	All FCwaves are in Error	1	3	Restore operation of at least one FCwave	Yes

Alarm ID	ID Prefix	ID Suffix	Subsystem	Alarm Name	Tagname	Unit	Operator	Limit	Severity	Description	Delay Time	State Enable Delay	Corrective Action	Remote Friendly
11001	11	1	Fuel Cell #1	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Mitigate alarm in Main Control	
11002	11	2	Fuel Cell #1	FCwave Comms Error	=RE01+GB01-GB01			TRUE	3	FCwave Communication Error	3	3	Inspect network cables between Fuel Cell Module and main controller, and fix loose cables and replace broken cables	No
11003	11	3	Fuel Cell #1	DCDC A Comms Error	=RE01+UC01-TA01			TRUE	4	DCDC A Communication Error	2	3	Inspect network cables between DCDC Converter and main controller, and fix loose cables and replace broken cables	No
11004	11	4	Fuel Cell #1	DCDC B Comms Error	=RE01+UC01-TA02			TRUE	4	DCDC B Communication Error	2	3	Inspect network cables between DCDC Converter and main controller, and fix loose cables and replace broken cables	No
11005	11	5	Fuel Cell #1	FCwave Safety Tripped	=RE01+GB01-GB01			TRUE	4	FCwave Internal Safety Tripped	2	3	Check if there are any other indications of dangerous situations. Contact Ballard.	No
11006	11	6	Fuel Cell #1	Main Safety Tripped FCwave	=RE01+GB01-GB01			FALSE	4	Main Safety Controller Tripped FCwave	0	3	Mitigate alarm in Main Control	No
11007	11	7	Fuel Cell #1	DCDC A Fault	=RE01+UC01-TA01			TRUE	4	DCDC A Fault	1	3	Attempt restart. If problem persists, contact Ballard	Yes
11008	11	8	Fuel Cell #1	DCDC B Fault	=RE01+UC01-TA02			TRUE	4	DCDC B Fault	1	3	Attempt restart. If problem persists, contact Ballard	Yes
11009	11	9	Fuel Cell #1	FCwave Sev3 Alarm	=RE01+GB01-GB01			TRUE	4	FCwave Emergency Shutdown Alarm	0	3	Contact Ballard	No
11010	11	10	Fuel Cell #1	FCwave Sev2 Alarm	=RE01+GB01-GB01			TRUE	3	FCwave Shutdown Alarm	0	3	Contact Ballard	No
11011	11	11	Fuel Cell #1	Main Control Sev4 Alarm				TRUE	4	Main State Machine Sev 4 Alarm	0	3	Mitigate alarm in Main Control	
11012	11	12	Fuel Cell #1	Main Control Sev3 Alarm				TRUE	3	Main State Machine Sev 3 Alarm	0	3	Mitigate alarm in Main Control	
11013	11	13	Fuel Cell #1	Main Control Sev1 Alarm				TRUE	1	Main State Machine Sev 1 Alarm	0	3	Mitigate alarm in Main Control	
11014	11	14	Fuel Cell #1	Decay Test Fail	=RE01+GB01-GB01			TRUE	3	FCwave Internal Decay Test Failure	1	0	Check if there are any other indications of dangerous situations. Contact Ballard.	No
11015	11	15	Fuel Cell #1	Hydrogen Alarm Lockout	=RE01+GB01-GB01			TRUE	3	FCwave Internal Hydrogen Lockout	1	0	Check if there are any other indications of dangerous situations. Contact Ballard.	No
11016	11	16	Fuel Cell #1	HT Coolant Unavail				TRUE	3	HT Coolant System Unavailable	0	0	Mitigate alarm in HT Coolant System 1	Yes
12001	12	1	Fuel Cell #2	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Mitigate alarm in Main Control	
12002	12	2	Fuel Cell #2	FCwave Comms Error	=RE01+GB02-GB02			TRUE	3	FCwave Communication Error	3	3	Inspect network cables between Fuel Cell Module and main controller, and fix loose cables and replace broken cables	No
12003	12	3	Fuel Cell #2	DCDC A Comms Error	=RE01+UC02-TA01			TRUE	4	DCDC A Communication Error	2	3	Inspect network cables between DCDC Converter and main controller, and fix loose cables and replace broken cables	No
12004	12	4	Fuel Cell #2	DCDC B Comms Error	=RE01+UC02-TA02			TRUE	4	DCDC B Communication Error	2	3	Inspect network cables between DCDC Converter and main controller, and fix loose cables and replace broken cables	No
12005	12	5	Fuel Cell #2	FCwave Safety Tripped	=RE01+GB02-GB02			TRUE	4	FCwave Internal Safety Tripped	2	3	Check if there are any other indications of dangerous situations. Contact Ballard.	No
12006	12	6	Fuel Cell #2	Main Safety Tripped FCwave	=RE01+GB02-GB02			FALSE	4	Main Safety Controller Tripped FCwave	0	3	Mitigate alarm in Main Control	No
12007	12	7	Fuel Cell #2	DCDC A Fault	=RE01+UC02-TA01			TRUE	4	DCDC A Fault	1	3	Attempt restart. If problem persists, contact Ballard	Yes
12008	12	8	Fuel Cell #2	DCDC B Fault	=RE01+UC02-TA02			TRUE	4	DCDC B Fault	1	3	Attempt restart. If problem persists, contact Ballard	Yes
12009	12	9	Fuel Cell #2	FCwave Sev3 Alarm	=RE01+GB02-GB02			TRUE	4	FCwave Emergency Shutdown Alarm	0	3	Contact Ballard	No
12010	12	10	Fuel Cell #2	FCwave Sev2 Alarm	=RE01+GB02-GB02			TRUE	3	FCwave Shutdown Alarm	0	3	Contact Ballard	No
12011	12	11	Fuel Cell #2	Main Control Sev4 Alarm				TRUE	4	Main State Machine Sev 4 Alarm	0	3	Mitigate alarm in Main Control	
12012	12	12	Fuel Cell #2	Main Control Sev3 Alarm				TRUE	3	Main State Machine Sev 3 Alarm	0	3	Mitigate alarm in Main Control	
12013	12	13	Fuel Cell #2	Main Control Sev1 Alarm				TRUE	1	Main State Machine Sev 1 Alarm	0	3	Mitigate alarm in Main Control	
12014	12	14	Fuel Cell #2	Decay Test Fail	=RE01+GB02-GB02			TRUE	3	FCwave Internal Decay Test Failure	1	0	Check if there are any other indications of dangerous situations. Contact Ballard.	No
12015	12	15	Fuel Cell #2	Hydrogen Alarm Lockout	=RE01+GB02-GB02			TRUE	3	FCwave Internal Hydrogen Lockout	1	0	Check if there are any other indications of dangerous situations. Contact Ballard.	No
12016	12	16	Fuel Cell #2	HT Coolant Unavail				TRUE	3	HT Coolant System Unavailable	0	0	Mitigate alarm in HT Coolant System 1	Yes
13001	13	1	Fuel Cell #3	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Mitigate alarm in Main Control	
13002	13	2	Fuel Cell #3	FCwave Comms Error	=RE01+GB03-GB03			TRUE	3	FCwave Communication Error	3	3	Inspect network cables between Fuel Cell Module and main controller, and fix loose cables and replace broken cables	No
13003	13	3	Fuel Cell #3	DCDC A Comms Error	=RE01+UC03-TA01			TRUE	4	DCDC A Communication Error	2	3	Inspect network cables between DCDC Converter and main controller, and fix loose cables and replace broken cables	No
13004	13	4	Fuel Cell #3	DCDC B Comms Error	=RE01+UC03-TA02			TRUE	4	DCDC B Communication Error	2	3	Inspect network cables between DCDC Converter and main controller, and fix loose cables and replace broken cables	No
13005	13	5	Fuel Cell #3	FCwave Safety Tripped	=RE01+GB03-GB03			TRUE	4	FCwave Internal Safety Tripped	2	3	Check if there are any other indications of dangerous situations. Contact Ballard.	No
13006	13	6	Fuel Cell #3	Main Safety Tripped FCwave	=RE01+GB03-GB03			FALSE	4	Main Safety Controller Tripped FCwave	0	3	Mitigate alarm in Main Control	No
13007	13	7	Fuel Cell #3	DCDC A Fault	=RE01+UC03-TA01			TRUE	4	DCDC A Fault	1	3	Attempt restart. If problem persists, contact Ballard	Yes
13008	13	8	Fuel Cell #3	DCDC B Fault	=RE01+UC03-TA02			TRUE	4	DCDC B Fault	1	3	Attempt restart. If problem persists, contact Ballard	Yes
13009	13	9	Fuel Cell #3	FCwave Sev3 Alarm	=RE01+GB03-GB03			TRUE	4	FCwave Emergency Shutdown Alarm	0	3	Contact Ballard	No
13010	13	10	Fuel Cell #3	FCwave Sev2 Alarm	=RE01+GB03-GB03			TRUE	3	FCwave Shutdown Alarm	0	3	Contact Ballard	No
13011	13	11	Fuel Cell #3	Main Control Sev4 Alarm				TRUE	4	Main State Machine Sev 4 Alarm	0	3	Mitigate alarm in Main Control	
13012	13	12	Fuel Cell #3	Main Control Sev3 Alarm				TRUE	3	Main State Machine Sev 3 Alarm	0	3	Mitigate alarm in Main Control	
13013	13	13	Fuel Cell #3	Main Control Sev1 Alarm				TRUE	1	Main State Machine Sev 1 Alarm	0	3	Mitigate alarm in Main Control	
13014	13	14	Fuel Cell #3	Decay Test Fail	=RE01+GB03-GB03			TRUE	3	FCwave Internal Decay Test Failure	1	0	Check if there are any other indications of dangerous situations. Contact Ballard.	No
13015	13	15	Fuel Cell #3	Hydrogen Alarm Lockout	=RE01+GB03-GB03			TRUE	3	FCwave Internal Hydrogen Lockout	1	0	Check if there are any other indications of dangerous situations. Contact Ballard.	No

13016	13	16	Fuel Cell #3	HT Coolant Unavail				TRUE	3	HT Coolant System Unavailable	0	0	Mitigate alarm in HT Coolant System 1	Yes
14001	14	1	Fuel Cell #4	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Mitigate alarm in Main Control	
14002	14	2	Fuel Cell #4	FCwave Comms Error	=RE01+GB04-GB04			TRUE	3	FCwave Communication Error	3	3	Inspect network cables between Fuel Cell Module and main controller, and fix loose cables and replace broken cables	No
14003	14	3	Fuel Cell #4	DCDC A Comms Error	=RE01+UC04-TA01			TRUE	4	DCDC A Communication Error	2	3	Inspect network cables between DCDC Converter and main controller, and fix loose cables and replace broken cables	No
14004	14	4	Fuel Cell #4	DCDC B Comms Error	=RE01+UC04-TA02			TRUE	4	DCDC B Communication Error	2	3	Inspect network cables between DCDC Converter and main controller, and fix loose cables and replace broken cables	No
14005	14	5	Fuel Cell #4	FCwave Safety Tripped	=RE01+GB04-GB04			TRUE	4	FCwave Internal Safety Tripped	2	3	Check if there are any other indications of dangerous situations. Contact Ballard.	No
14006	14	6	Fuel Cell #4	Main Safety Tripped FCwave	=RE01+GB04-GB04			FALSE	4	Main Safety Controller Tripped FCwave	0	3	Mitigate alarm in Main Control	No
14007	14	7	Fuel Cell #4	DCDC A Fault	=RE01+UC04-TA01			TRUE	4	DCDC A Fault	1	3	Attempt restart. If problem persists, contact Ballard	Yes
14008	14	8	Fuel Cell #4	DCDC B Fault	=RE01+UC04-TA02			TRUE	4	DCDC B Fault	1	3	Attempt restart. If problem persists, contact Ballard	Yes
14009	14	9	Fuel Cell #4	FCwave Sev3 Alarm	=RE01+GB04-GB04			TRUE	4	FCwave Emergency Shutdown Alarm	0	3	Contact Ballard	No
14010	14	10	Fuel Cell #4	FCwave Sev2 Alarm	=RE01+GB04-GB04			TRUE	3	FCwave Shutdown Alarm	0	3	Contact Ballard	No
14011	14	11	Fuel Cell #4	Main Control Sev4 Alarm				TRUE	4	Main State Machine Sev 4 Alarm	0	3	Mitigate alarm in Main Control	
14012	14	12	Fuel Cell #4	Main Control Sev3 Alarm				TRUE	3	Main State Machine Sev 3 Alarm	0	3	Mitigate alarm in Main Control	
14013	14	13	Fuel Cell #4	Main Control Sev1 Alarm				TRUE	1	Main State Machine Sev 1 Alarm	0	3	Mitigate alarm in Main Control	
14014	14	14	Fuel Cell #4	Decay Test Fail	=RE01+GB04-GB04			TRUE	3	FCwave Internal Decay Test Failure	1	0	Check if there are any other indications of dangerous situations. Contact Ballard.	No
14015	14	15	Fuel Cell #4	Hydrogen Alarm Lockout	=RE01+GB04-GB04			TRUE	3	FCwave Internal Hydrogen Lockout	1	0	Check if there are any other indications of dangerous situations. Contact Ballard.	No
14016	14	16	Fuel Cell #4	HT Coolant Unavail				TRUE	3	HT Coolant System Unavailable	0	0	Mitigate alarm in HT Coolant System 2	Yes
15001	15	1	Fuel Cell #5	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Mitigate alarm in Main Control	
15002	15	2	Fuel Cell #5	FCwave Comms Error	=RE01+GB05-GB05			TRUE	3	FCwave Communication Error	3	3	Inspect network cables between Fuel Cell Module and main controller, and fix loose cables and replace broken cables	No
15003	15	3	Fuel Cell #5	DCDC A Comms Error	=RE01+UC05-TA01			TRUE	4	DCDC A Communication Error	2	3	Inspect network cables between DCDC Converter and main controller, and fix loose cables and replace broken cables	No
15004	15	4	Fuel Cell #5	DCDC B Comms Error	=RE01+UC05-TA02			TRUE	4	DCDC B Communication Error	2	3	Inspect network cables between DCDC Converter and main controller, and fix loose cables and replace broken cables	No
15005	15	5	Fuel Cell #5	FCwave Safety Tripped	=RE01+GB05-GB05			TRUE	4	FCwave Internal Safety Tripped	2	3	Check if there are any other indications of dangerous situations. Contact Ballard.	No
15006	15	6	Fuel Cell #5	Main Safety Tripped FCwave	=RE01+GB05-GB05			FALSE	4	Main Safety Controller Tripped FCwave	0	3	Mitigate alarm in Main Control	No
15007	15	7	Fuel Cell #5	DCDC A Fault	=RE01+UC05-TA01			TRUE	4	DCDC A Fault	1	3	Attempt restart. If problem persists, contact Ballard	Yes
15008	15	8	Fuel Cell #5	DCDC B Fault	=RE01+UC05-TA02			TRUE	4	DCDC B Fault	1	3	Attempt restart. If problem persists, contact Ballard	Yes
15009	15	9	Fuel Cell #5	FCwave Sev3 Alarm	=RE01+GB05-GB05			TRUE	4	FCwave Emergency Shutdown Alarm	0	3	Contact Ballard	No
15010	15	10	Fuel Cell #5	FCwave Sev2 Alarm	=RE01+GB05-GB05			TRUE	3	FCwave Shutdown Alarm	0	3	Contact Ballard	No
15011	15	11	Fuel Cell #5	Main Control Sev4 Alarm				TRUE	4	Main State Machine Sev 4 Alarm	0	3	Mitigate alarm in Main Control	
15012	15	12	Fuel Cell #5	Main Control Sev3 Alarm				TRUE	3	Main State Machine Sev 3 Alarm	0	3	Mitigate alarm in Main Control	
15013	15	13	Fuel Cell #5	Main Control Sev1 Alarm				TRUE	1	Main State Machine Sev 1 Alarm	0	3	Mitigate alarm in Main Control	
15014	15	14	Fuel Cell #5	Decay Test Fail	=RE01+GB05-GB05			TRUE	3	FCwave Internal Decay Test Failure	1	0	Check if there are any other indications of dangerous situations. Contact Ballard.	No
15015	15	15	Fuel Cell #5	Hydrogen Alarm Lockout	=RE01+GB05-GB05			TRUE	3	FCwave Internal Hydrogen Lockout	1	0	Check if there are any other indications of dangerous situations. Contact Ballard.	No
15016	15	16	Fuel Cell #5	HT Coolant Unavail				TRUE	3	HT Coolant System Unavailable	0	0	Mitigate alarm in HT Coolant System 2	Yes
16001	16	1	Fuel Cell #6	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Mitigate alarm in Main Control	
16002	16	2	Fuel Cell #6	FCwave Comms Error	=RE01+GB06-GB06			TRUE	3	FCwave Communication Error	3	3	Inspect network cables between Fuel Cell Module and main controller, and fix loose cables and replace broken cables	No
16003	16	3	Fuel Cell #6	DCDC A Comms Error	=RE01+UC06-TA01			TRUE	4	DCDC A Communication Error	2	3	Inspect network cables between DCDC Converter and main controller, and fix loose cables and replace broken cables	No
16004	16	4	Fuel Cell #6	DCDC B Comms Error	=RE01+UC06-TA02			TRUE	4	DCDC B Communication Error	2	3	Inspect network cables between DCDC Converter and main controller, and fix loose cables and replace broken cables	No
16005	16	5	Fuel Cell #6	FCwave Safety Tripped	=RE01+GB06-GB06			TRUE	4	FCwave Internal Safety Tripped	2	3	Check if there are any other indications of dangerous situations. Contact Ballard.	No
16006	16	6	Fuel Cell #6	Main Safety Tripped FCwave	=RE01+GB06-GB06			FALSE	4	Main Safety Controller Tripped FCwave	0	3	Mitigate alarm in Main Control	No
16007	16	7	Fuel Cell #6	DCDC A Fault	=RE01+UC06-TA01			TRUE	4	DCDC A Fault	1	3	Attempt restart. If problem persists, contact Ballard	Yes
16008	16	8	Fuel Cell #6	DCDC B Fault	=RE01+UC06-TA02			TRUE	4	DCDC B Fault	1	3	Attempt restart. If problem persists, contact Ballard	Yes
16009	16	9	Fuel Cell #6	FCwave Sev3 Alarm	=RE01+GB06-GB06			TRUE	4	FCwave Emergency Shutdown Alarm	0	3	Contact Ballard	No
16010	16	10	Fuel Cell #6	FCwave Sev2 Alarm	=RE01+GB06-GB06			TRUE	3	FCwave Shutdown Alarm	0	3	Contact Ballard	No
16011	16	11	Fuel Cell #6	Main Control Sev4 Alarm				TRUE	4	Main State Machine Sev 4 Alarm	0	3	Mitigate alarm in Main Control	
16012	16	12	Fuel Cell #6	Main Control Sev3 Alarm				TRUE	3	Main State Machine Sev 3 Alarm	0	3	Mitigate alarm in Main Control	
16013	16	13	Fuel Cell #6	Main Control Sev1 Alarm				TRUE	1	Main State Machine Sev 1 Alarm	0	3	Mitigate alarm in Main Control	
16014	16	14	Fuel Cell #6	Decay Test Fail	=RE01+GB06-GB06			TRUE	3	FCwave Internal Decay Test Failure	1	0	Check if there are any other indications of dangerous situations. Contact Ballard.	No
16015	16	15	Fuel Cell #6	Hydrogen Alarm Lockout	=RE01+GB06-GB06			TRUE	3	FCwave Internal Hydrogen Lockout	1	0	Check if there are any other indications of dangerous situations. Contact Ballard.	No
16016	16	16	Fuel Cell #6	HT Coolant Unavail				TRUE	3	HT Coolant System Unavailable	0	0	Mitigate alarm in HT Coolant System 2	Yes

AlarmID	ID Prefix	ID Suffix	Subsystem	Alarm Name	Tagname	Unit	Operator	Limit	Severity	Description	Delay Time	State Enable Delay	Corrective Action	Remote Friendly
20001	20	1	HT Cooling #1	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Higher level control system has stopped this subsystem	Yes
20002	20	2	HT Cooling #1	Header Level LowLow	=HE01+DA02-CL01	%	<	25	3	HT Coolant Header Tank Level Low Alarm	5	0	Refill coolant header tank and check sensor. Check for coolant leaks	No
20003	20	3	HT Cooling #1	Header Level Low	=HE01+DA02-CL01	%	<	40	1	HT Coolant Header Tank Level Low Warning	5	0	Schedule coolant header tank refill. Check for coolant leaks	No
20004	20	4	HT Cooling #1	Header Level High	=HE01+DA02-CL01	%	>	95	1	HT Coolant Header Tank Level High Warning	5	0	Schedule coolant header tank inspection - overfill likely	No
20005	20	5	HT Cooling #1	Header Level HighHigh	=HE01+DA02-CL01	%	>	110	3	HT Coolant Header Tank Level High Alarm	5	0	Perform coolant header tank inspection - overfill likely	No
20006	20	6	HT Cooling #1	Pump Inlet Temp LowLow	=HE01+DA02-BT02	°C	<	-12	3	Pump Inlet Temp Low Alarm	10	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
20007	20	7	HT Cooling #1	Pump Inlet Temp Low	=HE01+DA02-BT02	°C	<	-6	1	Pump Inlet Temp Low Warning	20	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
20008	20	8	HT Cooling #1	Pump Inlet Temp High	=HE01+DA02-BT02	°C	>	55	1	Pump Inlet Temp High Warning	20	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
20009	20	9	HT Cooling #1	Pump Inlet Temp HighHigh	=HE01+DA02-BT02	°C	>	60	3	Pump Inlet Temp High Alarm	10	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
20010	20	10	HT Cooling #1	Coolant Return Temp LowLow	=HE01+DA02-BT01	°C	<	-12	3	Coolant Return Temp Low Alarm	10	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
20011	20	11	HT Cooling #1	Coolant Return Temp Low	=HE01+DA02-BT01	°C	<	-6	1	Coolant Return Temp Low Warning	20	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
20012	20	12	HT Cooling #1	Coolant Return Temp High	=HE01+DA02-BT01	°C	>	65	1	Coolant Return Temp High Warning	20	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
20013	20	13	HT Cooling #1	Coolant Return Temp HighHigh	=HE01+DA02-BT01	°C	>	70	3	Coolant Return Temp High Alarm	10	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
20014	20	14	HT Cooling #1	Cool Tower Return Temp LowLow	=HE01+DA02-BT03	°C	<	-12	3	Coolant Tower Return Temp Low Alarm	10	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
20015	20	15	HT Cooling #1	Cool Tower Return Temp Low	=HE01+DA02-BT03	°C	<	-6	1	Coolant Tower Return Temp Low Warning	20	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
20016	20	16	HT Cooling #1	Cool Tower Return Temp High	=HE01+DA02-BT03	°C	>	55	1	Coolant Tower Return Temp High Warning	20	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
20017	20	17	HT Cooling #1	Cool Tower Return Temp HighHigh	=HE01+DA02-BT03	°C	>	60	3	Coolant Tower Return Temp High Alarm	10	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
20018	20	18	HT Cooling #1	FCwave Max Outlet Temp High		°C	>	65	1	Highest FCwave Outlet Temp Warn	20	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
20019	20	19	HT Cooling #1	FCwave Max Outlet Temp HighHigh		°C	>	70	3	Highest FCwave Outlet Temp Alarm	10	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
20020	20	20	HT Cooling #1	Coolant Flow LowLow	=HE01+DA02-BF01	m3/h	<	8	4	Coolant Flow Sensor Low Critical Alarm	5	30	Check for restrictions in coolant loop and pump functionality	No
20021	20	21	HT Cooling #1	Coolant Flow Low	=HE01+DA02-BF01	m3/h	<	12,5	1	Coolant Flow Sensor Low Warning	10	30	Check for restrictions in coolant loop and pump functionality	No
20022	20	22	HT Cooling #1	Coolant Pump Fault	=HE01+DA02-GP19			TRUE	3	Coolant Pump Fault	5	0	Restart pump and discontinue operation of this coolant loop if it persists	Yes
20023	20	23	HT Cooling #1	Coolant Pump Alarm	=HE01+DA02-GP19			TRUE	3	Coolant Pump Alarm	5	0	Restart pump and discontinue operation of this coolant loop if it persists	Yes
20024	20	24	HT Cooling #1	Fuse Trip HV	=LA01+UC30-FC11..FC16			FALSE	3	Fuse Trip 400VAC	5	0	Inspect and reset listed MCCBs. Inspect wiring and continue troubleshooting if issue persists	No
20025	20	25	HT Cooling #1	Fuse Trip 24V	=LA01+UC30-RB30			FALSE	3	Fuse Trip 24V PSU	5	0	Inspect and reset listed MCCBs. Inspect wiring and continue troubleshooting if issue persists	No
20026	20	26	HT Cooling #1	Fan Stalled		rpm	<	20	1	One or more fans not running	5	10	Restart coolant system. Cooling performance may be impacted	Yes
20027	20	27	HT Cooling #1	Cooler Valve Position Mismatch	=HE01+DA02-QN02	%	>	7	1	Cooler Valve Setpoint and Feedback Mismatch	40	20	Inspect and schedule service for valve.	Yes
20028	20	28	HT Cooling #1	Bypass Valve Position Mismatch	=HE01+DA02-QN01	%	>	7	1	Bypass Valve Setpoint and Feedback Mismatch	40	20	Inspect and schedule service for valve.	Yes
20029	20	29	HT Cooling #1	Pump Comms Error				TRUE	3	HT Pump Communication Failure	5	25	Inspect network connection between Pump VFD and main controller, and fix loose cables, replace broken cables and check network switches	No
20030	20	30	HT Cooling #1	Fans Comms Error				TRUE	1	One or more fans Communication Failure	5	25	Inspect network connection between Fan VFDs and main controller, and fix loose cables, replace broken cables and check network switches	No
21001	21	1	HT Cooling #2	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Higher level control system has stopped this subsystem	Yes
21002	21	2	HT Cooling #2	Header Level LowLow	=HE02+DA02-CL01	%	<	25	3	HT Coolant Header Tank Level Low Alarm	5	0	Refill coolant header tank and check sensor. Check for coolant leaks	No
21003	21	3	HT Cooling #2	Header Level Low	=HE02+DA02-CL01	%	<	40	1	HT Coolant Header Tank Level Low Warning	5	0	Schedule coolant header tank refill. Check for coolant leaks	No
21004	21	4	HT Cooling #2	Header Level High	=HE02+DA02-CL01	%	>	95	1	HT Coolant Header Tank Level High Warning	5	0	Schedule coolant header tank inspection - overfill likely	No
21005	21	5	HT Cooling #2	Header Level HighHigh	=HE02+DA02-CL01	%	>	110	3	HT Coolant Header Tank Level High Alarm	5	0	Perform coolant header tank inspection - overfill likely	No
21006	21	6	HT Cooling #2	Pump Inlet Temp LowLow	=HE02+DA02-BT02	°C	<	-12	3	Pump Inlet Temp Low Alarm	10	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
21007	21	7	HT Cooling #2	Pump Inlet Temp Low	=HE02+DA02-BT02	°C	<	-6	1	Pump Inlet Temp Low Warning	20	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
21008	21	8	HT Cooling #2	Pump Inlet Temp High	=HE02+DA02-BT02	°C	>	55	1	Pump Inlet Temp High Warning	20	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
21009	21	9	HT Cooling #2	Pump Inlet Temp HighHigh	=HE02+DA02-BT02	°C	>	60	3	Pump Inlet Temp High Alarm	10	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
21010	21	10	HT Cooling #2	Coolant Return Temp LowLow	=HE02+DA02-BT01	°C	<	-12	3	Coolant Return Temp Low Alarm	10	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
21011	21	11	HT Cooling #2	Coolant Return Temp Low	=HE02+DA02-BT01	°C	<	-6	1	Coolant Return Temp Low Warning	20	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
21012	21	12	HT Cooling #2	Coolant Return Temp High	=HE02+DA02-BT01	°C	>	65	1	Coolant Return Temp High Warning	20	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
21013	21	13	HT Cooling #2	Coolant Return Temp HighHigh	=HE02+DA02-BT01	°C	>	70	3	Coolant Return Temp High Alarm	10	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
21014	21	14	HT Cooling #2	Cool Tower Return Temp LowLow	=HE02+DA02-BT03	°C	<	-12	3	Coolant Tower Return Temp Low Alarm	10	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
21015	21	15	HT Cooling #2	Cool Tower Return Temp Low	=HE02+DA02-BT03	°C	<	-6	1	Coolant Tower Return Temp Low Warning	20	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
21016	21	16	HT Cooling #2	Cool Tower Return Temp High	=HE02+DA02-BT03	°C	>	55	1	Coolant Tower Return Temp High Warning	20	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
21017	21	17	HT Cooling #2	Cool Tower Return Temp HighHigh	=HE02+DA02-BT03	°C	>	60	3	Coolant Tower Return Temp High Alarm	10	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
21018	21	18	HT Cooling #2	FCwave Max Outlet Temp High		°C	>	65	1	Highest FCwave Outlet Temp Warning	20	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
21019	21	19	HT Cooling #2	FCwave Max Outlet Temp HighHigh		°C	>	70	3	Highest FCwave Outlet Temp Alarm	10	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
21020	21	20	HT Cooling #2	Coolant Flow LowLow	=HE02+DA02-BF01	m3/h	<	8	4	Coolant Flow Sensor Low Critical Alarm	5	30	Check for restrictions in coolant loop and pump functionality	No
21021	21	21	HT Cooling #2	Coolant Flow Low	=HE02+DA02-BF01	m3/h	<	12,5	1	Coolant Flow Sensor Low Warning	10	30	Check for restrictions in coolant loop and pump functionality	No
21022	21	22	HT Cooling #2	Coolant Pump Fault	=HE02+DA02-GP19			TRUE	3	Coolant Pump Fault	5	0	Restart pump and discontinue operation of this coolant loop if it persists	Yes
21023	21	23	HT Cooling #2	Coolant Pump Alarm	=HE02+DA02-GP19			TRUE	3	Coolant Pump Alarm	5	0	Restart pump and discontinue operation of this coolant loop if it persists	Yes

21024	21	24	HT Cooling #2	Fuse Trip HV	=LA01+UC30-FC21..FC26			FALSE	3	Fuse Trip 400VAC	5	0	Inspect and reset listed MCCBs. Inspect wiring and continue troubleshooting if issue persists	No
21025	21	25	HT Cooling #2	Fuse Trip 24V	=LA01+UC30-RB30			FALSE	3	Fuse Trip 24V PSU	5	0	Inspect and reset listed MCCBs. Inspect wiring and continue troubleshooting if issue persists	No
21026	21	26	HT Cooling #2	Fan Stalled		rpm	<	20	1	One or more fans not running	5	10	Restart coolant system. Cooling performance may be impacted	Yes
21027	21	27	HT Cooling #2	Cooler Valve Position Mismatch	=HE02+DA02-QN02	%	>	7	1	Cooler Valve Setpoint and Feedback Mismatch	40	20	Inspect and schedule service for valve.	Yes
21028	21	28	HT Cooling #2	Bypass Valve Position Mismatch	=HE02+DA02-QN01	%	>	7	1	Bypass Valve Setpoint and Feedback Mismatch	40	20	Inspect and schedule service for valve.	Yes
21029	21	29	HT Cooling #2	Pump Comms Error				TRUE	3	HT Pump Communication Failure	5	25	Inspect network connection between Pump VFD and main controller, and fix loose cables, replace broken cables and check network switches	No
21030	21	30	HT Cooling #2	Fans Comms Error				TRUE	1	One or more fans Communication Failure	5	25	Inspect network connection between Fan VFDs and main controller, and fix loose cables, replace broken cables and check network switches	No

AlarmID	ID Prefix	ID Suffix	Subsystem	Alarm Name	Tagname	Unit	Operator	Limit	Severity	Description	Delay Time	State Enable Delay	Corrective Action	Remote Friendly
22001	22	1	LT Cooling	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Higher level control system has stopped this subsystem	
22002	22	2	LT Cooling	High Return Temp Warning	=HE03+DA01-BT01	°C	>=	60	1	Return Temperature High Warning	3	0	Coolant System temperature is high, maximum ambient temperature is 25°C.	Yes
22003	22	3	LT Cooling	Pump Fault Alarm	=HE03+DA01-GP11			TRUE	4	LT Pump Drive Fault	0	0	Restart pump and discontinue operation of this coolant loop if it persists	Yes
22004	22	4	LT Cooling	Startup Timeout			=	TRUE	3	LT Cooling Startup Timeout	0	30	Restart pump and discontinue operation of this coolant loop if it persists	Yes
22005	22	5	LT Cooling	LTCoolFlowLowLow	=HE03+DA01-BF01	l/min	<	200	4	LT Cooling Flow Low Alarm	2	20	Check for restrictions in coolant loop and pump functionality	No
22006	22	6	LT Cooling	LTCoolFlowLow	=HE03+DA01-BF01	l/min	<	220	1	LT Cooling Flow Low Warning	2	20	Check for restrictions in coolant loop and pump functionality	No
22007	22	7	LT Cooling	CoolantFlow10ftLowLow		l/min	<	5	4	Main DCAC Cooling Flow Low Alarm	2	20	Check for restrictions in coolant loop and pump functionality around the DCAC	No
22008	22	8	LT Cooling	CoolantFlow10ftLow		l/min	<	8	1	Main DCAC Cooling Flow Low Warning	2	20	Check for restrictions in coolant loop and pump functionality around the DCAC	No
22009	22	9	LT Cooling	LTCoolDPLowLow	=HE03+DA01-BP01	bard	<	1	3	LT Coolant Differential Pressure Low Alarm	2	0	Unable to build pressure in LT system, inspect circuit and pump and flow restrictor e	No
22010	22	10	LT Cooling	LTCoolDPLow	=HE03+DA01-BP01	bard	<	1,1	1	LT Coolant Differential Pressure Low Warning	2	0	Low pressure in LT system, schedule inspection of circuit and pump and flow restric	Yes
22011	22	11	LT Cooling	LTCoolDPHigh	=HE03+DA01-BP01	bard	>	1,8	1	LT Coolant Differential Pressure High Warning	2	0	Schedule inspection to check for restrictions in coolant loop and pump functionality	Yes
22012	22	12	LT Cooling	LTCoolDPHighHigh	=HE03+DA01-BP01	bard	>	2	3	LT Coolant Differential Pressure High Alarm	2	0	Check for restrictions in coolant loop and pump functionality	No
22013	22	13	LT Cooling	LTCoolHeaderLevelLowLow	=HE03+DA03-CL01	%	<	20	3	LT Coolant Header Tank Level Low Alarm	5	0	Refill coolant header tank and check sensor. Check for coolant leaks	No
22014	22	14	LT Cooling	LTCoolHeaderLevelLow	=HE03+DA03-CL01	%	<	40	1	LT Coolant Header Tank Level Low Warning	5	0	Schedule coolant header tank refill. Check for coolant leaks	No
22015	22	15	LT Cooling	LTCoolHeaderLevelHigh	=HE03+DA03-CL01	%	>	95	1	LT Coolant Header Tank Level High Warning	5	0	Schedule coolant header tank inspection - overfill likely	No
22016	22	16	LT Cooling	LTCoolHeaderLevelHighHigh	=HE03+DA03-CL01	%	>	110	3	LT Coolant Header Tank Level High Alarm	5	0	Perform coolant header tank inspection - overfill likely	No
22017	22	17	LT Cooling	LTCoolFC1InletHighHigh	=HE03+DA01-BP02	Barg	>	2	3	FC1 LT Inlet Pressure High Alarm	2	0	Check for restrictions in coolant loop around FCwave 1	No
22018	22	18	LT Cooling	LTCoolFC1InletHigh	=HE03+DA01-BP02	Barg	>	1,8	1	FC1 LT Inlet Pressure High Warning	2	0	Schedule inspection to check for restrictions in coolant loop around FCwave 1	Yes
22019	22	19	LT Cooling	LTCoolFC2InletHighHigh	=HE03+DA01-BP03	Barg	>	2	3	FC2 LT Inlet Pressure High Alarm	2	0	Check for restrictions in coolant loop around FCwave 2	No
22020	22	20	LT Cooling	LTCoolFC2InletHigh	=HE03+DA01-BP03	Barg	>	1,8	1	FC2 LT Inlet Pressure High Warning	2	0	Schedule inspection to check for restrictions in coolant loop around FCwave 2	Yes
22021	22	21	LT Cooling	LTCoolFC3InletHighHigh	=HE03+DA01-BP04	Barg	>	2	3	FC3 LT Inlet Pressure High Alarm	2	0	Check for restrictions in coolant loop around FCwave 3	No
22022	22	22	LT Cooling	LTCoolFC3InletHigh	=HE03+DA01-BP04	Barg	>	1,8	1	FC3 LT Inlet Pressure High Warning	2	0	Schedule inspection to check for restrictions in coolant loop around FCwave 3	Yes
22023	22	23	LT Cooling	LTCoolFC4InletHighHigh	=HE03+DA01-BP05	Barg	>	2	3	FC4 LT Inlet Pressure High Alarm	2	0	Check for restrictions in coolant loop around FCwave 4	No
22024	22	24	LT Cooling	LTCoolFC4InletHigh	=HE03+DA01-BP05	Barg	>	1,8	1	FC4 LT Inlet Pressure High Warning	2	0	Schedule inspection to check for restrictions in coolant loop around FCwave 4	Yes
22025	22	25	LT Cooling	LTCoolFC5InletHighHigh	=HE03+DA01-BP06	Barg	>	2	3	FC5 LT Inlet Pressure High Alarm	2	0	Check for restrictions in coolant loop around FCwave 5	No
22026	22	26	LT Cooling	LTCoolFC5InletHigh	=HE03+DA01-BP06	Barg	>	1,8	1	FC5 LT Inlet Pressure High Warning	2	0	Schedule inspection to check for restrictions in coolant loop around FCwave 5	Yes
22027	22	27	LT Cooling	LTCoolFC6InletHighHigh	=HE03+DA01-BP07	Barg	>	2	3	FC6 LT Inlet Pressure High Alarm	2	0	Check for restrictions in coolant loop around FCwave 6	No
22028	22	28	LT Cooling	LTCoolFC6InletHigh	=HE03+DA01-BP07	Barg	>	1,8	1	FC6 LT Inlet Pressure High Warning	2	0	Schedule inspection to check for restrictions in coolant loop around FCwave 6	Yes
22029	22	29	LT Cooling	LTCoolFC1InletWirebreak	=HE03+DA01-BP02	Barg	<	-0,5	1	Diag: FC1 LT Inlet Pressure Wirebreak	2	0	Schedule inspection to check/replace wire or sensor	Yes
22030	22	30	LT Cooling	LTCoolFC2InletWirebreak	=HE03+DA01-BP03	Barg	<	-0,5	1	Diag: FC2 LT Inlet Pressure Wirebreak	2	0	Schedule inspection to check/replace wire or sensor	Yes
22031	22	31	LT Cooling	LTCoolFC3InletWirebreak	=HE03+DA01-BP04	Barg	<	-0,5	1	Diag: FC3 LT Inlet Pressure Wirebreak	2	0	Schedule inspection to check/replace wire or sensor	Yes
22032	22	32	LT Cooling	LTCoolFC4InletWirebreak	=HE03+DA01-BP05	Barg	<	-0,5	1	Diag: FC4 LT Inlet Pressure Wirebreak	2	0	Schedule inspection to check/replace wire or sensor	Yes
22033	22	33	LT Cooling	LTCoolFC5InletWirebreak	=HE03+DA01-BP06	Barg	<	-0,5	1	Diag: FC5 LT Inlet Pressure Wirebreak	2	0	Schedule inspection to check/replace wire or sensor	Yes
22034	22	34	LT Cooling	LTCoolFC6InletWirebreak	=HE03+DA01-BP07	Barg	<	-0,5	1	Diag: FC6 LT Inlet Pressure Wirebreak	2	0	Schedule inspection to check/replace wire or sensor	Yes
22035	22	35	LT Cooling	Return Temp LowLow	=HE03+DA01-BT01	°C	<	-12	3	Return Temperature Low Alarm	20	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
22036	22	36	LT Cooling	Return Temp Low	=HE03+DA01-BT01	°C	<	-6	1	Return Temperature Low Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
22037	22	37	LT Cooling	Return Temp High	=HE03+DA01-BT01	°C	>	55	1	Return Temperature High Warning	10	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
22038	22	38	LT Cooling	Return Temp HighHigh	=HE03+DA01-BT01	°C	>	65	3	Return Temperature High Alarm	20	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
22039	22	39	LT Cooling	Forward Temp LowLow	=HE03+DA01-BT02	°C	<	-12	3	Forward Temperature Low Alarm	20	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
22040	22	40	LT Cooling	Forward Temp Low	=HE03+DA01-BT02	°C	<	-6	1	Forward Temperature Low Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
22041	22	41	LT Cooling	Forward Temp High	=HE03+DA01-BT02	°C	>	45	1	Forward Temperature High Warning	10	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
22042	22	42	LT Cooling	Forward Temp HighHigh	=HE03+DA01-BT02	°C	>	55	3	Forward Temperature High Alarm	20	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
22043	22	43	LT Cooling	Cool Tower Return Temp LowLow	=HE03+DA01-BT03	°C	<	-12	3	Coolant Tower Return Temperature Low Alarm	20	0	Minimum ambinent temperature is -6°C, do not operate system	Yes

22044	22	44	LT Cooling	Cool Tower Return Temp Low	=HE03+DA01-BT03	°C	<	-6	1	Coolant Tower Return Temperature Low Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
22045	22	45	LT Cooling	Cool Tower Return Temp High	=HE03+DA01-BT03	°C	>	55	1	Coolant Tower Return Temperature High Warning	10	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
22046	22	46	LT Cooling	Cool Tower Return Temp HighHigh	=HE03+DA01-BT03	°C	>	65	3	Coolant Tower Return Temperature High Alarm	20	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
22047	22	47	LT Cooling	Cool 10ft Forward Temp LowLow	=HE03+DA03-BT07	°C	<	-12	3	10ft Forward Temperature Low Alarm	20	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
22048	22	48	LT Cooling	Cool 10ft Forward Temp Low	=HE03+DA03-BT07	°C	<	-6	1	10ft Forward Temperature Low Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
22049	22	49	LT Cooling	Cool 10ft Forward Temp High	=HE03+DA03-BT07	°C	>	45	1	10ft Forward Temperature High Warning	10	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
22050	22	50	LT Cooling	Cool 10ft Forward Temp HighHigh	=HE03+DA03-BT07	°C	>	55	3	10ft Forward Temperature High Alarm	20	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
22051	22	51	LT Cooling	Cool 10ft Return Temp LowLow	=HE03+DA03-BF02	°C	<	-12	3	10ft Return Temperature Low Alarm	20	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
22052	22	52	LT Cooling	Cool 10ft Return Temp Low	=HE03+DA03-BF02	°C	<	-6	1	10ft Return Temperature Low Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system	Yes
22053	22	53	LT Cooling	Cool 10ft Return Temp High	=HE03+DA03-BF02	°C	>	55	1	10ft Return Temperature High Warning	10	0	Coolant System temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
22054	22	54	LT Cooling	Cool 10ft Return Temp HighHigh	=HE03+DA03-BF02	°C	>	65	3	10ft Return Temperature High Alarm	20	0	Coolant System temperature is too high, maximum ambient temperature is 25°C	Yes
22055	22	55	LT Cooling	Three Way Valve Position Mismatch	=HE03+DA01-QN01	%	>	7	1	3-way Valve Setpoint and Feedback Mismatch	40	20	Inspect and schedule service for valve.	Yes
22056	22	56	LT Cooling	Pump Comms Error	=HE03+DA01-GP11			TRUE	3	Pump Communication Error	5	0	Inspect network connection between Pump VFD and main controller, and fix loose cables, replace broken cables and check network switches	No
22057	22	57	LT Cooling	Fan Comms Error	=HE03+DA04-EG01			TRUE	1	LT Coolant Fan Communication Error	5	0	Inspect network connection between Fan VFD and main controller, and fix loose cables, replace broken cables and check network switches	No
22058	22	58	LT Cooling	Fan Stalled	=HE03+DA04-EG01	rpm	<	20	20	LT Coolant Fan Not Running	5	0	Restart coolant system. Cooling performance may be impacted	Yes

AlarmID	ID Prefix	ID Suffix	**Subsystem**	**Alarm Name**	**Tagname**	**Unit**	Operator	Limit	Severity	**Description**	Delay Time	State Enable Delay	Corrective Action	Remote Friendly
29001	29	1	Nanogrid	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Higher level control system has stopped this subsystem	No
29002	29	2	Nanogrid	Nanogrid HzVolt Not OK				FALSE	3	Nanogrid HzVolt Not OK	0	0	Internal BOP AC grid Voltage/Hz not within acceptable parameters	Yes
29003	29	3	Nanogrid	Aux HzVolt Not OK				FALSE	1	Aux HzVolt Not OK. Unable to start	0	0	External BOP AC grid Voltage/Hz not within acceptable parameters.	Yes
29004	29	4	Nanogrid	Nanogrid Contactor Malfunction	=LA01+UC50-FC01			TRUE	1	Nanogrid Contactor Not Actuating	2	0	Inspect and replace contactor	No
29005	29	5	Nanogrid	Aux Contactor Malfunction	=LA01+UC50-FC02			TRUE	1	Aux Contactor Not Actuating	2	0	Inspect and replace contactor	No

AlarmID	ID Prefix	ID Suffix	**Subsystem**	**Alarm Name**	**Tagname**	**Unit**	Operator	Limit	Severity	**Description**	Delay Time	State Enable Delay	Corrective Action	Remote Friendly
30001	30	1	Main DCAC	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Higher level control system has stopped this subsystem	No
30002	30	2	Main DCAC	MicrogridWarning	=BA30+DA30			TRUE	1	Main DCAC Warning - See Error Code	1	5	Schedule inspection of DC/AC. Contact Ballard	Yes
30003	30	3	Main DCAC	MicrogridFault	=BA30+DA30			TRUE	3	Main DCAC Fault - See Error Code	1	5	Attempt restart. If problem persists, contact Ballard	Yes
30004	30	4	Main DCAC	MicrogridNotStarting	=BA30+DA30			FALSE	3	Main DCAC Not Reaching Ready State	0	10	Attempt restart. If problem persists, contact Ballard	Yes
30005	30	5	Main DCAC	MicrogridNotRunning	=BA30+DA30			FALSE	3	Main DCAC Not Reaching Running	0	12	Attempt restart. If problem persists, contact Ballard	Yes
30006	30	6	Main DCAC	MicrogridDriveTempHighHigh	=BA30+DA30	°C	>	60	3	Main DCAC High Temperature Alarm	2	10	DCAC temperature is too high, maximum ambient temperature is 25°C	Yes
30007	30	7	Main DCAC	MicrogridDriveTempHigh	=BA30+DA30	°C	>	55	1	Main DCAC High Temperature Warning	2	10	DCAC temperature is high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
30008	30	8	Main DCAC	MicrogridDriveTempLow	=BA30+DA30	°C	<	3	1	Main DCAC Low Temperature Warning	20	600	Keep running system, if possible without reducing power	Yes
30009	30	9	Main DCAC	MicrogridDriveTempLowLow	=BA30+DA30	°C	<	-2	3	Main DCAC Low Temperature Alarm	20	600	Do not attempt run system until temperature has increased to above alarm limit. Inspect and fix Container Climate 10ft subsystem	Yes
30010	30	10	Main DCAC	MicrogridNotAtReference	=BA30+DA30			FALSE	1	Main DCAC Not At Reference	2	10	Schedule inspection of DC/AC if warning persists	Yes
30011	30	11	Main DCAC	MainbreakerSpringChargeFail	=BA30+DA30			FALSE	3	Main Breaker Spring Charge Fail	8	0	Inspect and service Main Breaker	No
30012	30	12	Main DCAC	Customer AC Fuse Trip	=LA01+UC30-FC11			FALSE	3	Customer AC Fuse Trip	5	0	Inspect and reset listed MCCBs. Inspect wiring and continue troubleshooting if issue persists	No
30013	30	13	Main DCAC	AC Busbar Fuse Trip	=LA01+UC30-FC10			FALSE	3	AC Busbar Fuse Trip	5	0	Inspect and reset listed MCCBs. Inspect wiring and continue troubleshooting if issue persists	No
30014	30	14	Main DCAC	Main Breaker Error	=BA30+DA03-FC30			TRUE	3	Main Breaker Error	0	0	Inspect and service Main Breaker	No
30015	30	15	Main DCAC	Customer HzVolt Not OK	<BLPH>			FALSE	1	Customer Busbar HzVolt Not OK	6	10	Lowside Main AC Voltage/Hz outside normal parameters. Correct and restart	Yes
30016	30	16	Main DCAC	Main Busbar HzVolt Not OK	<BLPH>			FALSE	1	Main Internal Busbar HzVolt Not OK	6	10	Lowside Main AC Voltage/Hz outside normal parameters. Correct and restart	Yes

AlarmID	ID Prefix	ID Suffix	Subsystem	Alarm Name	Tagname	Unit	Operator	Limit	Severity	Description	Delay Time	State Enable Delay	Corrective Action	Remote Friendly
40001	40	1	Ventilation	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Higher level control system has stopped this subsystem	
40002	40	2	Ventilation	VentA40ftTempIntakeLow	=JA01+DA01-BT01	°C	<	-1	0	Ventilation Intake Air Freezing	10	0	No action required	Yes
40003	40	3	Ventilation	Vent40ftTemp1Wirebreak	=JA01+DA01-BT02	°C	<	-200	3	BT02 Temp Sensor Wiring Fault	5	5	Schedule inspection and replacement of cable	Yes
40004	40	4	Ventilation	Vent40ftTemp1Short	=JA01+DA01-BT02	°C	>	150	1	n/a	5	5	n/a	Yes
40005	40	5	Ventilation	Vent40ftTemp2Wirebreak	=JA01+DA01-BT03	°C	<	-200	3	BT03 Temp Sensor Wiring Fault	5	5	Schedule inspection and replacement of cable	Yes
40006	40	6	Ventilation	Vent40ftTemp2Short	=JA01+DA01-BT03	°C	>	150	1	n/a	5	5	n/a	Yes
40007	40	7	Ventilation	Intake Damper A Wirebreak	=JA01+DA02-QM01	%	<	-10	1	Ventilation Intake Damper A Wirebreak	5	5	Schedule inspection and replacement of cable	Yes
40008	40	8	Ventilation	Intake Damper A Short	=JA01+DA02-QM01	%	>	110	1	Ventilation Intake Damper A Short	5	5	Schedule inspection and replacement of cable	Yes
40009	40	9	Ventilation	Intake Damper B Wirebreak	=JA01+DA02-QM02	%	<	-10	1	Ventilation Intake Damper B Wirebreak	5	5	Schedule inspection and replacement of cable	Yes
40010	40	10	Ventilation	Intake Damper B Short	=JA01+DA02-QM02	%	>	110	1	Ventilation Intake Damper B Short	5	5	Schedule inspection and replacement of cable	Yes
40011	40	11	Ventilation	Outlet Damper A Wirebreak	=JA01+DA01-QM03	%	<	-10	1	Ventilation Outlet Damper A Wirebreak	5	5	Schedule inspection and replacement of cable	Yes
40012	40	12	Ventilation	Outlet Damper A Short	=JA01+DA01-QM03	%	>	110	1	Ventilation Outlet Damper A Short	5	5	Schedule inspection and replacement of cable	Yes
40013	40	13	Ventilation	Outlet Damper B Wirebreak	=JA01+DA01-QM04	%	<	-10	1	Ventilation Outlet Damper B Wirebreak	5	5	Schedule inspection and replacement of cable	Yes
40014	40	14	Ventilation	Outlet Damper B Short	=JA01+DA01-QM04	%	>	110	1	Ventilation Outlet Damper B Short	5	5	Schedule inspection and replacement of cable	Yes
40015	40	15	Ventilation	Outlet Damper C Wirebreak	=JA01+DA01-QM05	%	<	-10	1	Ventilation Outlet Damper C Wirebreak	5	5	Schedule inspection and replacement of cable	Yes
40016	40	16	Ventilation	Outlet Damper C Short	=JA01+DA01-QM05	%	>	110	1	Ventilation Outlet Damper C Short	5	5	Schedule inspection and replacement of cable	Yes
40017	40	17	Ventilation	Outlet Damper D Wirebreak	=JA01+DA01-QM06	%	<	-10	1	Ventilation Outlet Damper D Wirebreak	5	5	Schedule inspection and replacement of cable	Yes
40018	40	18	Ventilation	Outlet Damper D Short	=JA01+DA01-QM06	%	>	110	1	Ventilation Outlet Damper D Short	5	5	Schedule inspection and replacement of cable	Yes
40019	40	19	Ventilation	Intake Damper A Stuck	=JA01+DA02-QM01	%	>	7	1	Ventilation Intake Damper A Stuck	50	5	Schedule inspection and fix damper	Yes
40020	40	20	Ventilation	Intake Damper B Stuck	=JA01+DA02-QM02	%	>	7	1	Ventilation Intake Damper B Stuck	50	5	Schedule inspection and fix damper	Yes
40021	40	21	Ventilation	Outlet Damper A Stuck	=JA01+DA01-QM03	%	>	7	1	Ventilation Outlet Damper A Stuck	50	5	Schedule inspection and fix damper	Yes
40022	40	22	Ventilation	Outlet Damper B Stuck	=JA01+DA01-QM04	%	>	7	1	Ventilation Outlet Damper B Stuck	50	5	Schedule inspection and fix damper	Yes
40023	40	23	Ventilation	Outlet Damper C Stuck	=JA01+DA02-QM05	%	>	7	1	Ventilation Outlet Damper C Stuck	50	5	Schedule inspection and fix damper	Yes
40024	40	24	Ventilation	Outlet Damper D Stuck	=JA01+DA02-QM06	%	>	7	1	Ventilation Outlet Damper D Stuck	50	5	Schedule inspection and fix damper	Yes
40025	40	25	Ventilation	Container Indoor/Outdoor dP Low	=JA01+DA01-BP02	Pa	<	15	1	Indoor/Outdoor Differential Pressure Low	300	300	Check for open doors or sensor malfunction	No
40026	40	26	Ventilation	Intake Filter dP High	=JA01+DA01-BP01	Pa	>	200	1	Intake Filter dP High	60	60	Schedule maintenance or replacement of intake filters	Yes
40027	40	27	Ventilation	Container Indoor/Outdoor dP Wirebreak	=JA01+DA01-BP02	Pa	<	-120	1	Container Indoor/Outdoor Wirebreak	5	5	Schedule inspection and replacement of cable	Yes
40028	40	28	Ventilation	Container Indoor/Outdoor dP Short	=JA01+DA01-BP02	Pa	>	120	1	Container Indoor/Outdoor Short	5	5	Schedule inspection and replacement of cable	Yes
40029	40	29	Ventilation	Intake Filter dP Wirebreak	=JA01+DA01-BP01	Pa	<	-120	1	Intake Filter dP Wirebreak	5	5	Schedule inspection and replacement of cable	Yes
40030	40	30	Ventilation	Intake Filter dP Short	=JA01+DA01-BP01	Pa	>	3000	1	Intake Filter dP Short	5	5	Schedule inspection and replacement of cable	Yes

AlarmID	ID Prefix	ID Suffix	Subsystem	Alarm Name	Tagname	Unit	Operator	Limit	Severity	Description	Delay Time	State Enable Delay	Corrective Action	Remote Friendly
41001	41	1	40ft Climate	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0		
41002	41	2	40ft Climate	Vent40ftTemp1High	=JA01+DA01-BT02	°C	>	41	1	Container Temperature High Warning	0	0	Container temperature is too high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	
41003	41	3	40ft Climate	Vent40ftTemp1HighHigh	=JA01+DA01-BT02	°C	>	46	3	Container Temperature High Alarm	5	0	Container temperature is too high, maximum ambient temperature is 25°C.	
41004	41	4	40ft Climate	Vent40ftTemp1Low	=JA01+DA01-BT02	°C	<	5	1	Container Temperature Low Warning	5	0	Minimum ambinent temperature is -6°C, allow system to selfheat	
41005	41	5	40ft Climate	Vent40ftTemp1LowLow	=JA01+DA01-BT02	°C	<	0	3	Container Internal Temperature Alarm	10	0	Minimum ambinent temperature is -6°C, prevent freezing or perform dryout on fuel cell modules	
41006	41	6	40ft Climate	Vent40ftTemp2High	=JA01+DA01-BT03	°C	>	41	1	Container Temperature High Warning	10	0	Container temperature is too high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	
41007	41	7	40ft Climate	Vent40ftTemp2HighHigh	=JA01+DA01-BT03	°C	>	46	3	Container Temperature High Alarm	5	0	Container temperature is too high, maximum ambient temperature is 25°C.	
41008	41	8	40ft Climate	Vent40ftTemp2Low	=JA01+DA01-BT03	°C	<	5	1	Container Temperature Low Warning	5	0	Minimum ambinent temperature is -6°C, allow system to selfheat	
41009	41	9	40ft Climate	Vent40ftTemp2LowLow	=JA01+DA01-BT03	°C	<	0	3	Container Temperature Low Alarm	10	0	Minimum ambinent temperature is -6°C, prevent freezing or perform dryout on fuel cell modules	
41010	41	10	40ft Climate	Vent40ftFan1Run	=JA01+UC07-GQ08	rpm	<	100	3	40ft Heater Fan 1 Not Running	10	0	Inspect and replace fan	No
41011	41	11	40ft Climate	Vent40ftFan2Run	=JA01+UC07-GQ08	rpm	<	100	3	40ft Heater Fan 2 Not Running	10	0	Inspect and replace fan	No
41012	41	12	40ft Climate	Vent40ftUC01High	=BA01+UC01-BT01	°C	>	45	1	DCDC Cabinet UC01 High Warning	5	0	Cabinet temperature is too high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	
41013	41	13	40ft Climate	Vent40ftUC01HighHigh	=BA01+UC01-BT01	°C	>	55	3	DCDC Cabinet UC01 HighHigh Alarm	5	0	Cabinet temperature is too high, maximum ambient temperature is 25°C.	
41014	41	14	40ft Climate	Vent40ftUC01Low	=BA01+UC01-BT01	°C	<	5	1	DCDC Cabinet UC01 Low Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system below	
41015	41	15	40ft Climate	Vent40ftUC01LowLow	=BA01+UC01-BT01	°C	<	0	1	DCDC Cabinet UC01 LowLow Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system below	
41016	41	16	40ft Climate	Vent40ftUC01Wirebreak	=BA01+UC01-BT01	°C	<	-200	3	Diag: UC01 Temp Sensor Wiring Fault	1	0	Inspect cable between Sensor and Main Controller, and fix loose/replace broken cable	
41017	41	17	40ft Climate	Vent40ftUC01Short	=BA01+UC01-BT01	°C	>	150	1	n/a	1	0	n/a	
41018	41	18	40ft Climate	Vent40ftUC02High	=BA01+UC02-BT01	°C	>	45	1	DCDC Cabinet UC02 High Warning	5	0	Cabinet temperature is too high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	
41019	41	19	40ft Climate	Vent40ftUC02HighHigh	=BA01+UC02-BT01	°C	>	55	3	DCDC Cabinet UC02 HighHigh Alarm	5	0	Cabinet temperature is too high, maximum ambient temperature is 25°C.	
41020	41	20	40ft Climate	Vent40ftUC02Low	=BA01+UC02-BT01	°C	<	5	1	DCDC Cabinet UC02 Low Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system below	
41021	41	21	40ft Climate	Vent40ftUC02LowLow	=BA01+UC02-BT01	°C	<	0	1	DCDC Cabinet UC02 LowLow Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system below	
41022	41	22	40ft Climate	Vent40ftUC02Wirebreak	=BA01+UC02-BT01	°C	<	-200	3	Diag: UC01 Temp Sensor Wiring Fault	1	0	Inspect cable between Sensor and Main Controller, and fix loose/replace broken cable	
41023	41	23	40ft Climate	Vent40ftUC02Short	=BA01+UC02-BT01	°C	>	150	1	n/a	1	0	n/a	
41024	41	24	40ft Climate	Vent40ftUC03High	=BA01+UC03-BT01	°C	>	45	1	DCDC Cabinet UC03 High Warning	5	0	Cabinet temperature is too high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	
41025	41	25	40ft Climate	Vent40ftUC03HighHigh	=BA01+UC03-BT01	°C	>	55	3	DCDC Cabinet UC03 HighHigh Alarm	5	0	Cabinet temperature is too high, maximum ambient temperature is 25°C.	
41026	41	26	40ft Climate	Vent40ftUC03Low	=BA01+UC03-BT01	°C	<	5	1	DCDC Cabinet UC03 Low Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system below	
41027	41	27	40ft Climate	Vent40ftUC03LowLow	=BA01+UC03-BT01	°C	<	0	1	DCDC Cabinet UC03 LowLow Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system below	
41028	41	28	40ft Climate	Vent40ftUC03Wirebreak	=BA01+UC03-BT01	°C	<	-200	3	Diag: UC01 Temp Sensor Wiring Fault	1	0	Inspect cable between Sensor and Main Controller, and fix loose/replace broken cable	
41029	41	29	40ft Climate	Vent40ftUC03Short	=BA01+UC03-BT01	°C	>	150	1	n/a	1	0	n/a	
41030	41	30	40ft Climate	Vent40ftUC04High		°C	>	45	1	DCDC Cabinet UC04 High Warning	5	0	Cabinet temperature is too high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	
41031	41	31	40ft Climate	Vent40ftUC04HighHigh	=BA01+UC04-BT01	°C	>	55	3	DCDC Cabinet UC04 HighHigh Alarm	5	0	Cabinet temperature is too high, maximum ambient temperature is 25°C.	
41032	41	32	40ft Climate	Vent40ftUC04Low	=BA01+UC04-BT01	°C	<	5	1	DCDC Cabinet UC04 Low Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system below	
41033	41	33	40ft Climate	Vent40ftUC04LowLow	=BA01+UC04-BT01	°C	<	0	1	DCDC Cabinet UC04 LowLow Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system below	
41034	41	34	40ft Climate	Vent40ftUC04Wirebreak	=BA01+UC04-BT01	°C	<	-200	3	Diag: UC01 Temp Sensor Wiring Fault	1	0	Inspect cable between Sensor and Main Controller, and fix loose/replace broken cable	
41035	41	35	40ft Climate	Vent40ftUC04Short	=BA01+UC04-BT01	°C	>	150	1	n/a	1	0	n/a	
41036	41	36	40ft Climate	Vent40ftUC05High	=BA01+UC05-BT01	°C	>	45	1	DCDC Cabinet UC05 High Warning	5	0	Cabinet temperature is too high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	
41037	41	37	40ft Climate	Vent40ftUC05HighHigh	=BA01+UC05-BT01	°C	>	55	3	DCDC Cabinet UC05 HighHigh Alarm	5	0	Cabinet temperature is too high, maximum ambient temperature is 25°C.	
41038	41	38	40ft Climate	Vent40ftUC05Low	=BA01+UC05-BT01	°C	<	5	1	DCDC Cabinet UC05 Low Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system below	
41039	41	39	40ft Climate	Vent40ftUC05LowLow	=BA01+UC05-BT01	°C	<	0	1	DCDC Cabinet UC05 LowLow Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system below	
41040	41	40	40ft Climate	Vent40ftUC05Wirebreak	=BA01+UC05-BT01	°C	<	-200	3	Diag: UC01 Temp Sensor Wiring Fault	1	0	Inspect cable between Sensor and Main Controller, and fix loose/replace broken cable	
41041	41	41	40ft Climate	Vent40ftUC05Short	=BA01+UC05-BT01	°C	>	150	1	n/a	1	0	n/a	
41042	41	42	40ft Climate	Vent40ftUC06High	=BA01+UC05-BT01	°C	>	45	1	DCDC Cabinet UC06 High Warning	5	0	Cabinet temperature is too high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	
41043	41	43	40ft Climate	Vent40ftUC06HighHigh	=BA01+UC06-BT01	°C	>	55	3	DCDC Cabinet UC06 HighHigh Alarm	5	0	Cabinet temperature is too high, maximum ambient temperature is 25°C.	
41044	41	44	40ft Climate	Vent40ftUC06Low	=BA01+UC06-BT01	°C	<	5	1	DCDC Cabinet UC06 Low Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system below	
41045	41	45	40ft Climate	Vent40ftUC06LowLow	=BA01+UC06-BT01	°C	<	0	1	DCDC Cabinet UC06 LowLow Warning	10	0	Minimum ambinent temperature is -6°C, do not operate system below	
41046	41	46	40ft Climate	Vent40ftUC06Wirebreak	=BA01+UC06-BT01	°C	<	-200	3	Diag: UC01 Temp Sensor Wiring Fault	1	0	Inspect cable between Sensor and Main Controller, and fix loose/replace broken cable	
41047	41	47	40ft Climate	Vent40ftUC06Short	=BA01+UC06-BT01	°C	>	150	1	n/a	1	0	n/a	

AlarmID	ID Prefix	ID Suffix	**Subsystem**	**Alarm Name**	**Tagname**	**Unit**	Operator	Limit	Severity	**Description**	Delay Time	State Enable Delay	Corrective Action	Remote Friendly
42001	42	1	10ft Climate	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Higher level control system has stopped this subsystem	No
42002	42	2	10ft Climate	TransformerUTempHighHigh	=BA20+DA03-TA30	°C	>	80	3	Transformer Temperature High Alarm	2	0	Transformer temperature is too high, maximum ambient temperature is 25°C	Yes
42003	42	3	10ft Climate	TransformerVTempHighHigh	=BA20+DA03-TA30	°C	>	80	3	Transformer Temperature High Alarm	2	0	Transformer temperature is too high, maximum ambient temperature is 25°C	Yes
42004	42	4	10ft Climate	TransformerWTempHighHigh	=BA20+DA03-TA30	°C	>	80	3	Transformer Temperature High Alarm	2	0	Transformer temperature is too high, maximum ambient temperature is 25°C	Yes
42005	42	5	10ft Climate	TransformerUTempHigh	=BA20+DA03-TA30	°C	>	70	1	Transformer Temperature High Warning	2	0	Transformer temperature is too high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
42006	42	6	10ft Climate	TransformerVTempHigh	=BA20+DA03-TA30	°C	>	70	1	Transformer Temperature High Warning	2	0	Transformer temperature is too high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
42007	42	7	10ft Climate	TransformerWTempHigh	=BA20+DA03-TA30	°C	>	70	1	Transformer Temperature High Warning	2	0	Transformer temperature is too high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
42008	42	8	10ft Climate	Vent10ftTempHighHigh	=JA01+DA03-BT01	°C	>	46	3	10ft Container Temperature High Alarm	2	0	Container temperature is too high, maximum ambient temperature is 25°C. Reducing power might mitigate warning	Yes
42009	42	9	10ft Climate	Vent10ftTempHigh	=JA01+DA03-BT01	°C	>	41	1	10ft Container Temperature High Warning	1	0	Container temperature is too high, maximum ambient temperature is 25°C.	Yes
42010	42	10	10ft Climate	Vent10ftTempLow	=JA01+DA03-BT01	°C	<	2	1	10ft Container Temperature Low Warning	1	0	Minimum ambinent temperature is -6°C, allow system to selfheat	Yes
42011	42	11	10ft Climate	Vent10ftTempLowLow	=JA01+DA03-BT01	°C	<	-2	3	10ft Container Temperature Low Alarm	2	0	Minimum ambinent temperature is -6°C, do not operate system below	Yes
42012	42	12	10ft Climate	TransformerUWirebreak	=BA20+DA03-TA30	°C	<	-200	1	Transformer Temperature Sensor Wiring Fault	5	0	Inspect cable between Sensor and Main Controller, and fix loose/replace broken cable	No
42013	42	13	10ft Climate	TransformerVWirebreak	=BA20+DA03-TA30	°C	<	-200	1	Transformer Temperature Sensor Wiring Fault	5	0	Inspect cable between Sensor and Main Controller, and fix loose/replace broken cable	No
42014	42	14	10ft Climate	TransformerWWirebreak	=BA20+DA03-TA30	°C	<	-200	1	Transformer Temperature Sensor Wiring Fault	5	0	Inspect cable between Sensor and Main Controller, and fix loose/replace broken cable	No
42015	42	15	10ft Climate	Vent10ftTempWirebreak	=JA01+DA03-BT01	°C	<	-200	1	10ft Container Temperature Wiring Fault	5	0	Inspect cable between Sensor and Main Controller, and fix loose/replace broken cable	No

AlarmID	ID Prefix	ID Suffix	**Subsystem**	**Alarm Name**	**Tagname**	**Unit**	Operator	Limit	Severity	**Description**	Delay Time	State Enable Delay	Corrective Action	Remote Friendly
43001	43	1	H2 Heater	Induced Emerg Error Alarm				TRUE	4	Main State Machine Emergency Stop	0	0	Higher level control system has stopped this subsystem	
43002	43	2	H2 Heater	H2HeatTempHighHigh	=HA01+DA02-BT01	°C	>	90	3	H2 Heater High Temperature Alarm	2	0	Contact Ballard	Yes
43003	43	3	H2 Heater	H2HeatTempHigh	=HA01+DA02-BT01	°C	>	80	1	H2 Heater High Temperature Warning	5	0	Contact Ballard	Yes
43004	43	4	H2 Heater	H2HeatTempLow	=HA01+DA02-BT01	°C	<	-10	1	H2 Heater Low Temperature Warning	5	0	Minimum ambinent temperature is -6°C, do not operate system below	Yes
43005	43	5	H2 Heater	H2HeatTempLowLow	=HA01+DA02-BT01	°C	<	-12	3	H2 Heater Low Temperature Alarm	2	0	Minimum ambinent temperature is -6°C, do not operate system below	Yes
43006	43	6	H2 Heater	H2HeatLevelLow	=HA01+DA02-BL01		=	FALSE	3	H2 Heater Low Liquid Level	2	0	Refill H2 Heating System Tank	No
43007	43	7	H2 Heater	H2HeatLevelLowStby	=HA01+DA02-BL01		=	FALSE	1	H2 Heater Low Liquid Level	2	0	Schedule refill of the H2 Heating System Tank	Yes