Base Load Power Hub (BLPH)

HAZOP Report

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.1.1 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.

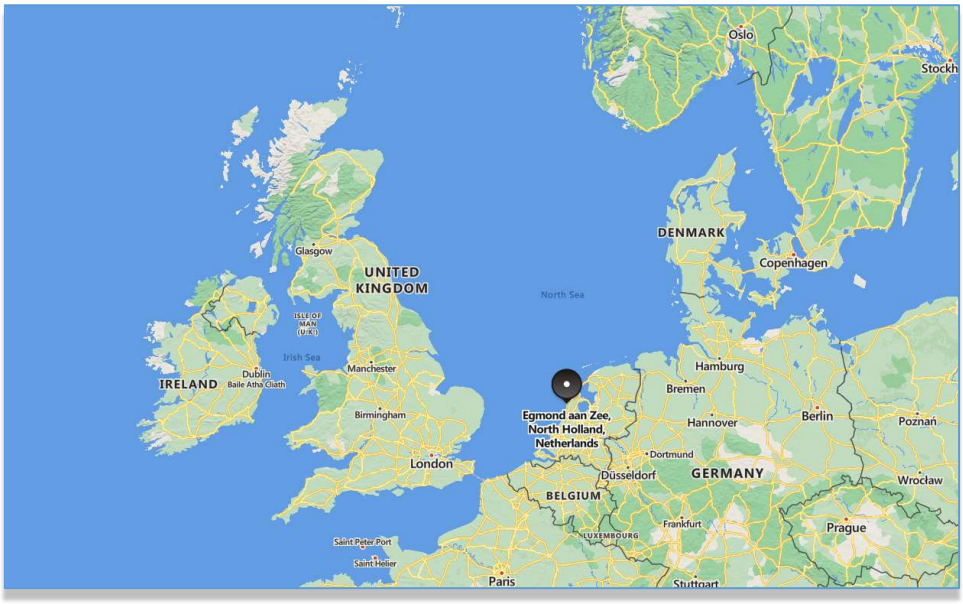


Figure 1 - Hollandse Kust Noord Wind Park Location Map

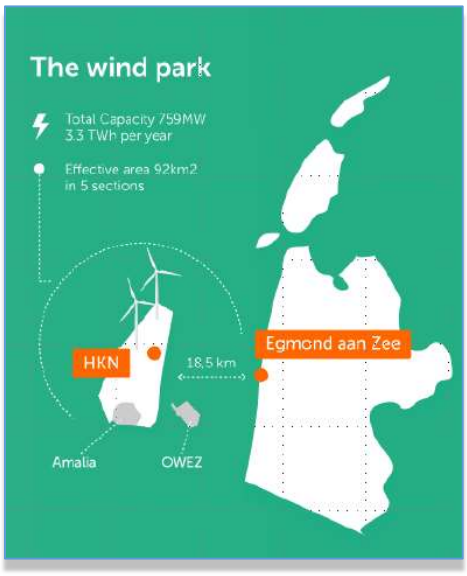


Figure 2 - Wind Park Details

The wind farm will consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile located on coordinates E 590719.1, N 5841602.3 is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

1.1.2 Project Concept

All components included in the BLPH will be integrated onshore on a topsides and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

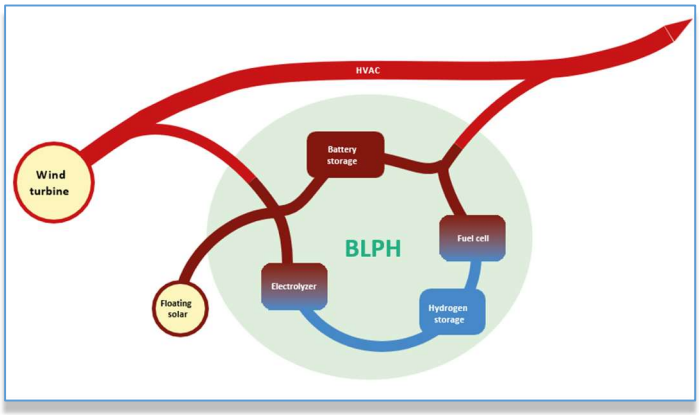


Figure 3 – BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining

power output. This will be by discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.

The purpose of the BLPH s to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

2 DOCUMENT SCOPE

This document is the Hazard and Operability study (HAZOP) report for the Integration Package Scope. The HAZOP study was integrated with the Layer of Protection Analysis (LOPA), for which a separate LOPA report has been issued.

2.1 REPORT OBJECTIVES

The objectives of this HAZOP report are to:

- Define the boundaries of the HAZOP study;
- Present the workshop details and composition / competencies of the workshop team;
- Define the main documents that were used during the HAZOP workshop;
- Present the findings of the HAZOP workshop, including:
  - HAZOP worksheet; and,
  - HAZOP recommendations.

2.2 REFERENCES

DEP 01.00.02.13	Layers of Protection Analysis (LOPA)
DEP 80.45.10.11-Gen	Overpressure and Underpressure – Prevention and Protection
123A90-DDL-SAF-RE-30005	HAZOP Terms of Reference
-	PHApro workable file included as soft-copy

Table 1 - Reference Documents

2.3 DEFINITIONS AND ABBREVIATIONS

COMPANY or Client (CPY)	Crosswind
CONTRACTOR (CTR)	ROSETTI MARINO S.p.A.
PROJECT:	Hollandse Kust Noord Wind Park Project
ALARP	As Low As Reasonably Practicable
BDV	Blowdown Valve
BESS	Battery Energy Storage System
BLPH	Base Load Power Hub
BPCS	Basic Process Control System
CBL	Consequential Business Loss
CW	Crosswind
DC	Direct Current
DCS	Distributed Control System
DEP	Design and Engineering Practice
DP	Design Pressure
DSM	Downstream Manufacturing

ESD	Emergency Shut Down
F&G	Fire and Gas
FO	Fail Open
FV	Full Vacuum
HAZOP	Hazard and Operability
HER	Hazard and Effects Register
HKN	Hollandse Kust Noord
HSE	Health, Safety and Environment
H2	Hydrogen
I&C	Instrumentation and Control
IE	Initiating Event
IPL	Independent Protection Layer
KO	Knock Out
LO	Locked Open
LOPA	Layer of Protection Analysis
LOPC	Loss of Primary Containment
MEF	Mitigated Event Frequency
NRV	Non-Return Valve
N2	Nitrogen
O2	Oxygen
PACO	Process Automation, Control & Optimisation
PEFS	Process Engineering Flow Sheets
PFD	Process Flow Diagram
PFD	Probability of Failure on Demand
PM	Project Manager
PV	Photovoltaic
PSC	PSC S.p.A. Engineering & Contracting
PST	Process Safety Time
PSV	Pressure Safety Valve
RAM	Risk Assessment Matrix
RM	Rosetti Marino
RO	Reverse Osmosis
SAFOP	Safety and Operability Study
SDV	Shut Down Valve
SIF	Safety Instrumented Function
SIL	Safety Integrity Level

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TBC	To be Confirmed
TOR	Terms of Reference
UFD	Utility Flow Diagram
VooW	Van Oord Offshore Wind
WTG	Wind Turbine Generator
XV	Control Valve

Table 2 - Definitions and Abbreviations

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3 OBJECTIVES

The objectives of the HAZOP study were to:

- Review the design and consider whether any of the conditions which may occur from all operating modes (e.g. start-up/shutdown, maintenance), malfunction or mal-operation, can cause harm to people, environment, community or cause damage to equipment/plant.
- Review whether the precautions incorporated in the design are sufficient to prevent the consequence of the hazard occurring or reduce the residual risk As Low As Reasonably Practicable (ALARP).
- Consider whether the plant remains safely operable, goes to a safe hold state or shuts down safely under the circumstances described above.
- Ensure that the hazards of the substances and processes and their impact on the design, construction, testing, operation and maintenance of the plant are fully considered and that relevant safety measures are defined sufficiently.

3.1 MANAGING RISK TO ALARP

Identified hazards were ranked in the HAZOP in accordance with the Project Hazards and Effects Register (HER) which was supplied by Shell. The project HER sets the expectation as to how HSE risks are to be managed to ALARP.

Key steps in managing risks to ALARP are:

- Eliminate or reduce the hazard by an inherently safer design;

Manage the risk by:

- Meeting laws and regulations and stakeholder expectations;
- Applying codes, Shell or industry standards, and best practices if the risk is well understood; and
- Performing hazard analysis (e.g. LOPA) if the risk is not well understood.
- Assess the risk and demonstrate that the barriers incorporated in design reduce the risk to a tolerable level as a minimum with additional barriers considered and applied to demonstrate ALARP.

3.2 LOPA REPORT

The HAZOP study was integrated with the LOPA, for which a separate LOPA Allocation report, doc. N. 123A90-DDL-SAF-RE-30036, has been issued.

4 WORKSHOP

4.1 WORKSHOP TOR

The HAZOP workshop was conducted in accordance with the scope, objectives and methodology as defined in the HAZOP Terms of Reference (TOR).

4.2 WORKSHOP SCHEDULE

HAZOP workshops were conducted between the 27th and 30th November 2023 covering Nodes 1 to 5. Further workshops were held on the 17th to 19th July 2024 to consider the Water Treatment Package (WTP), vendor units and finalise the HAZOP for the linked utility systems.

The workshops were predominantly carried out face-to-face at the Rosetti Marino office in Milan, Italy. However, a number of personnel joined the workshop virtually using Microsoft Teams.

4.3 WORKSHOP ATTENDEES

The team members for the Integration Package HAZOP Workshop included the following as a minimum requirement:

- Chairperson;
- Recorder (HAZOP Scribe);
- Process Engineer;
- Operations Representative;
- Technical Safety Engineer; and
- Process, Automation, Control and Optimisation (PACO)/Instrumentation Engineer.

A list of attendance for each day of the HAZOP workshop is included in Attachment 5.

4.4 REFERENCE DOCUMENTS

The documents presented in Table 3 & Table 4 were used / referenced for the HAZOP workshop.

Doc. No.	Description
123A90-DDL-IN-CE-40000	Process Safety Cause & Effect Matrix
123A90-DDL-IN-LIS-40027	Master Alarm Database
123A90-DDL-PP-DL-70070	Plot Plan - Lower & Upper deck
123A90-DDL-PP-DL-70071	Plot Plan - Below Lower deck
123A90-DDL-PP-DL-70072	Plot Plan - Elevation looking north & East
123A90-DDL-PR-RE-80040	Process Design Philosophy
123A90-DDL-SAF-RE-30001	Fire Protection Philosophy
123A90-DDL-SAF-RE-30046	HSE Design Philosophy
1724000448-MAC-SP-00003	WTP System Functional Description

Table 3 - DEFINE HAZOP Documents

The Process Engineering Flow Sheets (PEFS) listed were marked-up with nodes to be studied prior to the HAZOP workshop and are contained in Attachment 1. The analysis of Nodes 1 to 4 (the hydrogen systems) was based on Rev.01 PEFS, while the utility systems were based on Rev.02 PEFS.

Doc. No.	Rev.	Description
123A90-DDL-PR-PID-80009	02	GENERAL NOTES
123A90-DDL-PR-PID-80010	02	PIPING SYMBOLOGY
123A90-DDL-PR-PID-80011	02	ELECTROLYSER PACKAGE
123A90-DDL-PR-PID-80012	01	FUEL CELL PACKAGE
123A90-DDL-PR-PID-80013	01	HYDROGEN STORAGE VESSELS HEADER (INLET)
123A90-DDL-PR-PID-80014	01	HYDROGEN STORAGE VESSELS HEADER (OUTLET)
123A90-DDL-PR-PID-80015	01	HYDROGEN STORAGE VESSEL A
123A90-DDL-PR-PID-80016	01	HYDROGEN STORAGE VESSEL B
123A90-DDL-PR-PID-80017	01	HYDROGEN STORAGE VESSEL C
123A90-DDL-PR-PID-80018	01	HYDROGEN STORAGE VESSEL D
123A90-DDL-PR-PID-80019	01	HYDROGEN STORAGE VESSEL E
123A90-DDL-PR-PID-80020	01	HYDROGEN STORAGE VESSEL F
123A90-DDL-PR-PID-80021	02	SEA-WATER INTAKE SYSTEM SHEET 1
123A90-DDL-PR-PID-80022	02	SEA-WATER INTAKE SYSTEM SHEET 2
123A90-DDL-PR-PID-80023	02	WATER TREATMENT PLANT SHEET 1
123A90-DDL-PR-PID-80024	02	WATER TREATMENT PLANT SHEET 2
123A90-DDL-PR-PID-80025	02	WATER DISPOSAL SHEET 1
123A90-DDL-PR-PID-80026	02	WATER DISPOSAL SHEET 2
123A90-DDL-PR-PID-80027	02	INSTRUMENT AIR PACKAGE
123A90-DDL-PR-PID-80028	02	HYDROGEN VENT HEADER
123A90-DDL-PR-PID-80029	02	HYDROGEN VENT DRUM
123A90-DDL-PR-PID-80041	02	INSTRUMENTATION AND DISTRIBUTION HEADER
123A90-DDL-PR-PID-80042	01	INSTRUMENTATION SYMBOLOGY
123A90-DDL-PR-PID-80043	00	OPEN DRAIN SYSTEM
1724000448-PR-PID-00013-001	01	WTP SEA WATER FINE FILTRATION
1724000448-PR-PID-00013-002	01	WTP SEA WATER FINE FILTRATION
1724000448-PR-PID-00013-003	01	WTP SEA WATER REVERSE OSMOSIS
1724000448-PR-PID-00013-004	01	WTP FRESH WATER STORAGE
1724000448-PR-PID-00013-005	01	WTP ACID & ANTISCALANT DOSAGES
1724000448-PR-PID-00013-006	01	WTP BIOCIDE DOSAGE

Table 4 - List of Unit PFD, UFD and PEFS

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5 HAZOP METHODOLOGY

5.1 INTRODUCTION

The HAZOP was executed in accordance with the Shell HAZOP DEP.

5.2 PARAMETERS AND GUIDE WORDS

Table 5 shows the parameter – guide word combinations that were used for the HAZOP.

Parameter	Guide Words						
	No/ less/ low	More/ high	Mis-directed	Reverse	As well as	Other than	General
Flow	✓	✓	✓	✓	✓		
Pressure	✓	✓					
Temperature	✓	✓					
Level	✓	✓					
Phase						✓	
Composition/ Contamination						✓	
Operations							✓
Start-up/ shutdown							✓
Catalysts							✓
Maintenance							✓
Utilities							✓
Corrosion/ erosion							✓
Other							✓

Table 5 - Parameters and Guide Words

5.3 RAM SCORE

The RAM Score recorded in the HAZOP was in accordance with the Project HER.

Within the Integration Package, hydrogen as a Hazard was ranked according to the project HER as:

- People, 5A;
- Asset, 4B;
- Community, 4B; and
- Environment, 3B.

The Project risk assessment matrix (RAM) is presented below in Figure 4.

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Severity	Consequences				Increasing Likelihood				
	People	Assets	Environment	Community	A Never heard of in the Industry	B Heard of in the Industry	C Has happened in the Organization or more than once per year in the Industry	D Has happened at the location or more than once per year in the Organization	E Has happened more than once per year at the location
0	No injury or health effect	No damage	No effect	No impact	0A	0B	0C	0D	0E
1	Slight injury or health effect	Slight damage	Slight effect	Slight impact	1A	1B	1C	1D	1E
2	Minor injury or health effect	Minor damage	Minor effect	Minor impact	2A	2B	2C	2D	2E
3	Major injury or health effect	Moderate damage	Moderate effect	Moderate impact	3A	3B	3C	3D	3E
4	PTD or up to 3 fatalities	Major damage	Major effect	Major impact	4A	4B	4C	4D	4E
5	More than 3 fatalities	Massive damage	Massive effect	Massive impact	5A	5B	5C	5D	5E

Figure 4 – Project Risk Assessment Matrix

5.4 GROUND RULES AND ASSUMPTIONS

5.4.1 Consequence Development

The following ground rules & assumption were followed when developing the consequences:

- All Individual Basic Process Control System (BPCS) loops were assumed to be on manual to analyse the unmitigated consequence. The individual control system loops were listed as a barrier and identified as "valid" if they meet the criteria in the LOPA DEP.
- In the HAZOP, it was allowed to make references to scenarios where the same consequence is fully developed and the same barriers apply. An additional barrier in the 'barrier' column was added, where applicable
- It was not allowed to make references to scenarios when the cause led to a scenario which was included in the LOPA, according to the LOPA DEP rules. Where there is a scenario for LOPA and the initiating events/valid barrier combinations were not significant (Mitigated Event Frequency (MEF) at least one order of magnitude lower than the determining case) a reference was allowed.
- Where there is a Loss of Primary Containment (LOPC) as a result of the upset, it was not required to split the right hand side of the bowtie into separate consequences in the HAZOP. The hazard was ranked on the material.
- Not all consequences were required to be developed/LOPA'd separately where it was clear which one was determining. Where not all consequences were developed, a justification was indicated in the HAZOP as to the reason why (e.g., equipment rupture not determining in view of its probability

of 0.01, or, for this scenario, there is no potential for 10+ fatalities. The tolerability criteria for fire and explosion is identical. Fire case is therefore determining).

5.4.2 Valves

All valves, both manual and actuated, were listed as separate causes. Where there were multiple manual valves in the same line, these were added together as one cause. Open valves were recorded under the deviation "no flow". Normally closed valves were recorded under the deviation "mis-directed flow".

5.4.3 Blinds, Spectacle Plates & Caps

Where a "blind", "closed spectacle plate" or "cap" was shown on a PEFS, then the HAZOP Team did not consider the "blind", "closed spectacle plate" or "cap" being in the incorrect position. However, the closed spectacle blind may be opened during a certain (transient) mode of operation (e.g., start-up). Use of the line-up during the transient mode and scenarios associated with the line-up was identified and assessed.

5.4.4 Safeguards/Barriers

The following definitions were applied when identifying barriers in the HAZOP:

- Barriers are engineered systems or administrative controls designed to prevent the causes or mitigate the consequences of deviations (e.g., process alarms, process controls, interlocks, SIFs); and
- Barriers were only be taken into account if they are part of the design (e.g., already part of the design hardware, documentation or operating procedures).

The barriers identified satisfied the following criteria, so as to be considered valid:

- Effective;
- Independent;
- Auditable; and.
- Dependable (applicable for Safety Instrumented Functions (SIFs) only - being designed, implemented, maintained, inspected and tested in accordance with IEC 61511.

In the HAZOP all safeguards (barriers) were listed, both valid and non-valid. Barrier validity was recorded in the HAZOP for yellow and red risks. Where a safeguard was identified as non-valid then the reason why was recorded. When the barrier was identified as valid, the checks made to ascertain validity were recorded, e.g., nature of operator response (e.g. tag of the valve that the operator will close), which operator (field or control room) will act (when the initiating event is a human error), sufficient time for operator response, direction of failure of the valve for a control loop barrier, sensors and final elements for SIFs, clean service, etc.

Control actions for those BPCS loops (in or outside the unit being considered) that detect the deviation caused by the initiating event and react to it to restore normal conditions/resolve the upset were recorded as barriers in the HAZOP. Example: a level control loop in a vessel of which the inlet control valve fails open. Barrier validity was assessed.

Control actions for those BPCS loops (in or outside the unit being considered) that do not detect the deviation caused by the initiating event and (therefore) do not react to it to restore normal conditions/resolve the upset are considered independent from the initiating event (of course only if they also have independent

sensors and final elements). Example: a steam system pressure control loop is independent from the reflux control loop in the column the steam is used as reboiler medium.

The challenge of whether the BPCS can be claimed as an Independent Protection Layer (IPL), in accordance with the Shell LOPA DEP was carried out in the HAZOP.

The challenge of whether the alarm can be claimed as an IPL, in accordance with the Shell LOPA DEP, was carried out in the HAZOP.

5.4.5 SIFs

Only the final elements for each respective SIF which prevent the consequence were recorded, i.e. if the C&Es identifies several executive actions, only the primary actions which prevent the consequence were recorded against the SIF.

If a SIF was considered for a particular consequence (e.g. overpressure) but the SIF design intent did not include the consequence being discussed (e.g. prevent sending liquid to furnace), the SIF was recorded in the HAZOP but the threat to consequence line did not take part in the LOPA to determine the SIL of the SIF. The SIF design intent was recorded. If the final element that would be effective for the consequence being considered (e.g. valve in inlet) is not a primary final element (in SIFPro), the SIF was not considered valid for the particular consequence.

5.4.6 Relief Valves

The following information was recorded for relief valves:

- Set points; and
- Correctly sized for the over-pressure event, with documentary evidence.

Passing relief valves was not taken as a "cause" unless the relief valve discharges to atmosphere.

5.4.7 Over-Pressure Consequences

In accordance with the Shell LOPA DEP, the HAZOP Team recorded over-pressure consequences as follows:

1. Consequence of rupture – this was allocated the highest severity
2. Consequence of flange leak – allocated with a lower severity

Recording the consequences allowed the probability of rupture to be identified in the LOPA in accordance with the data in Table 6 and the leak hole size in accordance with the data in Table 7.

The consequence was written to clearly indicate the design pressure and the maximum pressure generated from the upset case so that over-pressure ratio can be clearly seen.

A suitably sized relief valve is the default minimum safeguarding solution for overpressure cases. Only if implementing an adequate relief system is not practicable, an alternative design approach may be adopted. See Shell Overpressure DEP Section 2.10.3 for definition of what is not practicable and for an alternative safeguarding approach. It was not the purpose of the HAZOP or LOPA to design safeguarding systems.

Vessel Design Code	Safety Factor	Probability of equipment rupture (Note 1)		
		Prob = 0.01	Prob = 0.1	Prob = 1.0
ASME Section VIII Pre-2000	4:1	2.8≤PR<3.2	3.2≤PR<3.6	3.6≤PR
ASME Section VIII 2000 and newer	3.5:1	2.5≤PR<2.8	2.8≤PR<3.2	3.2≤PR
ASME Section VIII Div 2, Stoomwezen, or CODAP	3:1	2.2≤PR<2.4	2.4≤PR<2.7	2.7≤PR
EN-13445	2.4:1	1.8≤PR<2.0	2.0≤PR<2.2	2.2≤PR
AS-1210 or PD5500	2.35:1	1.8≤PR<2.0	2.0≤PR<2.2	2.2≤PR

Table 6 - Probability of Rupture

Vessel Design Code	Safety Factor	Pressure/MAWP ratio or design pressure (PR) that results in hole of given diameter (probability = 1) (Note 1)		
		7 mm (0.28 in) (Note 2)	25mm (1 in.)	100mm (4 in.) (Note 3)
ASME Section VIII Pre-2000	4:1	cHTP≤PR<1.9	1.9≤PR<3	3≤PR<3.6
ASME Section VIII 2000 and newer	3.5:1	cHTP ≤PR<1.9	1.9≤PR<2.7	2.7≤PR<3.2
ASME Section VIII Div 2, Stoomwezen, or CODAP	3:1	cHTP ≤PR<1.9	1.9≤PR<2.5	2.5≤PR<2.7
EN-13445	2.4:1	cHTP ≤PR<1.9	1.9≤PR<2.1	2.1≤PR<2.2
AS-1210 or PD5500	2.35:1	cHTP ≤PR<1.9	1.9 ≤PR<2.1	2.1 ≤PR<2.2

NOTES:

1. PR = Pressure ratio, this being the ratio of [vessel over-pressure] to [MAWP or design pressure].
2. cHTP = corrected Hydrotest Pressure= actual hydrotest pressure corrected for relief scenario or design temperature.
3. beyond the value of PR given in the 100mm (4 in) diameter hole size column, there is no need to assess a leak case as the probability for equipment rupture is considered to be 1 (i.e., leak case will not be determining).

Table 7 - Flange Hole Size

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5.4.8 Locked Manual Valves

If inadvertent closure of a Locked Open (LO) valve causes "immediate" overpressure, verify compliance with ASME VIII Appendix M (North America) or corresponding (outside North America) Shell interpretation (single valve with or without lock is normally not accepted as an open system if closure of that valve can create an immediate overpressure case greater than 110% of the design pressure).

For locked valves, 2 human errors could occur:

1. The operator has intentionally operated the locked valve (e.g. for shutdown/start-up) and forgot to re-instate it in its normal, locked position. In this case, the lock is not a barrier since the valve was intentionally operated. Operating a locked valve should follow a procedure and therefore initiating event frequencies can be calculated based on LOPA DEP Table 5 and the expected frequency of operation of the locked valve. For this, it was important to understand why the valve was implemented and why it needs to be operated. It is quite different to have a valve that was put for construction purposes only and will never be operated versus a valve that will be used for some special modes of operation.
2. Inadvertent operation of the wrong valve. Operator should close valve B but closes valve A instead. In this case, the lock is a barrier with PFD=0.1 as per LOPA DEP Table 2 Row 25 (Keyed Bypass /Interlock). In this case, the frequency of operation of the "other/right" valve (in this example valve B) was considered. This could be a valve physically nearby or a valve on a parallel string/train.

In cases where the human error related to the locked valve is another reason for e.g. a path to be closed, it may not be significant mathematically (in a LOPA/SIF classification). However, it may be quite important to look at if the locked valve is not the only cause for the scenario to develop.

5.5 DEFINED NODES

The nodes studied for the Interface Package are listed in Table 8 below. Details of the operation and operating conditions for each node, including corresponding drawings for each node, are detailed in Attachment 2.

Node No.	Node Name
1	Hydrogen (Filling Operation)
2	Hydrogen (Purging)
3	Hydrogen (Electricity Production)
4	Hydrogen (Vent System)
5	Seawater and Treated Water Systems
6	Instrument Air
7	Nitrogen
8	Brine Discharge System
9	Wastewater Discharge System
10	WTP Caustic Soda Dosing System
11	WTP Anti-Scalant Dosing System

Node No.	Node Name
12	WTP Biocide Dosing System
13	WTP Container Heater/Vent System

Table 8 - Node List

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6 FINDINGS

6.1 HAZOP WORKSHEET

The completed HAZOP worksheet is included in Attachment 2, which includes the findings of the HAZOP study for each of the nodes.

6.2 LOPA WORKSHEET

The HAZOP study was integrated with the LOPA, for which a separate LOPA report has been issued.

6.3 HAZOP RECOMMENDATIONS

Recommendations raised in the HAZOP workshop are included in Attachment 4. These recommendations should be closed-out and tracked in a HSSE Action Tracking Register and Close out report, doc. No. 123A90-DDL-SAF-RE-30007 by Rosetti Marina. Each action-sheet should state the recommendation, the party responsible for closing the action, and the action showing how the recommendation is properly closed.

Where design changes are implemented, the HAZOP and LOPA worksheets should be revisited to ensure the recommendation has been fully met and that all reasonably foreseeable risks associated with the system are managed to an acceptable level.

6.4 FURTHER WORK

A number of specific items relating to package interface queries were identified, which require resolving. These were captured as 'Parking Lot' items:

- Hazards relating to potential overpressurisation of the fuel cell package from the storage system operation which require review with the Fuel Cell design team in an interface HAZOP. (See 3.16.1.1.1, 3.16.1.2)
- Hazards relating to low pressure at the fuel cell package from the storage system operation which require review with the Fuel Cell design team in an interface HAZOP. (See 3.18.2.2).
- Hazards relating to a blocked outlet for the electrolyser package within the storage system which require review with the Electrolyser design team in an interface HAZOP. (See 4.1.1.1)

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ATTACHMENT 1 – NODE DESCRIPTIONS

Nodes	Design Intent	Operating Conditions	Design Conditions	Drawings	Components	Comment
1. Hydrogen (Filling Operation)	To store H2 that is distributed from Electrolyser package in 6 storage vessels. Vessels are filled individually. Consider filling mode for Vessel V25001A only.	1. **V-25001A-F:** P: 7 to 30barg T: 5 to 65degC **Downstream 25PV025A/B:** P: 6barg T: 5 to 65degC **A-80000:** P: 4 to 6 barg T: Ambient	**V-25001A-F:** P: FV to 40barg T: -10 to 80 degC **Downstream 25PV025A/B:** P: 10 barg T: -10 to 80 degC **A-80000:** P: 10 barg T: 60 degC	3. 123A90-DDL-PR-PID-80011 4. 123A90-DDL-PR-PID-80012 5. 123A90-DDL-PR-PID-80013 6. 123A90-DDL-PR-PID-80014 7. 123A90-DDL-PR-PID-80015 8. 123A90-DDL-PR-PID-80016 9. 123A90-DDL-PR-PID-80017 10. 123A90-DDL-PR-PID-80018 11. 123A90-DDL-PR-PID-80019 12. 123A90-DDL-PR-PID-80020	V-25001A-F A-80000	
2. Hydrogen (Purging)	To prepare the storage system for H2 storage. Alternate H2 pressurisation depressurisation (Pulse purging) or N2 purging followed by air purging is carried out in preparation for maintenance. Starting condition is vessel containing N2 at small positive pressure following maintenance. End point of purge is considered to be pressurisation of a single vessel up to 5barg.	2. **V-25001A-F:** P: 0 to 7barg T: 5 to 65degC	**V-25001A-F:** P: FV to 40barg T: -10 to 80 degC	3. 123A90-DDL-PR-PID-80011 4. 123A90-DDL-PR-PID-80012 5. 123A90-DDL-PR-PID-80013 6. 123A90-DDL-PR-PID-80014 7. 123A90-DDL-PR-PID-80015 8. 123A90-DDL-PR-PID-80016 9. 123A90-DDL-PR-PID-80017 10. 123A90-DDL-PR-PID-80018 11. 123A90-DDL-PR-PID-80019 12. 123A90-DDL-PR-PID-80020	V-25001A-F	
3. Hydrogen (Electricity Production)		3. **V-25001A-F:**	**V-25001A-F:**	3. 123A90-DDL-PR-PID-80011	V-25001A-F	

Nodes	Design Intent	Operating Conditions	Design Conditions	Drawings	Components	Comment
	At least 1 vessel at up to 30barg filled with H2 other vessels may be filled with low pressure H2 or N2. Upstream system from Electrolyser isolated from all XVs on inlet to vessels closed.	P: 7 to 30barg T: 5 to 65degC **Downstream 25PV025A/B:** P: 6barg T: 5 to 65degC **A-80000:** P: 4 to 6 barg T: Ambient	P: FV to 40barg T: -10 to 80 degC **Downstream 25PV025A/B:** P: 10 barg T: -10 to 80 degC **A-80000:** P: 10 barg T: 60 degC	4. 123A90-DDL-PR-PID-80012 5. 123A90-DDL-PR-PID-80013 6. 123A90-DDL-PR-PID-80014 7. 123A90-DDL-PR-PID-80015 8. 123A90-DDL-PR-PID-80016 9. 123A90-DDL-PR-PID-80017 10. 123A90-DDL-PR-PID-80018 11. 123A90-DDL-PR-PID-80019 12. 123A90-DDL-PR-PID-80020	A-80000	
4. Hydrogen Vent System	To safely vent, blowdown and relieve H2 from the BLPH.	4. **V-43001** P: Atmospheric T: Ambient **Q43004** P: Atmospheric T: Ambient	**V-43001** P: 3.5barg T: -10 to 80degC **Pipework** P: 17.7barg T: -29 to 100degC **Q43004** P: 3.5barg T: -10 to 80degC	3. 123A90-DDL-PR-PID-80011 4. 123A90-DDL-PR-PID-80012 5. 123A90-DDL-PR-PID-80013 6. 123A90-DDL-PR-PID-80014 7. 123A90-DDL-PR-PID-80015 8. 123A90-DDL-PR-PID-80016 9. 123A90-DDL-PR-PID-80017 10. 123A90-DDL-PR-PID-80018 11. 123A90-DDL-PR-PID-80019 12. 123A90-DDL-PR-PID-80020 20. 123A90-DDL-PR-PID-80028 21. 123A90-DDL-PR-PID-80029	V-43001	
8. Brine Discharge System		8. P: Ambient		3. 123A90-DDL-PR-PID-80011		

Nodes	Design Intent	Operating Conditions	Design Conditions	Drawings	Components	Comment
	To dispose of uncontaminated fluids to sea via desgnated Caisson	T: Ambient		4. 123A90-DDL-PR-PID-80012 14. 123A90-DDL-PR-PID-80022 17. 123A90-DDL-PR-PID-80025 19. 123A90-DDL-PR-PID-80027 32. 172400048-PR-PID-00013-001 34. 172400048-PR-PID-00013-003 35. 172400048-PR-PID-00013-004		
7. Nitrogen	Supply nitrogen to inerting and purging systems.	7. P: 7barg T: Ambient		3. 123A90-DDL-PR-PID-80011 7. 123A90-DDL-PR-PID-80015 8. 123A90-DDL-PR-PID-80016 9. 123A90-DDL-PR-PID-80017 10. 123A90-DDL-PR-PID-80018 11. 123A90-DDL-PR-PID-80019 12. 123A90-DDL-PR-PID-80020 19. 123A90-DDL-PR-PID-80027 20. 123A90-DDL-PR-PID-80028		
5. Seawater and Treated Water Systems	To take seawater, filter and treat to a quality that is acceptable to the Electrolyser Water Treatment Plant. Non-oxidising biocide, anti scalant and caustic soda used for treatment of water and adjustment of PH to 7.5-8 for electrolysis unit.	5. **P50001A/B** P: T: **B50013A/B** P: T:	5. **P50001A/B** P: 20barg T: -10 to 80degC F: 3 m3/h **B50013A/B** P: Ambient	3. 123A90-DDL-PR-PID-80011 13. 123A90-DDL-PR-PID-80021 14. 123A90-DDL-PR-PID-80022 15. 123A90-DDL-PR-PID-80023 16. 123A90-DDL-PR-PID-80024 32. 172400048-PR-PID-00013-001		

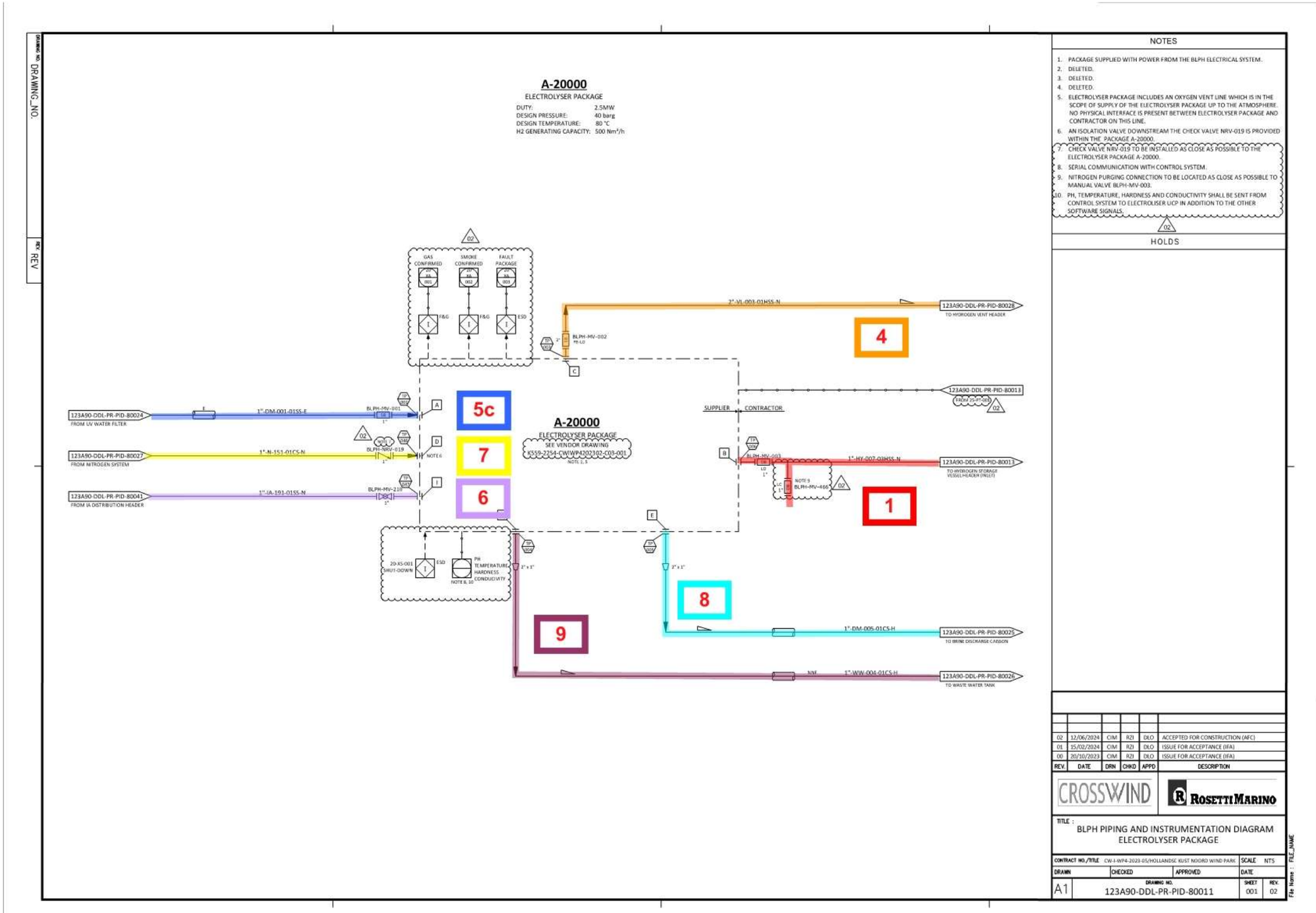
Nodes	Design Intent	Operating Conditions	Design Conditions	Drawings	Components	Comment
	For operating conditions see doc 1724000448-MAC-SP-00003	**T50006** P: T: **T50008** P: T: **P50009A/B** P: T:	T: -10 to 80degC **T50006** P: 3.5barg T: -10 to 80degC **T50008** P: 3.5barg T: -10 to 80degC **P50009A/B** P: 10barg T: -10 to 80degC	33. 172400048-PR-PID-00013-002 34. 172400048-PR-PID-00013-003 35. 172400048-PR-PID-00013-004		
9. Wastewater Discharge System	To contain contaminated fluids onboard for disposal/removal during maintenance visits	9. P: Ambient T: Ambient		3. 123A90-DDL-PR-PID-80011 14. 123A90-DDL-PR-PID-80022 18. 123A90-DDL-PR-PID-80026 21. 123A90-DDL-PR-PID-80029 36. 172400048-PR-PID-00013-005 37. 172400048-PR-PID-00013-006		
6. Instrument Air	Supply instrument air	6.		3. 123A90-DDL-PR-PID-80011 19. 123A90-DDL-PR-PID-80027 22. 123A90-DDL-PR-PID-80041		
12. Biocide System	For prevention of biological growth within the WTP system For design & operating conditions see doc 1724000448-MAC-SP-00003	12.		37. 172400048-PR-PID-00013-006 13. 123A90-DDL-PR-PID-80021 14. 123A90-DDL-PR-PID-80022		

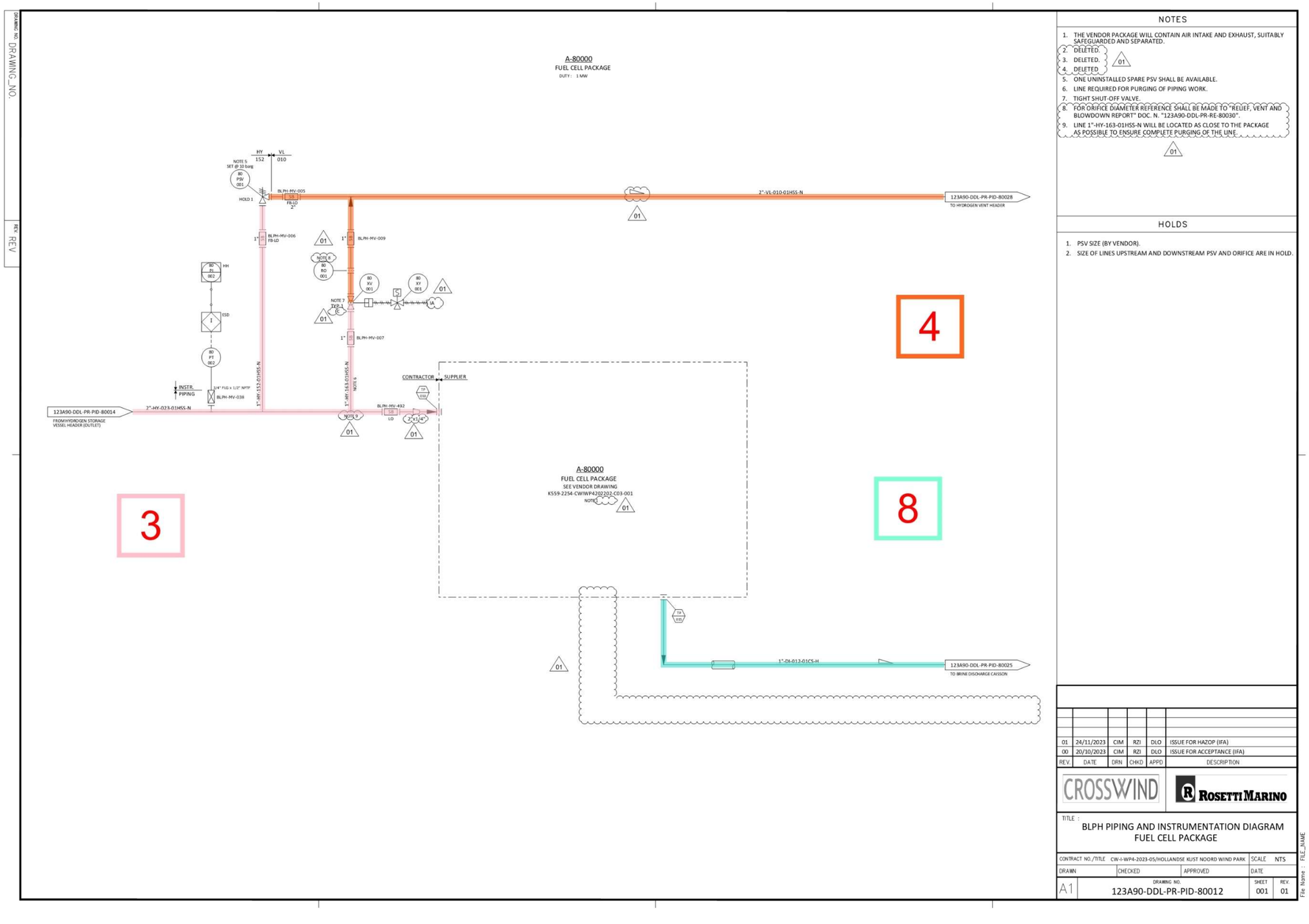
Nodes	Design Intent	Operating Conditions	Design Conditions	Drawings	Components	Comment
				18. 123A90-DDL-PR-PID-80026		
13. HVAC System	For maintenance of the temperature within the WTP container For design & operating conditions see doc 1724000448-MAC-SP-00003	13. P: Ambient T: Ambient		32. 172400048-PR-PID-00013-001		
10. Caustic Soda System	For adjusting the pH of treated water to minimise the potential for CO2 adsorption For design & operating conditions see doc 1724000448-MAC-SP-00003	10.		32. 172400048-PR-PID-00013-001 33. 172400048-PR-PID-00013-002 34. 172400048-PR-PID-00013-003 35. 172400048-PR-PID-00013-004 36. 172400048-PR-PID-00013-005 37. 172400048-PR-PID-00013-006		
11. Antiscalant System	For prevention of scale forming within the WTP system For design & operating conditions see doc 1724000448-MAC-SP-00003	11.		32. 172400048-PR-PID-00013-001 36. 172400048-PR-PID-00013-005		

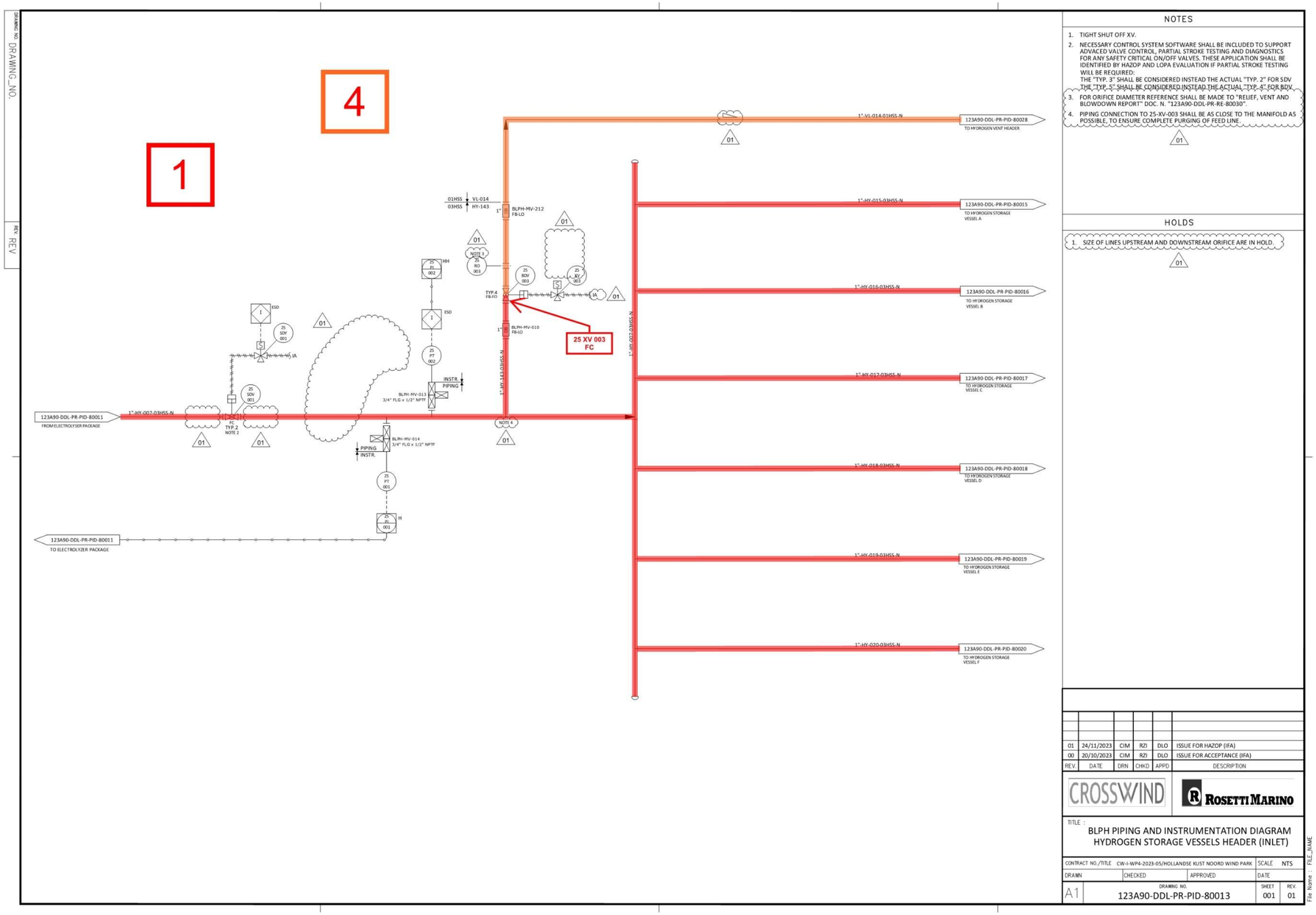
Table 9 - Node Descriptions

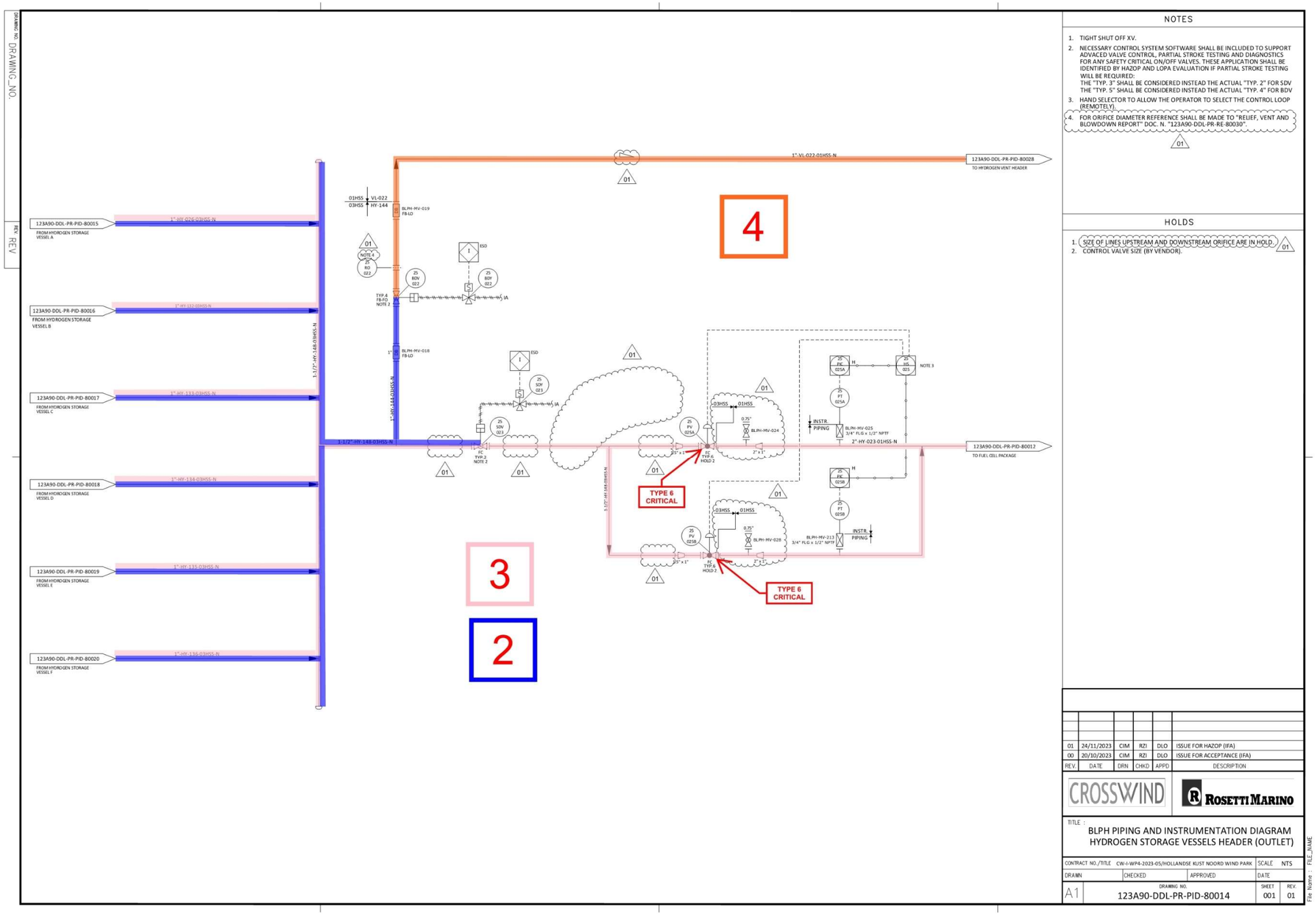
ATTACHMENT 2 – MARKED-UP P&IDs

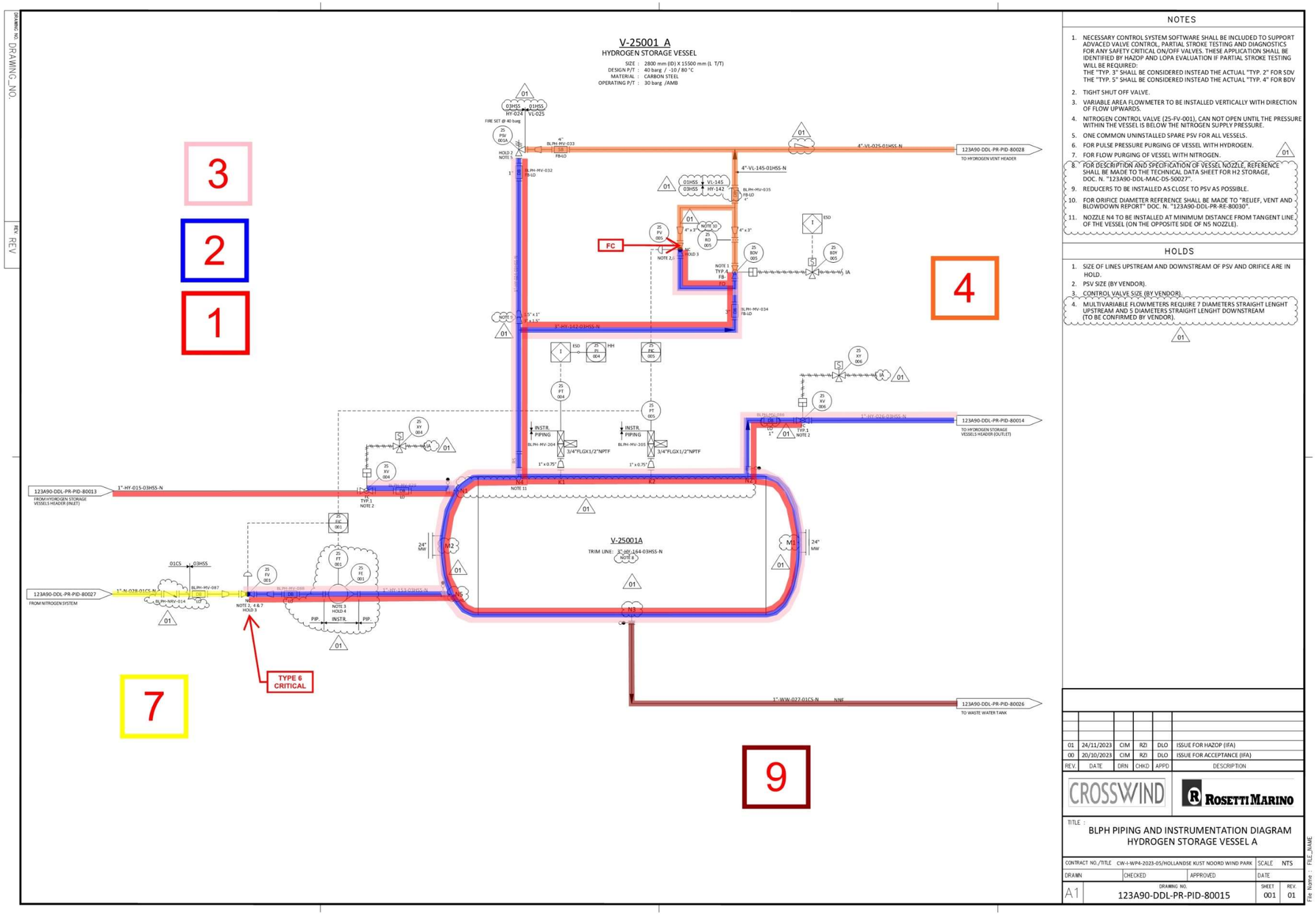
The attached PEFS are the diagrams studied during the HAZOP sessions

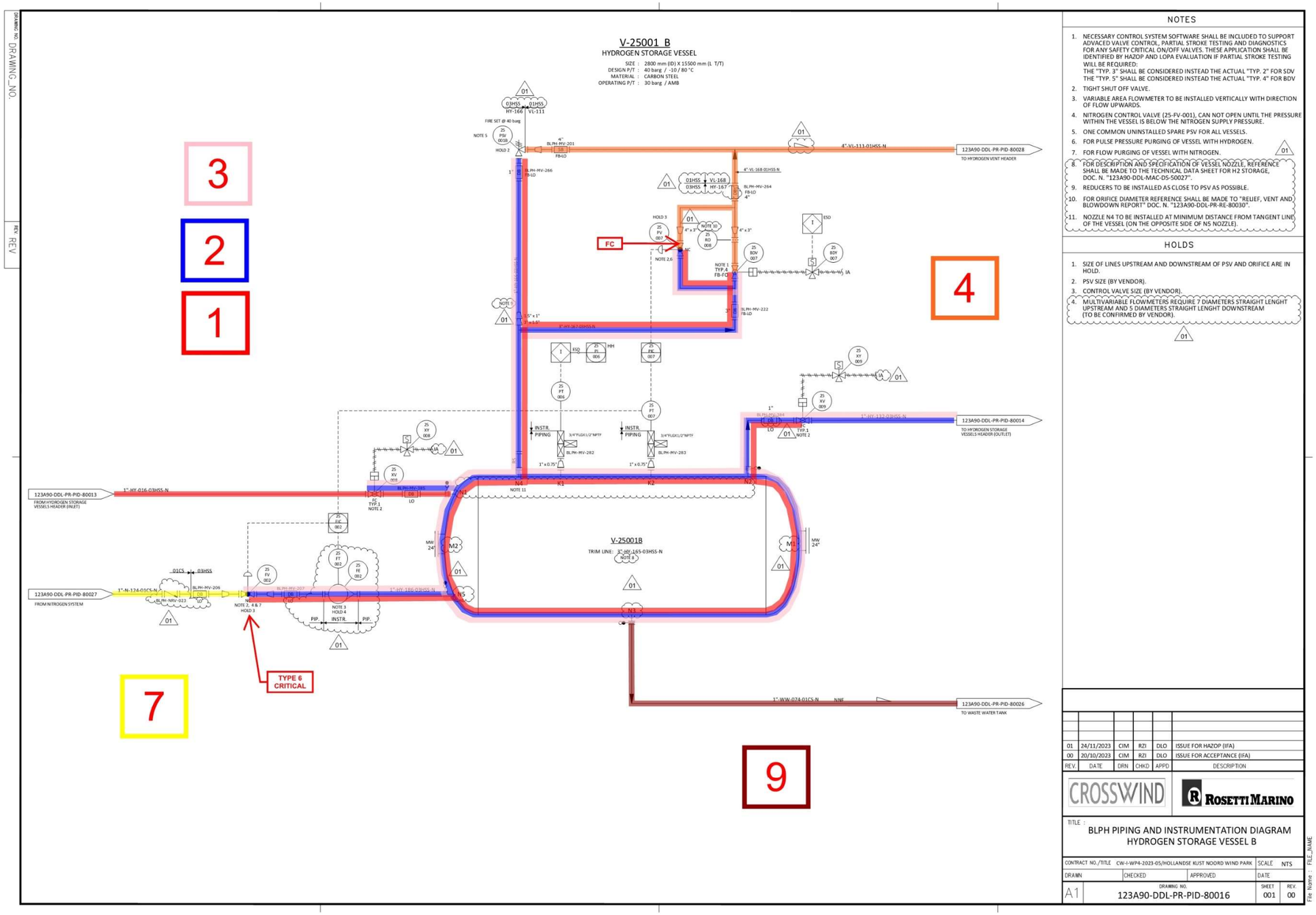

DRAWING NO.
REV
A-20000
ELECTROLYSER PACKAGE
DUTY: 2.5MW
DESIGN PRESSURE: 40 barg
DESIGN TEMPERATURE: 80 °C
H2 GENERATING CAPACITY: 500 Nm³/h
GAS CONFIRMED
SMOKE CONFIRMED
FAULT PACKAGE
F&G
F&G
ESD
2"-VL-003-01HSS-N
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
BLPH-MV-002
4
123A90-DDL-PR-PID-80013
SUPPLIER
CONTRACTOR
123A90-DDL-PR-PID-80024
FROM UV WATER FILTER
1"-DM-001-01SS-E
BLPH-MV-001
5c
A-20000
ELECTROLYSER PACKAGE
SEE VENDOR DRAWING
K559-2254-CWIWP4202302-C03-001
123A90-DDL-PR-PID-80027
FROM NITROGEN SYSTEM
1"-N-151-01CS-N
BLPH-NRV-019
7
BLPH-MV-003
1"-HY-007-03HSS-N
123A90-DDL-PR-PID-80013
TO HYDROGEN STORAGE VESSEL HEADER (INLET)
123A90-DDL-PR-PID-80041
FROM IA DISTRIBUTION HEADER
1"-IA-191-01SS-N
BLPH-MV-210
6
BLPH-MV-466
1
20-XS-001
SHUT-DOWN
ESD
PH
TEMPERATURE
HARDNESS
CONDUCIVITY
8
9
1"-DM-005-01CS-H
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
1"-WW-004-01CS-H
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
NOTES
1. PACKAGE SUPPLIED WITH POWER FROM THE BLPH ELECTRICAL SYSTEM.
2. DELETED.
3. DELETED.
4. DELETED.
5. ELECTROLYSER PACKAGE INCLUDES AN OXYGEN VENT LINE WHICH IS IN THE SCOPE OF SUPPLY OF THE ELECTROLYSER PACKAGE UP TO THE ATMOSPHERE. NO PHYSICAL INTERFACE IS PRESENT BETWEEN ELECTROLYSER PACKAGE AND CONTRACTOR ON THIS LINE.
6. AN ISOLATION VALVE DOWNSTREAM THE CHECK VALVE NRV-019 IS PROVIDED WITHIN THE PACKAGE A-20000.
7. CHECK VALVE NRV-019 TO BE INSTALLED AS CLOSE AS POSSIBLE TO THE ELECTROLYSER PACKAGE A-20000.
8. SERIAL COMMUNICATION WITH CONTROL SYSTEM.
9. NITROGEN PURGING CONNECTION TO BE LOCATED AS CLOSE AS POSSIBLE TO MANUAL VALVE BLPH-MV-003.
10. PH, TEMPERATURE, HARDNESS AND CONDUCTIVITY SHALL BE SENT FROM CONTROL SYSTEM TO ELECTROLISER UCP IN ADDITION TO THE OTHER SOFTWARE SIGNALS.
HOLDS
02 12/06/2024 CIM RZI DLO ACCEPTED FOR CONSTRUCTION (AFC)
01 15/02/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
ELECTROLYSER PACKAGE
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80011
SHEET 001
REV. 02
File Name : FILE_NAME

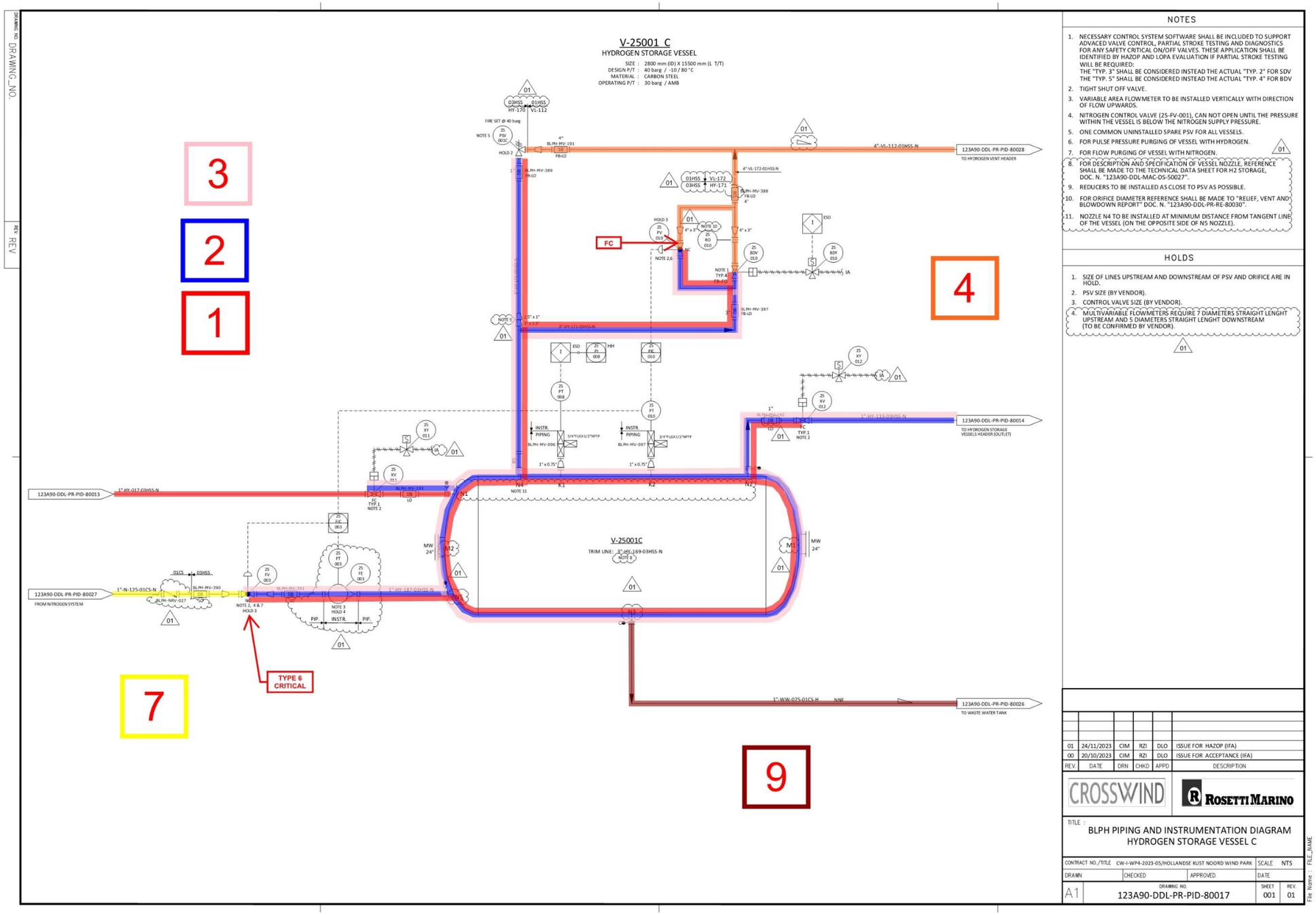

A-80000
FUEL CELL PACKAGE
DUTY : 1 MW
2"-VL-010-01HSS-N
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
BLPH-MV-005
BLPH-MV-006
BLPH-MV-009
BLPH-MV-007
BLPH-MV-038
BLPH-MV-492
2"-HY-073-01HSS-N
123A90-DDL-PR-PID-80014
FROM HYDROGEN STORAGE VESSEL HEADER (OUTLET)
1"-HY-152-01HSS-N
1"-HY-163-01HSS-N
CONTRACTOR
SUPPLIER
A-80000
FUEL CELL PACKAGE
SEE VENDOR DRAWING
K559-2254-CWIWP4202202-C03-001
1"-DI-012-01CS-H
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
3
4
8
NOTES
1. THE VENDOR PACKAGE WILL CONTAIN AIR INTAKE AND EXHAUST, SUITABLY SAFEGUARDED AND SEPARATED.
2. DELETED.
3. DELETED.
4. DELETED
5. ONE UNINSTALLED SPARE PSV SHALL BE AVAILABLE.
6. LINE REQUIRED FOR PURGING OF PIPING WORK.
7. TIGHT SHUT-OFF VALVE.
8. FOR ORIFICE DIAMETER REFERENCE SHALL BE MADE TO "RELIEF, VENT AND BLOWDOWN REPORT" DOC. N. "123A90-DDL-PR-RE-80030".
9. LINE 1"-HY-163-01HSS-N WILL BE LOCATED AS CLOSE TO THE PACKAGE AS POSSIBLE TO ENSURE COMPLETE PURGING OF THE LINE.
HOLDS
1. PSV SIZE (BY VENDOR).
2. SIZE OF LINES UPSTREAM AND DOWNSTREAM PSV AND ORIFICE ARE IN HOLD.
01 24/11/2023 CIM RZI DLO ISSUE FOR HAZOP (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
FUEL CELL PACKAGE
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO.
123A90-DDL-PR-PID-80012
SHEET 001
REV. 01
DRAWING NO.
REV.
File Name : FILE_NAME

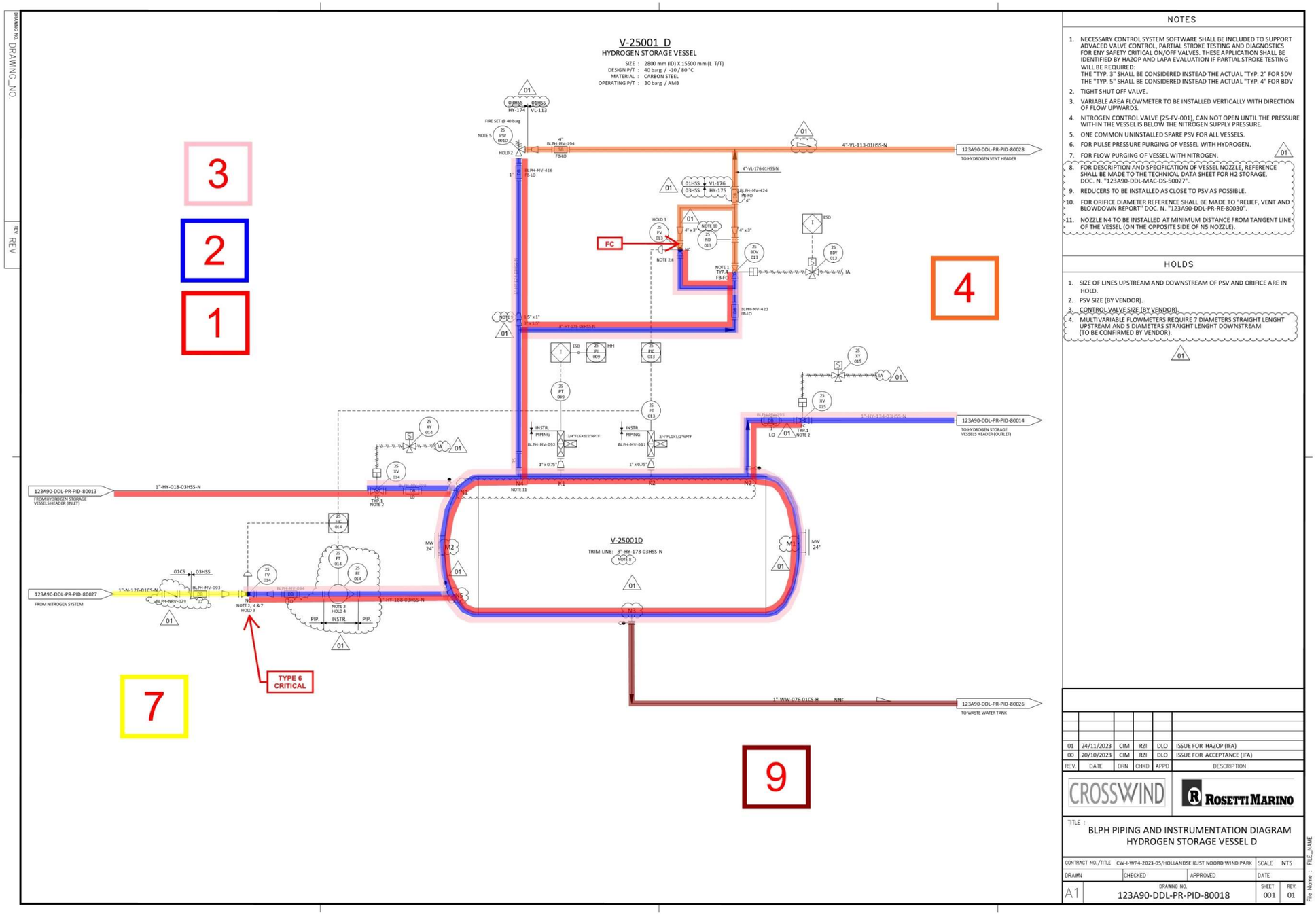

4
1
123A90-DDL-PR-PID-80011
FROM ELECTROLYSER PACKAGE
1"-HY-007-03HSS-N
123A90-DDL-PR-PID-80011
TO ELECTROLYZER PACKAGE
01HSS VL-014
03HSS HY-143
BLPH-MV-212
FB-LO
BLPH-MV-010
FB-LO
TYP.4
FB-FO
25 XV 003 FC
BLPH-MV-013
3/4" FLG x 1/2" NPTF
BLPH-MV-014
3/4" FLG x 1/2" NPTF
INSTR. PIPING
PIPING INSTR.
1"-VL-014-01HSS-N
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
1"-HY-015-03HSS-N
123A90-DDL-PR-PID-80015
TO HYDROGEN STORAGE VESSEL A
1"-HY-016-03HSS-N
123A90-DDL-PR-PID-80016
TO HYDROGEN STORAGE VESSEL B
1"-HY-017-03HSS-N
123A90-DDL-PR-PID-80017
TO HYDROGEN STORAGE VESSEL C
1"-HY-018-03HSS-N
123A90-DDL-PR-PID-80018
TO HYDROGEN STORAGE VESSEL D
1"-HY-019-03HSS-N
123A90-DDL-PR-PID-80019
TO HYDROGEN STORAGE VESSEL E
1"-HY-020-03HSS-N
123A90-DDL-PR-PID-80020
TO HYDROGEN STORAGE VESSEL F
1"-HY-007-03HSS-N
1"-HY-143-03HSS-N
NOTES
1. TIGHT SHUT OFF XV.
2. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ANY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LOPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
3. FOR ORIFICE DIAMETER REFERENCE SHALL BE MADE TO "RELIEF, VENT AND BLOWDOWN REPORT" DOC. N. "123A90-DDL-PR-RE-80030".
4. PIPING CONNECTION TO 25-XV-003 SHALL BE AS CLOSE TO THE MANIFOLD AS POSSIBLE, TO ENSURE COMPLETE PURGING OF FEED LINE.
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM ORIFICE ARE IN HOLD.
01 24/11/2023 CIM RZI DLO ISSUE FOR HAZOP (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN STORAGE VESSELS HEADER (INLET)
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN
CHECKED
APPROVED
DATE
A1
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SHEET 001
REV. 01
DRAWING NO.
REV.
File Name : FILE_NAME

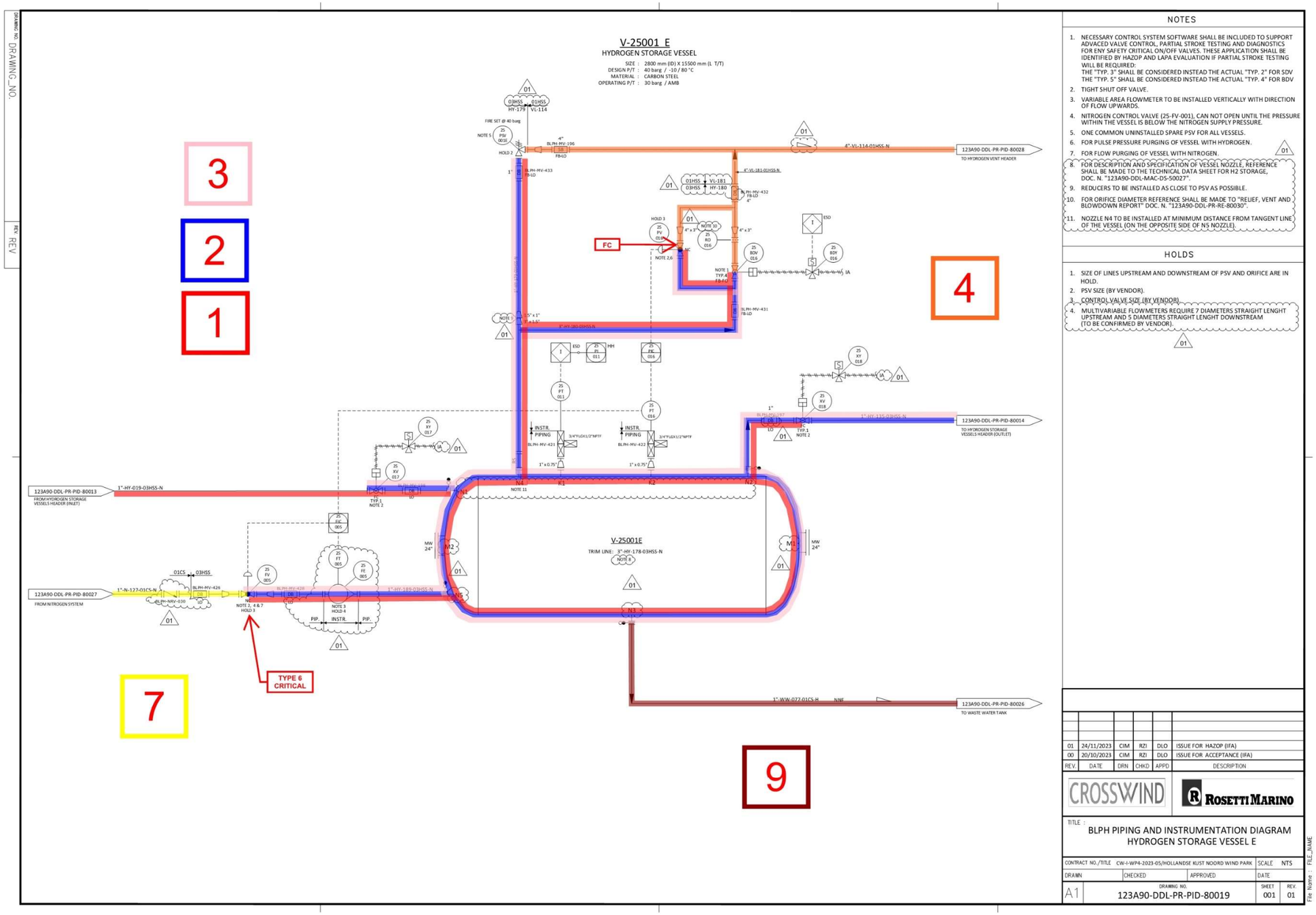

DRAWING_NO.
REV
123A90-DDL-PR-PID-80015
FROM HYDROGEN STORAGE VESSEL A
123A90-DDL-PR-PID-80016
FROM HYDROGEN STORAGE VESSEL B
123A90-DDL-PR-PID-80017
FROM HYDROGEN STORAGE VESSEL C
123A90-DDL-PR-PID-80018
FROM HYDROGEN STORAGE VESSEL D
123A90-DDL-PR-PID-80019
FROM HYDROGEN STORAGE VESSEL E
123A90-DDL-PR-PID-80020
FROM HYDROGEN STORAGE VESSEL F
1"-VL-022-01HSS-N
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
123A90-DDL-PR-PID-80012
TO FUEL CELL PACKAGE
BLPH-MV-019
BLPH-MV-018
BLPH-MV-024
BLPH-MV-025
BLPH-MV-028
BLPH-MV-213
TYPE 6 CRITICAL
TYPE 6 CRITICAL
4
3
2
NOTES
1. TIGHT SHUT OFF XV.
2. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ANY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LOPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
3. HAND SELECTOR TO ALLOW THE OPERATOR TO SELECT THE CONTROL LOOP (REMOTELY).
4. FOR ORIFICE DIAMETER REFERENCE SHALL BE MADE TO "RELIEF, VENT AND BLOWDOWN REPORT" DOC. N. "123A90-DDL-PR-RE-80030".
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM ORIFICE ARE IN HOLD
2. CONTROL VALVE SIZE (BY VENDOR).
01 24/11/2023 CIM RZI DLO ISSUE FOR HAZOP (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN STORAGE VESSELS HEADER (OUTLET)
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN
CHECKED
APPROVED
DATE
A1
DRAWING NO.
123A90-DDL-PR-PID-80014
SHEET 001
REV. 01
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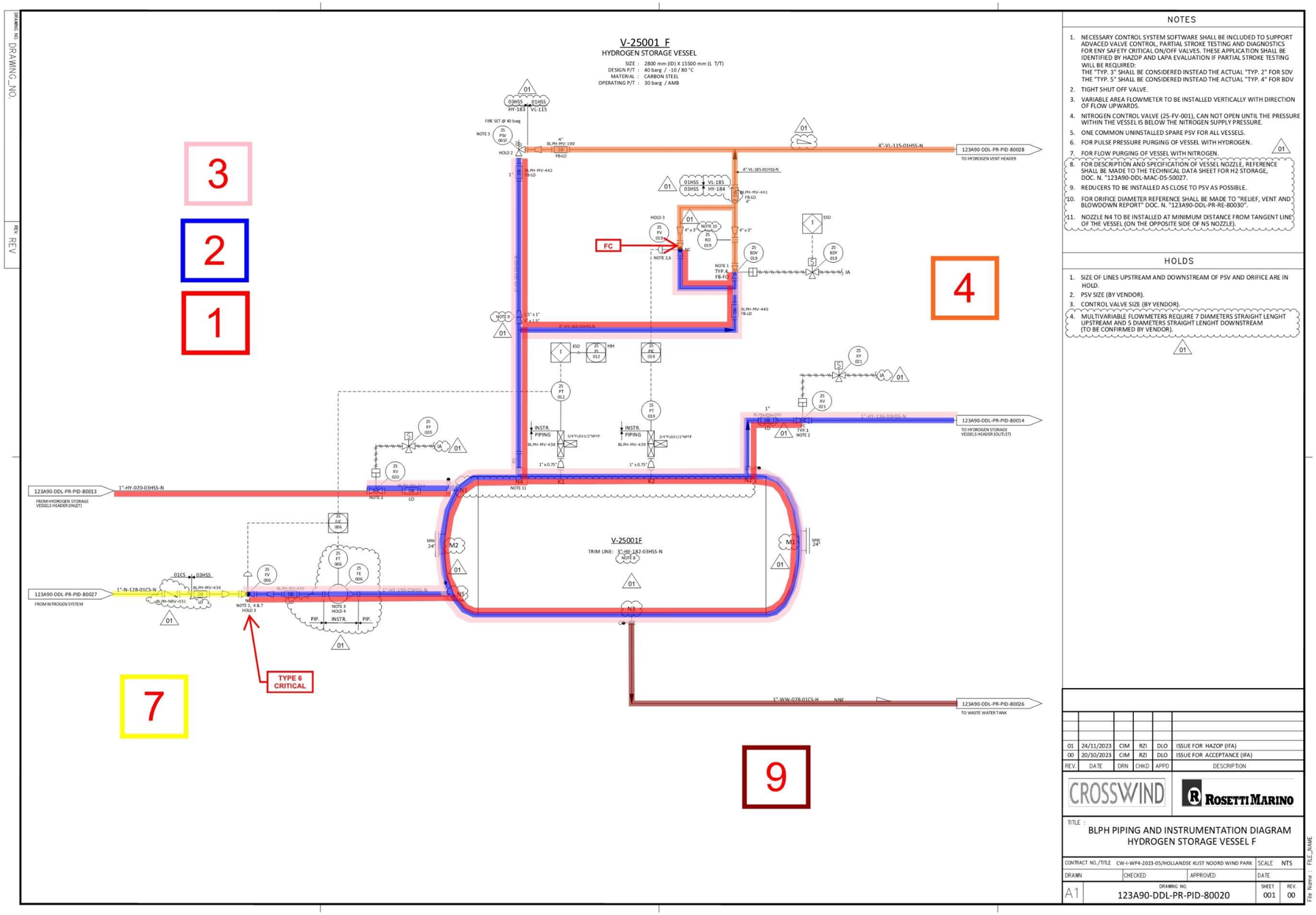

V-25001 A
HYDROGEN STORAGE VESSEL
SIZE : 2800 mm (ID) X 15500 mm (L T/T)
DESIGN P/T : 40 barg / -10 / 80 °C
MATERIAL : CARBON STEEL
OPERATING P/T : 30 barg /AMB
NOTES
1. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ANY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LOPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
2. TIGHT SHUT OFF VALVE.
3. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
4. NITROGEN CONTROL VALVE (25-FV-001), CAN NOT OPEN UNTIL THE PRESSURE WITHIN THE VESSEL IS BELOW THE NITROGEN SUPPLY PRESSURE.
5. ONE COMMON UNINSTALLED SPARE PSV FOR ALL VESSELS.
6. FOR PULSE PRESSURE PURGING OF VESSEL WITH HYDROGEN.
7. FOR FLOW PURGING OF VESSEL WITH NITROGEN.
8. FOR DESCRIPTION AND SPECIFICATION OF VESSEL NOZZLE, REFERENCE SHALL BE MADE TO THE TECHNICAL DATA SHEET FOR H2 STORAGE, DOC. N. "123A90-DDL-MAC-DS-50027".
9. REDUCERS TO BE INSTALLED AS CLOSE TO PSV AS POSSIBLE.
10. FOR ORIFICE DIAMETER REFERENCE SHALL BE MADE TO "RELIEF, VENT AND BLOWDOWN REPORT" DOC. N. "123A90-DDL-PR-RE-80030".
11. NOZZLE N4 TO BE INSTALLED AT MINIMUM DISTANCE FROM TANGENT LINE OF THE VESSEL (ON THE OPPOSITE SIDE OF N5 NOZZLE).
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM OF PSV AND ORIFICE ARE IN HOLD.
2. PSV SIZE (BY VENDOR).
3. CONTROL VALVE SIZE (BY VENDOR).
4. MULTIVARIABLE FLOWMETERS REQUIRE 7 DIAMETERS STRAIGHT LENGHT UPSTREAM AND 5 DIAMETERS STRAIGHT LENGHT DOWNSTREAM (TO BE CONFIRMED BY VENDOR).
123A90-DDL-PR-PID-80028
123A90-DDL-PR-PID-80014
123A90-DDL-PR-PID-80013
123A90-DDL-PR-PID-80027
123A90-DDL-PR-PID-80026
V-25001A
TRIM LINE: 3"-HY-164-03HSS-N
TYPE 6 CRITICAL
3
2
1
4
7
9
01 24/11/2023 CIM RZI DLO ISSUE FOR HAZOP (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN STORAGE VESSEL A
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80015
SHEET 001
REV. 01
DRAWING NO.
REV
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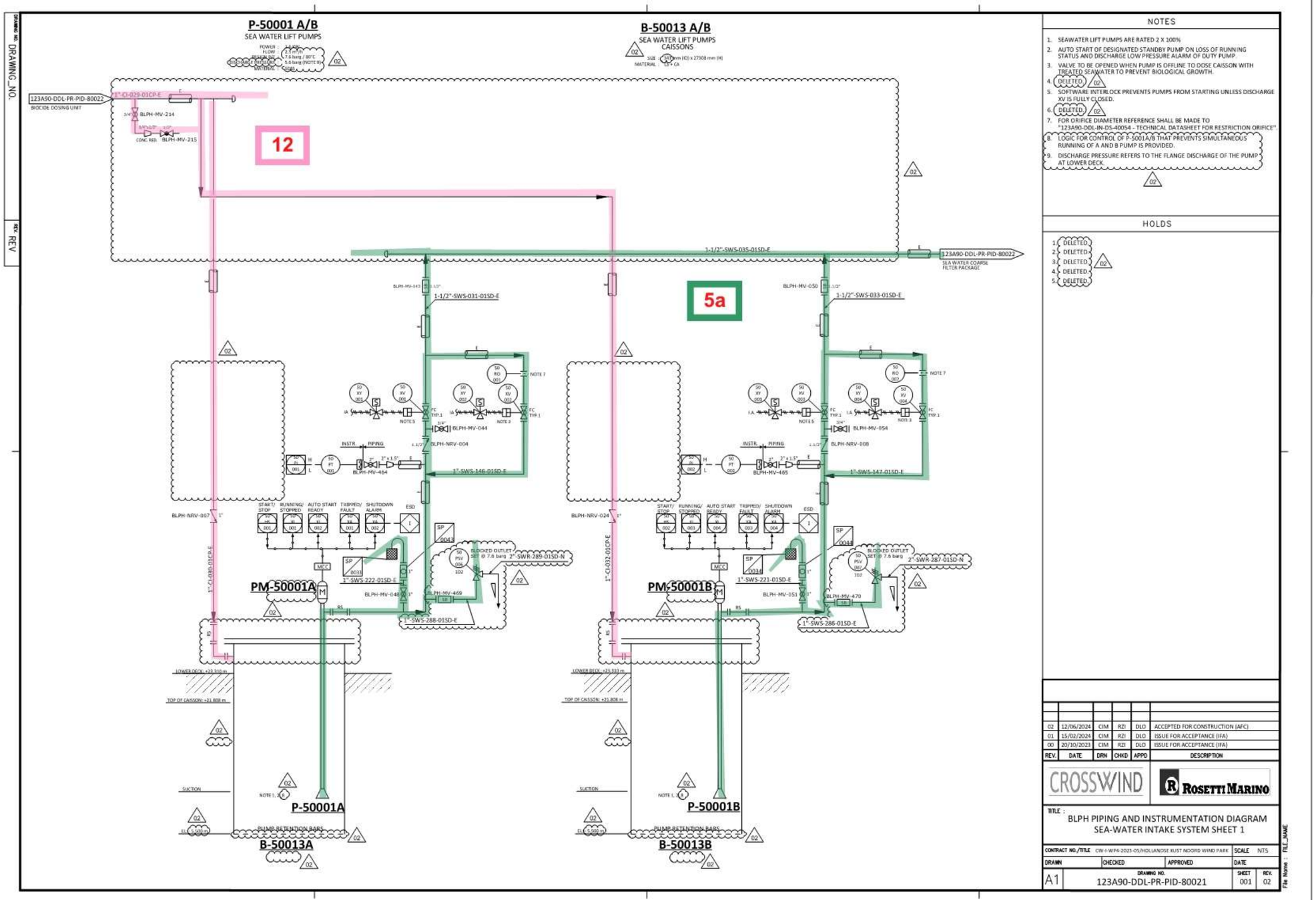

V-25001_B
HYDROGEN STORAGE VESSEL
SIZE : 2800 mm (ID) X 15500 mm (L T/T)
DESIGN P/T : 40 barg / -10 / 80 °C
MATERIAL : CARBON STEEL
OPERATING P/T : 30 barg / AMB
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
123A90-DDL-PR-PID-80014
TO HYDROGEN STORAGE VESSELS HEADER (OUTLET)
123A90-DDL-PR-PID-80013
FROM HYDROGEN STORAGE VESSELS HEADER (INLET)
123A90-DDL-PR-PID-80027
FROM NITROGEN SYSTEM
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
V-25001B
TRIM LINE: 3"-HY-165-03HSS-N
FC
TYPE 6 CRITICAL
NOTES
1. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ANY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LOPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
2. TIGHT SHUT OFF VALVE.
3. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
4. NITROGEN CONTROL VALVE (25-FV-001), CAN NOT OPEN UNTIL THE PRESSURE WITHIN THE VESSEL IS BELOW THE NITROGEN SUPPLY PRESSURE.
5. ONE COMMON UNINSTALLED SPARE PSV FOR ALL VESSELS.
6. FOR PULSE PRESSURE PURGING OF VESSEL WITH HYDROGEN.
7. FOR FLOW PURGING OF VESSEL WITH NITROGEN.
8. FOR DESCRIPTION AND SPECIFICATION OF VESSEL NOZZLE, REFERENCE SHALL BE MADE TO THE TECHNICAL DATA SHEET FOR H2 STORAGE, DOC. N. "123A90-DDL-MAC-DS-50027".
9. REDUCERS TO BE INSTALLED AS CLOSE TO PSV AS POSSIBLE.
10. FOR ORIFICE DIAMETER REFERENCE SHALL BE MADE TO "REUEF, VENT AND BLOWDOWN REPORT" DOC. N. "123A90-DDL-PR-RE-80030".
11. NOZZLE N4 TO BE INSTALLED AT MINIMUM DISTANCE FROM TANGENT LINE OF THE VESSEL (ON THE OPPOSITE SIDE OF N5 NOZZLE).
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM OF PSV AND ORIFICE ARE IN HOLD.
2. PSV SIZE (BY VENDOR).
3. CONTROL VALVE SIZE (BY VENDOR).
4. MULTIVARIABLE FLOWMETERS REQUIRE 7 DIAMETERS STRAIGHT LENGHT UPSTREAM AND 5 DIAMETERS STRAIGHT LENGHT DOWNSTREAM (TO BE CONFIRMED BY VENDOR).
01 24/11/2023 CIM RZI DLO ISSUE FOR HAZOP (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
TITLE : BLPH PIPING AND INSTRUMENTATION DIAGRAM HYDROGEN STORAGE VESSEL B
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1 DRAWING NO. 123A90-DDL-PR-PID-80016
SHEET 001 REV. 00
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REV.

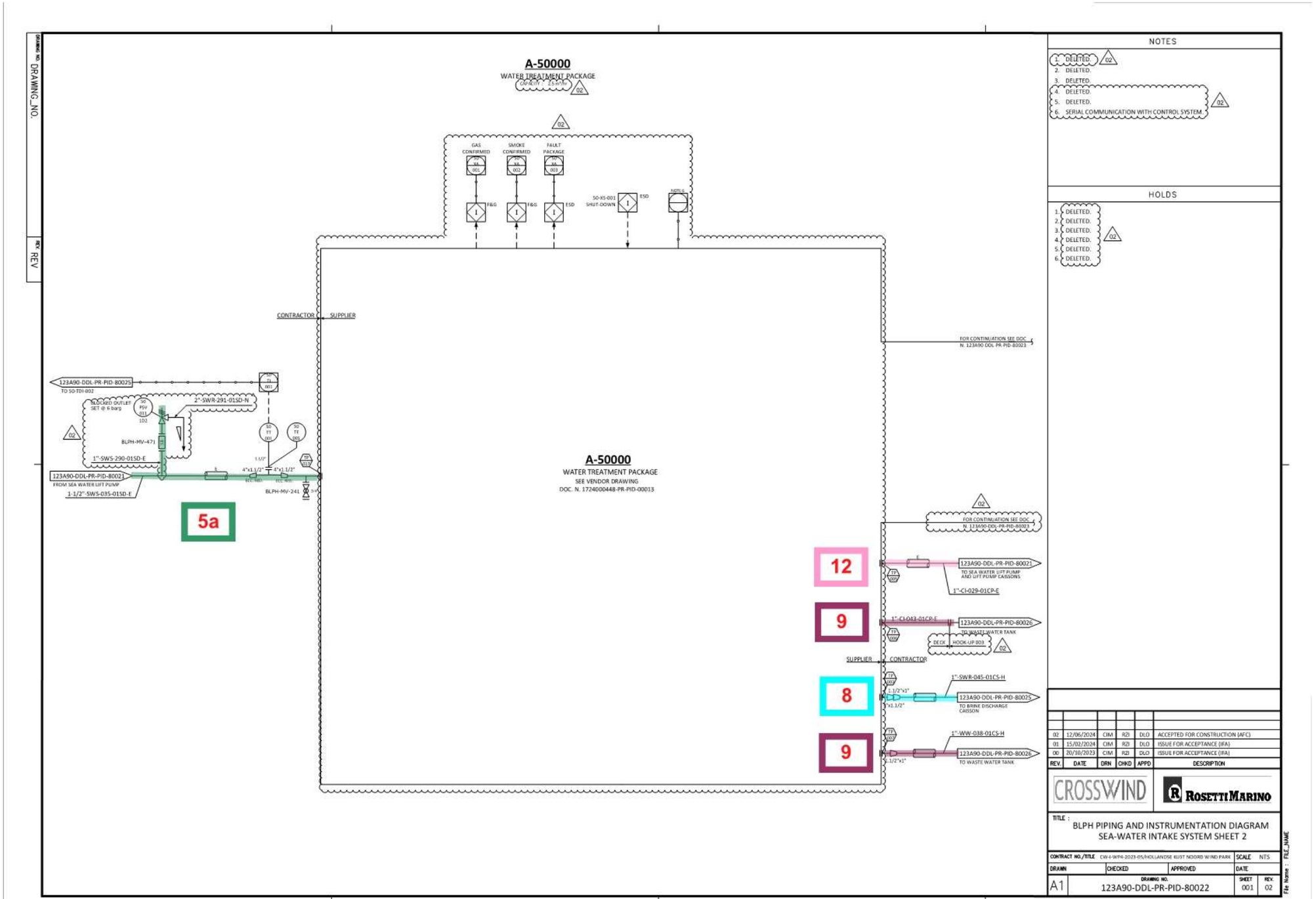

V-25001 C
HYDROGEN STORAGE VESSEL
SIZE : 2800 mm (ID) X 15500 mm (L T/T)
DESIGN P/T : 40 barg / -10 / 80 °C
MATERIAL : CARBON STEEL
OPERATING P/T : 30 barg / AMB
NOTES
1. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ANY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LOPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
2. TIGHT SHUT OFF VALVE.
3. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
4. NITROGEN CONTROL VALVE (25-FV-001), CAN NOT OPEN UNTIL THE PRESSURE WITHIN THE VESSEL IS BELOW THE NITROGEN SUPPLY PRESSURE.
5. ONE COMMON UNINSTALLED SPARE PSV FOR ALL VESSELS.
6. FOR PULSE PRESSURE PURGING OF VESSEL WITH HYDROGEN.
7. FOR FLOW PURGING OF VESSEL WITH NITROGEN.
8. FOR DESCRIPTION AND SPECIFICATION OF VESSEL NOZZLE, REFERENCE SHALL BE MADE TO THE TECHNICAL DATA SHEET FOR H2 STORAGE, DOC. N. "123A90-DDL-MAC-DS-50027".
9. REDUCERS TO BE INSTALLED AS CLOSE TO PSV AS POSSIBLE.
10. FOR ORIFICE DIAMETER REFERENCE SHALL BE MADE TO "RELIEF, VENT AND BLOWDOWN REPORT" DOC. N. "123A90-DDL-PR-RE-80030".
11. NOZZLE N4 TO BE INSTALLED AT MINIMUM DISTANCE FROM TANGENT LINE OF THE VESSEL (ON THE OPPOSITE SIDE OF N5 NOZZLE).
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM OF PSV AND ORIFICE ARE IN HOLD.
2. PSV SIZE (BY VENDOR).
3. CONTROL VALVE SIZE (BY VENDOR).
4. MULTIVARIABLE FLOWMETERS REQUIRE 7 DIAMETERS STRAIGHT LENGHT UPSTREAM AND 5 DIAMETERS STRAIGHT LENGHT DOWNSTREAM (TO BE CONFIRMED BY VENDOR).
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
123A90-DDL-PR-PID-80014
TO HYDROGEN STORAGE VESSELS HEADER (OUTLET)
123A90-DDL-PR-PID-80013
123A90-DDL-PR-PID-80027
FROM NITROGEN SYSTEM
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
V-25001C
TRIM LINE: 3"-HY-169-03HSS-N
TYPE 6 CRITICAL
1
2
3
4
7
9
01 24/11/2023 CIM RZI DLO ISSUE FOR HAZOP (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
TITLE : BLPH PIPING AND INSTRUMENTATION DIAGRAM HYDROGEN STORAGE VESSEL C
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
A1
123A90-DDL-PR-PID-80017
SHEET 001
REV. 01

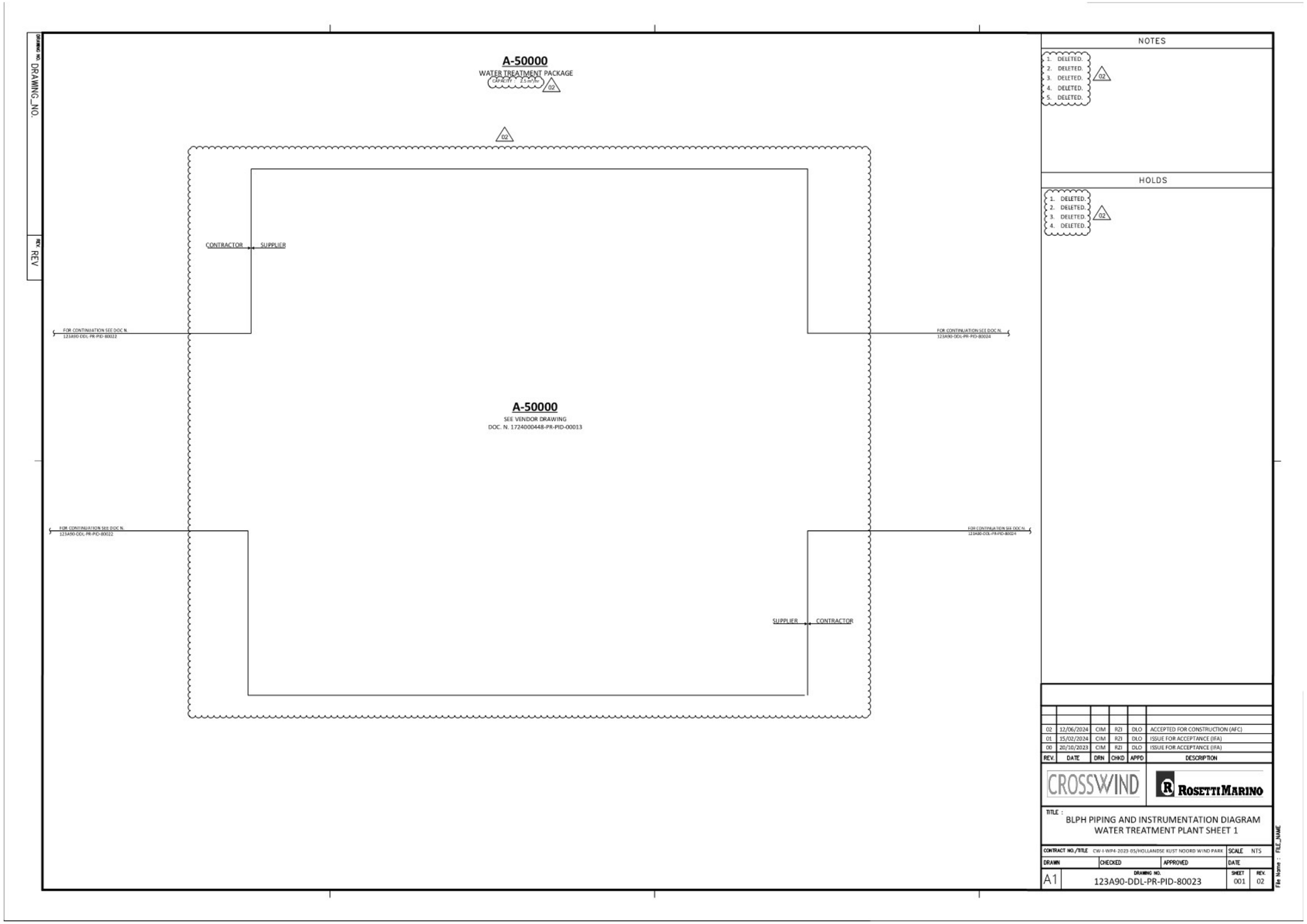

V-25001 D
HYDROGEN STORAGE VESSEL
SIZE : 2800 mm (ID) X 15500 mm (L T/T)
DESIGN P/T : 40 barg / -10 / 80 °C
MATERIAL : CARBON STEEL
OPERATING P/T : 30 barg / AMB
NOTES
1. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ENY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LAPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
2. TIGHT SHUT OFF VALVE.
3. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
4. NITROGEN CONTROL VALVE (25-FV-001), CAN NOT OPEN UNTIL THE PRESSURE WITHIN THE VESSEL IS BELOW THE NITROGEN SUPPLY PRESSURE.
5. ONE COMMON UNINSTALLED SPARE PSV FOR ALL VESSELS.
6. FOR PULSE PRESSURE PURGING OF VESSEL WITH HYDROGEN.
7. FOR FLOW PURGING OF VESSEL WITH NITROGEN.
8. FOR DESCRIPTION AND SPECIFICATION OF VESSEL NOZZLE, REFERENCE SHALL BE MADE TO THE TECHNICAL DATA SHEET FOR H2 STORAGE, DOC. N. "123A90-DDL-MAC-DS-50027".
9. REDUCERS TO BE INSTALLED AS CLOSE TO PSV AS POSSIBLE.
10. FOR ORIFICE DIAMETER REFERENCE SHALL BE MADE TO "RELIEF, VENT AND BLOWDOWN REPORT" DOC. N. "123A90-DDL-PR-RE-80030".
11. NOZZLE N4 TO BE INSTALLED AT MINIMUM DISTANCE FROM TANGENT LINE OF THE VESSEL (ON THE OPPOSITE SIDE OF N5 NOZZLE).
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM OF PSV AND ORIFICE ARE IN HOLD.
2. PSV SIZE (BY VENDOR).
3. CONTROL VALVE SIZE (BY VENDOR).
4. MULTIVARIABLE FLOWMETERS REQUIRE 7 DIAMETERS STRAIGHT LENGHT UPSTREAM AND 5 DIAMETERS STRAIGHT LENGHT DOWNSTREAM (TO BE CONFIRMED BY VENDOR).
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
123A90-DDL-PR-PID-80014
TO HYDROGEN STORAGE VESSELS HEADER (OUTLET)
123A90-DDL-PR-PID-80013
FROM HYDROGEN STORAGE VESSELS HEADER (INLET)
123A90-DDL-PR-PID-80027
FROM NITROGEN SYSTEM
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
V-25001D
TRIM LINE: 3"-HY-173-03HSS-N
TYPE 6 CRITICAL
3
2
1
4
7
9
01 24/11/2023 CIM RZI DLO ISSUE FOR HAZOP (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN STORAGE VESSEL D
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80018
SHEET 001
REV. 01

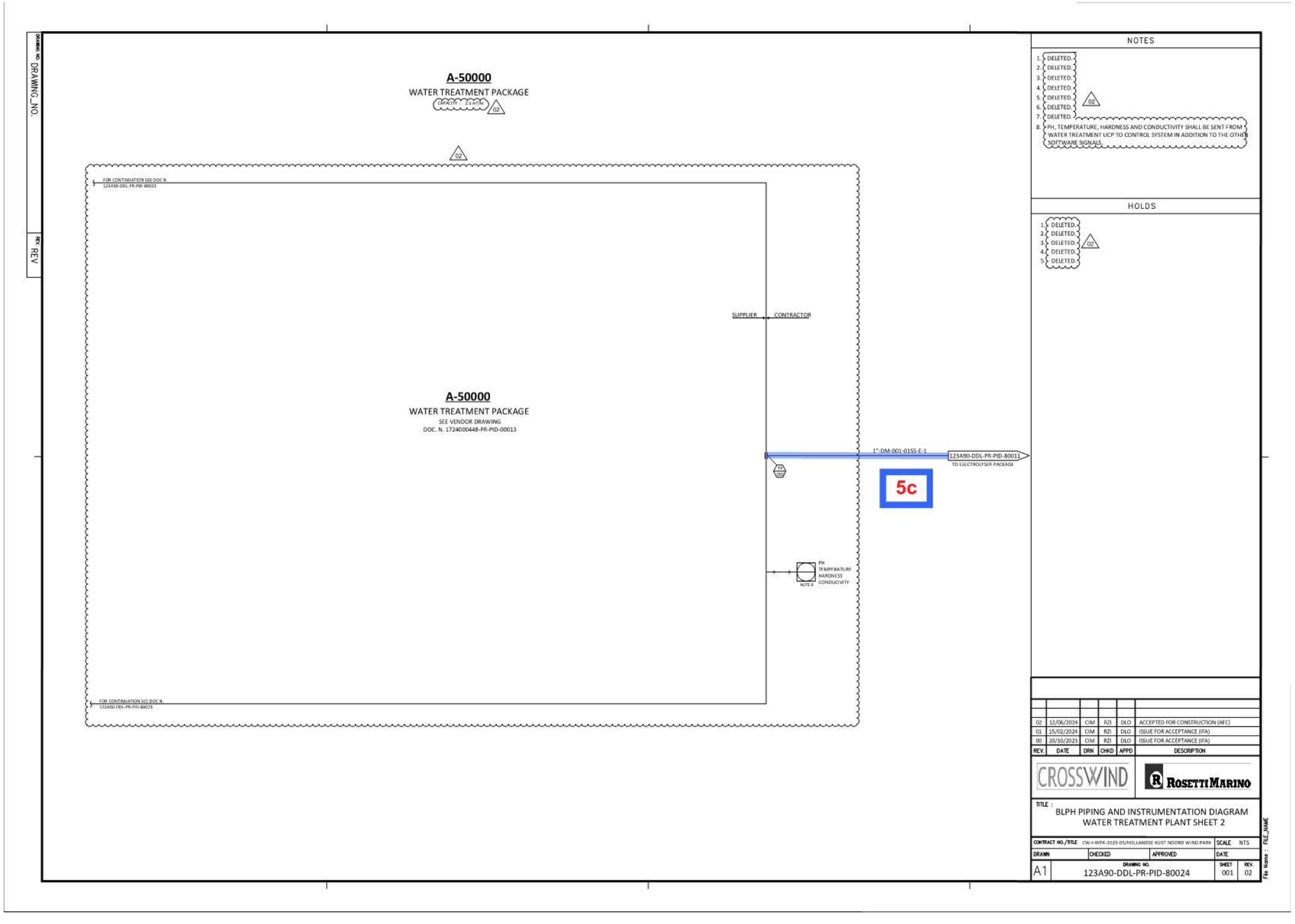

V-25001 E
HYDROGEN STORAGE VESSEL
SIZE : 2800 mm (ID) X 15500 mm (L T/T)
DESIGN P/T : 40 barg / -10 / 80 °C
MATERIAL : CARBON STEEL
OPERATING P/T : 30 barg / AMB
V-25001E
TRIM LINE: 3"-HY-178-03HSS-N
FC
TYPE 6 CRITICAL
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
123A90-DDL-PR-PID-80014
TO HYDROGEN STORAGE VESSELS HEADER (OUTLET)
123A90-DDL-PR-PID-80013
FROM HYDROGEN STORAGE VESSELS HEADER (INLET)
123A90-DDL-PR-PID-80027
FROM NITROGEN SYSTEM
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
1"-HY-019-03HSS-N
1"-N-127-01CS-N
1"-WW-077-01CS-H
3"-HY-180-03HSS-N
3"-HY-178-03HSS-N
1"-HY-135-03HSS-N
4"-VL-114-01HSS-N
4"-VL-181-01HSS-N
BLPH-HV-196
BLPH-HV-433
BLPH-HV-432
BLPH-HV-431
BLPH-HV-426
BLPH-HV-428
BLPH-NRV-030
BLPH-HV-421
BLPH-HV-422
BLPH-NRV-197
INSTR. PIPING
3/4"FLGX1/2"MPTF
1" x 0.75"
MW 24"
NOTE 11
NOTE 2, 4 & 7 HOLD 3
NOTE 3 HOLD 4
NOTE 8
NOTE 10
NOTE 2,6
NOTE 1 TYP.4
TYP.1 NOTE 2
TYP.1 NOTE 3
HOLD 2
HOLD 3
FIRE SET @ 40 barg
NOTE 5
01HSS VL-181
03HSS HY-180
01HSS VL-114
03HSS HY-179
25 PSV 001E
25 RO 016
25 BDV 016
25 FV 005
25 FE 005
25 FIC 005
25 FT 005
25 IT 005
25 FT 011
25 PT 011
25 FIC 016
25 FT 016
25 XV 017
25 XV 018
ESD
HH
IA
PIP
INSTR.
NOTES
1. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ENY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LAPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
2. TIGHT SHUT OFF VALVE.
3. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
4. NITROGEN CONTROL VALVE (25-FV-001), CAN NOT OPEN UNTIL THE PRESSURE WITHIN THE VESSEL IS BELOW THE NITROGEN SUPPLY PRESSURE.
5. ONE COMMON UNINSTALLED SPARE PSV FOR ALL VESSELS.
6. FOR PULSE PRESSURE PURGING OF VESSEL WITH HYDROGEN.
7. FOR FLOW PURGING OF VESSEL WITH NITROGEN.
8. FOR DESCRIPTION AND SPECIFICATION OF VESSEL NOZZLE, REFERENCE SHALL BE MADE TO THE TECHNICAL DATA SHEET FOR H2 STORAGE, DOC. N. "123A90-DDL-MAC-DS-50027".
9. REDUCERS TO BE INSTALLED AS CLOSE TO PSV AS POSSIBLE.
10. FOR ORIFICE DIAMETER REFERENCE SHALL BE MADE TO "RELIEF, VENT AND BLOWDOWN REPORT" DOC. N. "123A90-DDL-PR-RE-80030".
11. NOZZLE N4 TO BE INSTALLED AT MINIMUM DISTANCE FROM TANGENT LINE OF THE VESSEL (ON THE OPPOSITE SIDE OF N5 NOZZLE).
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM OF PSV AND ORIFICE ARE IN HOLD.
2. PSV SIZE (BY VENDOR).
3. CONTROL VALVE SIZE (BY VENDOR).
4. MULTIVARIABLE FLOWMETERS REQUIRE 7 DIAMETERS STRAIGHT LENGHT UPSTREAM AND 5 DIAMETERS STRAIGHT LENGHT DOWNSTREAM (TO BE CONFIRMED BY VENDOR).
01 24/11/2023 CIM RZI DLO ISSUE FOR HAZOP (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN. CHKD APPD DESCRIPTION
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN STORAGE VESSEL E
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80019
SHEET 001
REV. 01
DRAWING NO.
REV
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1
2
3
4
7
9

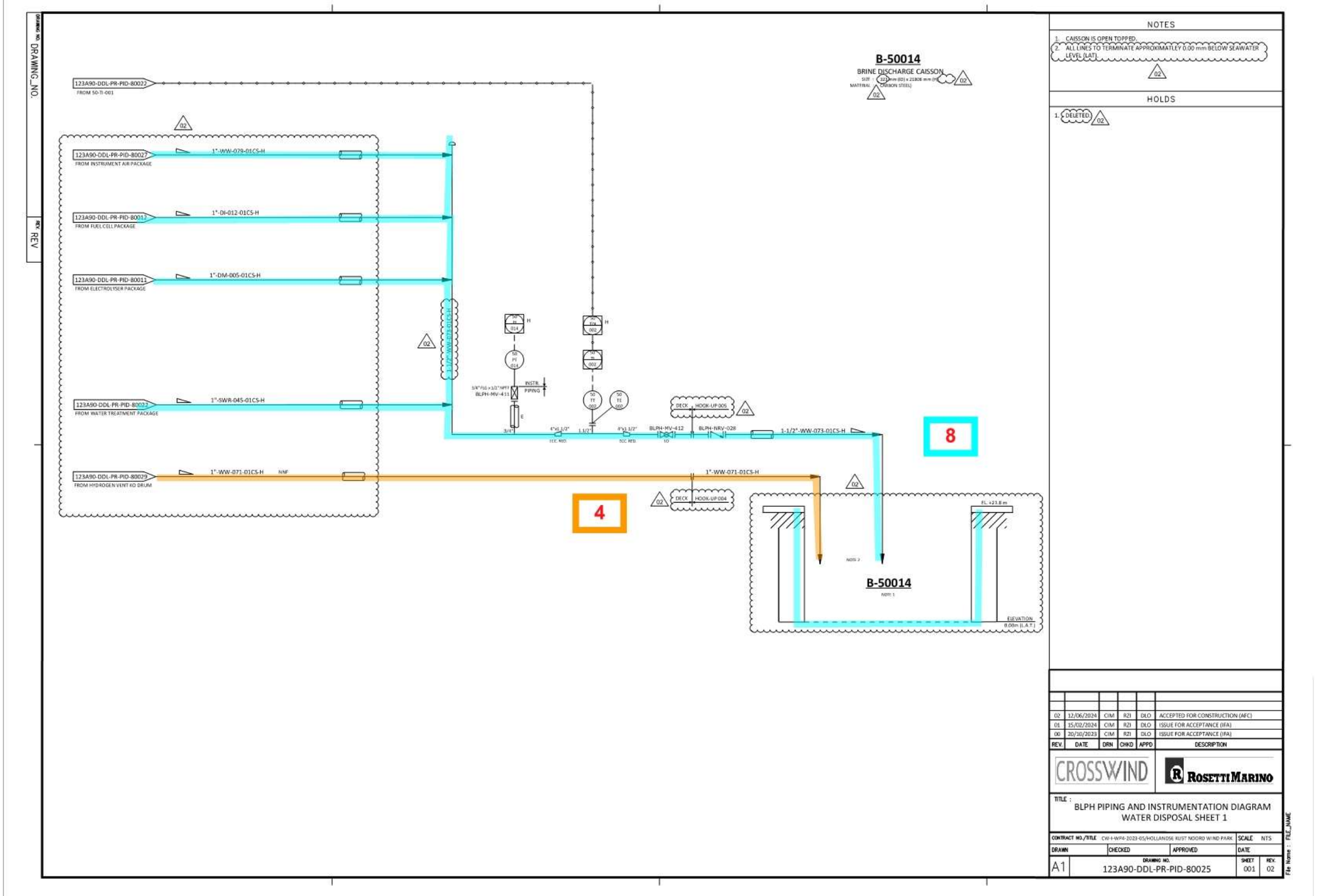

V-25001 F
HYDROGEN STORAGE VESSEL
SIZE : 2800 mm (ID) X 15500 mm (L T/T)
DESIGN P/T : 40 barg / -10 / 80 °C
MATERIAL : CARBON STEEL
OPERATING P/T : 30 barg / AMB
V-25001F
TRIM LINE: 3"-HY-182-03HSS-N
FC
TYPE 6 CRITICAL
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
123A90-DDL-PR-PID-80014
TO HYDROGEN STORAGE VESSELS HEADER (OUTLET)
123A90-DDL-PR-PID-80013
FROM HYDROGEN STORAGE VESSELS HEADER (INLET)
123A90-DDL-PR-PID-80027
FROM NITROGEN SYSTEM
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
1"-HY-020-03HSS-N
1"-N-128-01CS-N
1"-WW-078-01CS-H
3"-HY-184-03HSS-N
1"-HY-136-03HSS-N
1"-HY-180-03HSS-N
4"-VL-115-01HSS-N
4"-VL-185-01HSS-N
NOTES
1. NECESSARY CONTROL SYSTEM SOFTWARE SHALL BE INCLUDED TO SUPPORT ADVACED VALVE CONTROL, PARTIAL STROKE TESTING AND DIAGNOSTICS FOR ENY SAFETY CRITICAL ON/OFF VALVES. THESE APPLICATION SHALL BE IDENTIFIED BY HAZOP AND LAPA EVALUATION IF PARTIAL STROKE TESTING WILL BE REQUIRED:
THE "TYP. 3" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 2" FOR SDV
THE "TYP. 5" SHALL BE CONSIDERED INSTEAD THE ACTUAL "TYP. 4" FOR BDV
2. TIGHT SHUT OFF VALVE.
3. VARIABLE AREA FLOWMETER TO BE INSTALLED VERTICALLY WITH DIRECTION OF FLOW UPWARDS.
4. NITROGEN CONTROL VALVE (25-FV-001), CAN NOT OPEN UNTIL THE PRESSURE WITHIN THE VESSEL IS BELOW THE NITROGEN SUPPLY PRESSURE.
5. ONE COMMON UNINSTALLED SPARE PSV FOR ALL VESSELS.
6. FOR PULSE PRESSURE PURGING OF VESSEL WITH HYDROGEN.
7. FOR FLOW PURGING OF VESSEL WITH NITROGEN.
8. FOR DESCRIPTION AND SPECIFICATION OF VESSEL NOZZLE, REFERENCE SHALL BE MADE TO THE TECHNICAL DATA SHEET FOR H2 STORAGE, DOC. N. "123A90-DDL-MAC-DS-50027.
9. REDUCERS TO BE INSTALLED AS CLOSE TO PSV AS POSSIBLE.
10. FOR ORIFICE DIAMETER REFERENCE SHALL BE MADE TO "RELIEF, VENT AND BLOWDOWN REPORT" DOC. N. "123A90-DDL-PR-RE-80030".
11. NOZZLE N4 TO BE INSTALLED AT MINIMUM DISTANCE FROM TANGENT LINE OF THE VESSEL (ON THE OPPOSITE SIDE OF N5 NOZZLE).
HOLDS
1. SIZE OF LINES UPSTREAM AND DOWNSTREAM OF PSV AND ORIFICE ARE IN HOLD.
2. PSV SIZE (BY VENDOR).
3. CONTROL VALVE SIZE (BY VENDOR).
4. MULTIVARIABLE FLOWMETERS REQUIRE 7 DIAMETERS STRAIGHT LENGHT UPSTREAM AND 5 DIAMETERS STRAIGHT LENGHT DOWNSTREAM (TO BE CONFIRMED BY VENDOR).
01 24/11/2023 CIM RZI DLO ISSUE FOR HAZOP (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN. CHKD APPD DESCRIPTION
TITLE : BLPH PIPING AND INSTRUMENTATION DIAGRAM HYDROGEN STORAGE VESSEL F
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80020
SHEET 001
REV. 00
DRAWING NO.
REV
File Name : FILE_NAME

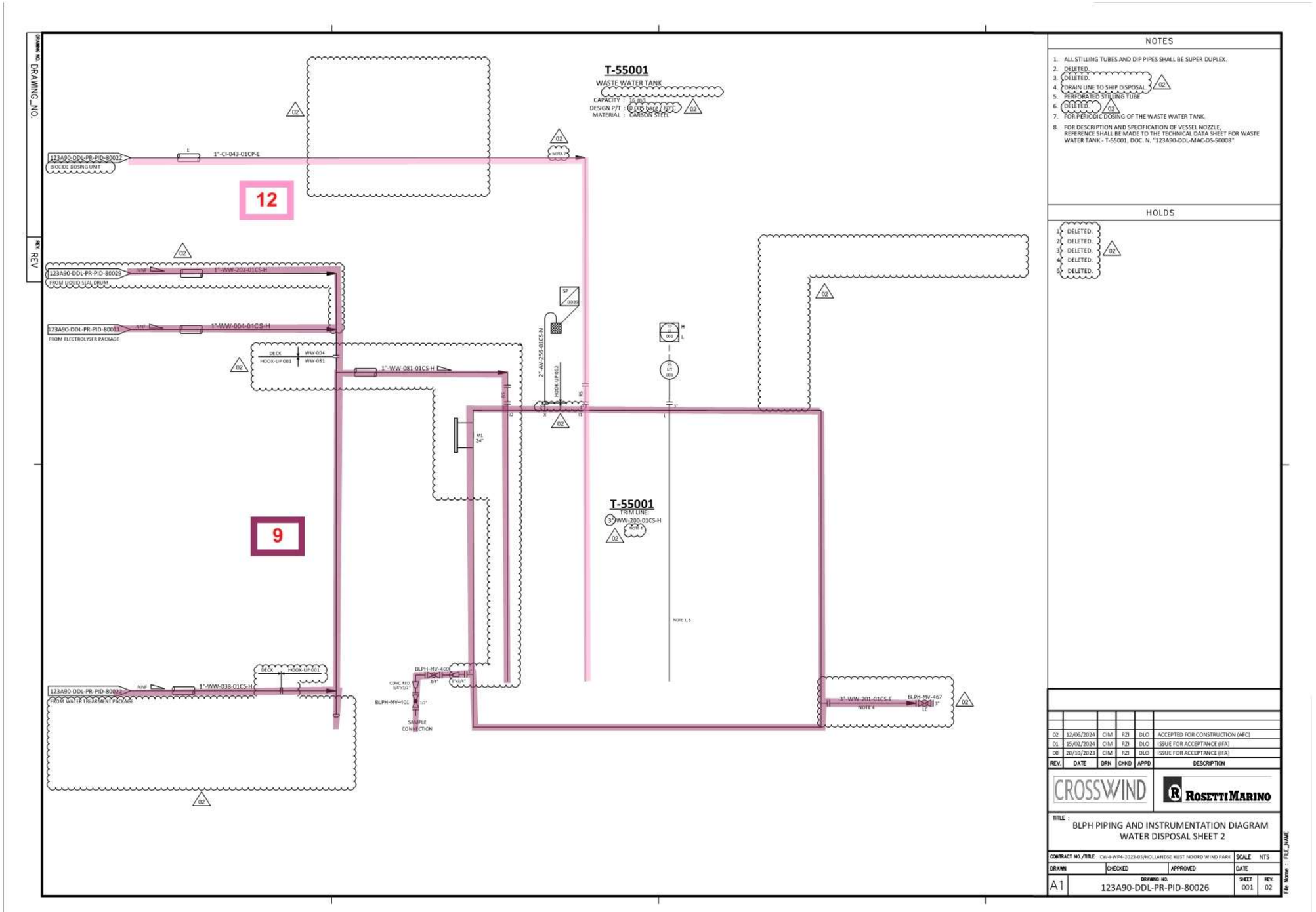

P-50001 A/B
SEA WATER LIFT PUMPS
B-50013 A/B
SEA WATER LIFT PUMPS CAISSONS
NOTES
1. SEAWATER LIFT PUMPS ARE RATED 2 X 100%
2. AUTO START OF DESIGNATED STANDBY PUMP ON LOSS OF RUNNING STATUS AND DISCHARGE LOW PRESSURE ALARM OF DUTY PUMP.
3. VALVE TO BE OPENED WHEN PUMP IS OFFLINE TO DOSE CAISSON WITH TREATED SEAWATER TO PREVENT BIOLOGICAL GROWTH.
4. DELETED
5. SOFTWARE INTERLOCK PREVENTS PUMPS FROM STARTING UNLESS DISCHARGE XV IS FULLY CLOSED.
6. DELETED
7. FOR ORIFICE DIAMETER REFERENCE SHALL BE MADE TO "123A90-DDL-IN-DS-40054 - TECHNICAL DATASHEET FOR RESTRICTION ORIFICE"
8. LOGIC FOR CONTROL OF P-5001A/B THAT PREVENTS SIMULTANEOUS RUNNING OF A AND B PUMP IS PROVIDED.
9. DISCHARGE PRESSURE REFERS TO THE FLANGE DISCHARGE OF THE PUMP AT LOWER DECK.
HOLDS
1. DELETED
2. DELETED
3. DELETED
4. DELETED
5. DELETED
12
5a
123A90-DDL-PR-PID-80022
BIOCIDE DOSING UNIT
BLPH-MV-214
BLPH-MV-215
1-1/2"-SWS-035-01SD-E
1-1/2"-SWS-031-01SD-E
1-1/2"-SWS-033-01SD-E
SEA WATER COARSE FILTER PACKAGE
BLPH-MV-044
BLPH-NRV-004
BLPH-MV-464
1"-SWS-146-01SD-E
BLPH-MV-054
BLPH-NRV-008
BLPH-MV-465
1"-SWS-147-01SD-E
BLPH-NRV-007
BLPH-NRV-024
START/ STOP
RUNNING/ STOPPED
AUTO START READY
TRIPPED/ FAULT
SHUTDOWN ALARM
ESD
PM-50001A
PM-50001B
1"-SWS-222-01SD-E
BLPH-MV-048
BLPH-MV-469
1"-SWS-288-01SD-E
1"-SWS-289-01SD-N
BLPH-MV-051
BLPH-MV-470
1"-SWS-286-01SD-E
1"-SWR-287-01SD-N
P-50001A
P-50001B
B-50013A
B-50013B
SUCTION
PUMP RETENTION BARS
LOWER DECK: +23.310 m
TOP OF CAISSON: +21.808 m
BLOCKED OUTLET SET @ 7.6 barg
REV. DATE DRN CHKD APPD DESCRIPTION
02 12/06/2024 CIM RZI DLO ACCEPTED FOR CONSTRUCTION (AFC)
01 15/02/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
CROSSWIND
ROSETTI MARINO
TITLE : BLPH PIPING AND INSTRUMENTATION DIAGRAM SEA-WATER INTAKE SYSTEM SHEET 1
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80021
SHEET 001
REV. 02
File Name : FILE_NAME

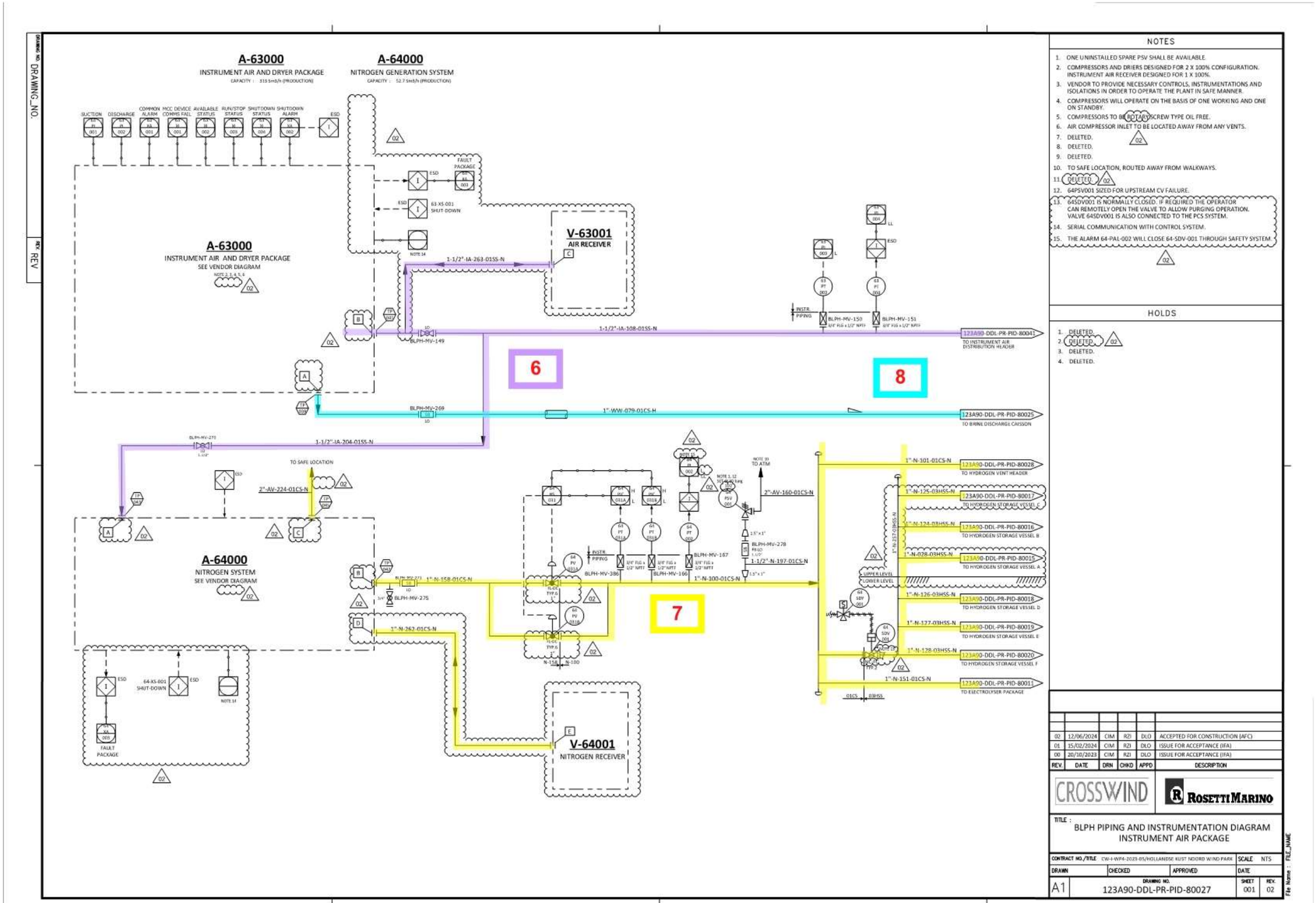

DRAWING NO.
REV
A-50000
WATER TREATMENT PACKAGE
CAPACITY 2.5 m³/hr
GAS CONFIRMED
SMOKE CONFIRMED
FAULT PACKAGE
F&G
ESD
50-XS-001 SHUT-DOWN
NOTES
1. DELETED.
2. DELETED.
3. DELETED.
4. DELETED.
5. DELETED.
6. SERIAL COMMUNICATION WITH CONTROL SYSTEM.
HOLDS
1. DELETED.
2. DELETED.
3. DELETED.
4. DELETED.
5. DELETED.
6. DELETED.
CONTRACTOR
SUPPLIER
123A90-DDL-PR-PID-80025
TO 50-TDI-002
BLOCKED OUTLET SET @ 6 barg
2"-SWR-291-01SD-N
BLPH-MV-471
1"-SWS-290-01SD-E
123A90-DDL-PR-PID-80021
FROM SEA WATER LIFT PUMP
1-1/2"-SWS-035-01SD-E
BLPH-MV-24L
5a
A-50000
WATER TREATMENT PACKAGE
SEE VENDOR DRAWING
DOC. N. 1724000448-PR-PID-00013
FOR CONTINUATION SEE DOC N. 123A90-DDL-PR-PID-80023
12
123A90-DDL-PR-PID-80021
TO SEA WATER LIFT PUMP AND LIFT PUMP CAISSONS
1"-CI-029-01CP-E
9
1"-CI-043-01CP-E
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
DECK
HOOK-UP 803
8
1"-SWR-045-01CS-H
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
9
1"-WW-038-01CS-H
123A90-DDL-PR-PID-80026
TO WASTE WATER TANK
02 12/06/2024 CIM RZI DLO ACCEPTED FOR CONSTRUCTION (AFC)
01 15/02/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
SEA-WATER INTAKE SYSTEM SHEET 2
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80022
SHEET 001
REV. 02
File Name : FILE_NAME

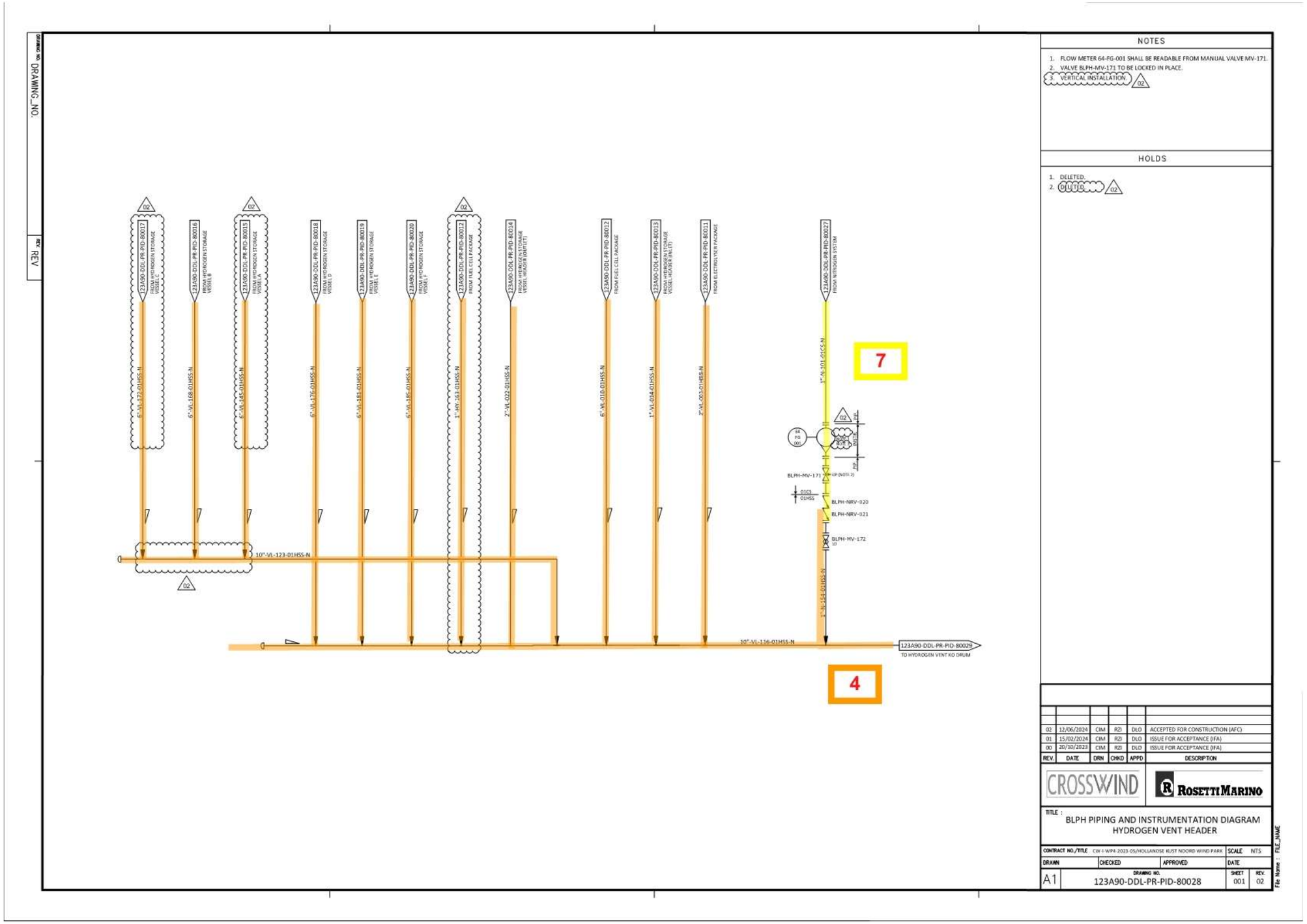

DRAWING NO.
REV.
A-50000
WATER TREATMENT PACKAGE
CAPACITY : 2.5 m³/hr
02
CONTRACTOR
SUPPLIER
FOR CONTINUATION SEE DOC N. 123A90-DDL-PR-PID-80022
FOR CONTINUATION SEE DOC N. 123A90-DDL-PR-PID-80024
A-50000
SEE VENDOR DRAWING
DOC. N. 1724000448-PR-PID-00013
FOR CONTINUATION SEE DOC N. 123A90-DDL-PR-PID-80022
FOR CONTINUATION SEE DOC N. 123A90-DDL-PR-PID-80024
SUPPLIER
CONTRACTOR
NOTES
1. DELETED.
2. DELETED.
3. DELETED.
4. DELETED.
5. DELETED.
02
HOLDS
1. DELETED.
2. DELETED.
3. DELETED.
4. DELETED.
02
02 12/06/2024 CIM RZI DLO ACCEPTED FOR CONSTRUCTION (AFC)
01 15/02/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
WATER TREATMENT PLANT SHEET 1
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN
CHECKED
APPROVED
DATE
A1
DRAWING NO.
123A90-DDL-PR-PID-80023
SHEET 001
REV. 02
File Name : FILE_NAME

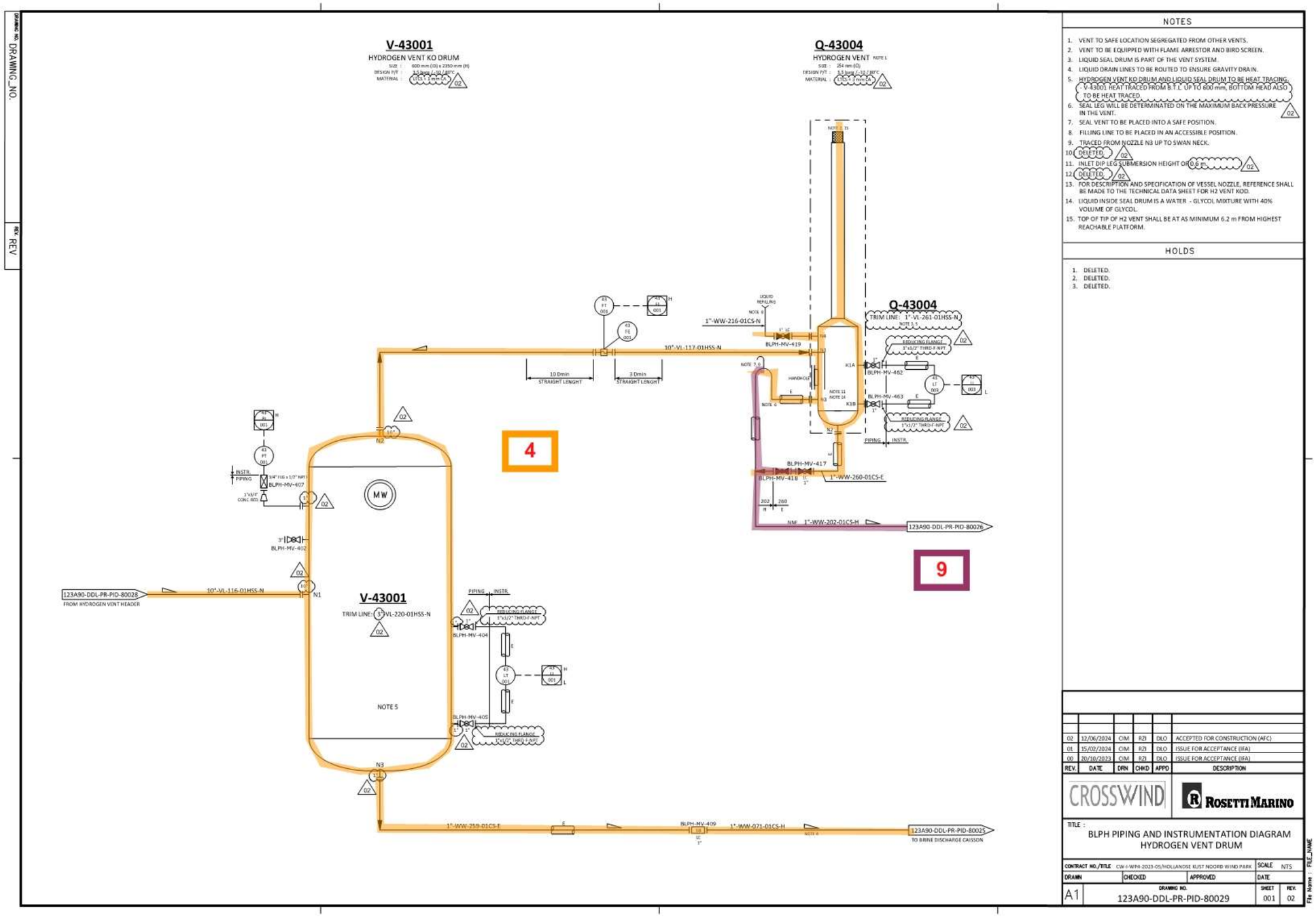

DRAWING NO.
REV
A-50000
WATER TREATMENT PACKAGE
CAPACITY 2,5 m³/h
02
FOR CONTINUATION SEE DOC N. 123A90-DDL-PR-PID-80023
SUPPLIER
CONTRACTOR
A-50000
WATER TREATMENT PACKAGE
SEE VENDOR DRAWING
DOC. N. 1724000448-PR-PID-00013
1"-DM-001-01SS-E-1
123A90-DDL-PR-PID-80011
TO ELECTROLYSER PACKAGE
FT
VSD
5c
PH
TEMPERATURE
HARDNESS
CONDUCTIVITY
NOTE 8
FOR CONTINUATION SEE DOC N. 123A90-DDL-PR-PID-80035
NOTES
1. DELETED.
2. DELETED.
3. DELETED.
4. DELETED.
5. DELETED.
6. DELETED.
7. DELETED.
8. PH, TEMPERATURE, HARDNESS AND CONDUCTIVITY SHALL BE SENT FROM WATER TREATMENT UCP TO CONTROL SYSTEM IN ADDITION TO THE OTHER SOFTWARE SIGNALS.
02
HOLDS
1. DELETED.
2. DELETED.
3. DELETED.
4. DELETED.
5. DELETED.
02
02 12/06/2024 CIM RZI DLO ACCEPTED FOR CONSTRUCTION (AFC)
01 15/02/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
WATER TREATMENT PLANT SHEET 2
CONTRACT NO./TITLE : CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN
CHECKED
APPROVED
DATE
A1
DRAWING NO.
123A90-DDL-PR-PID-80024
SHEET 001
REV. 02
File Name : FILE_NAME

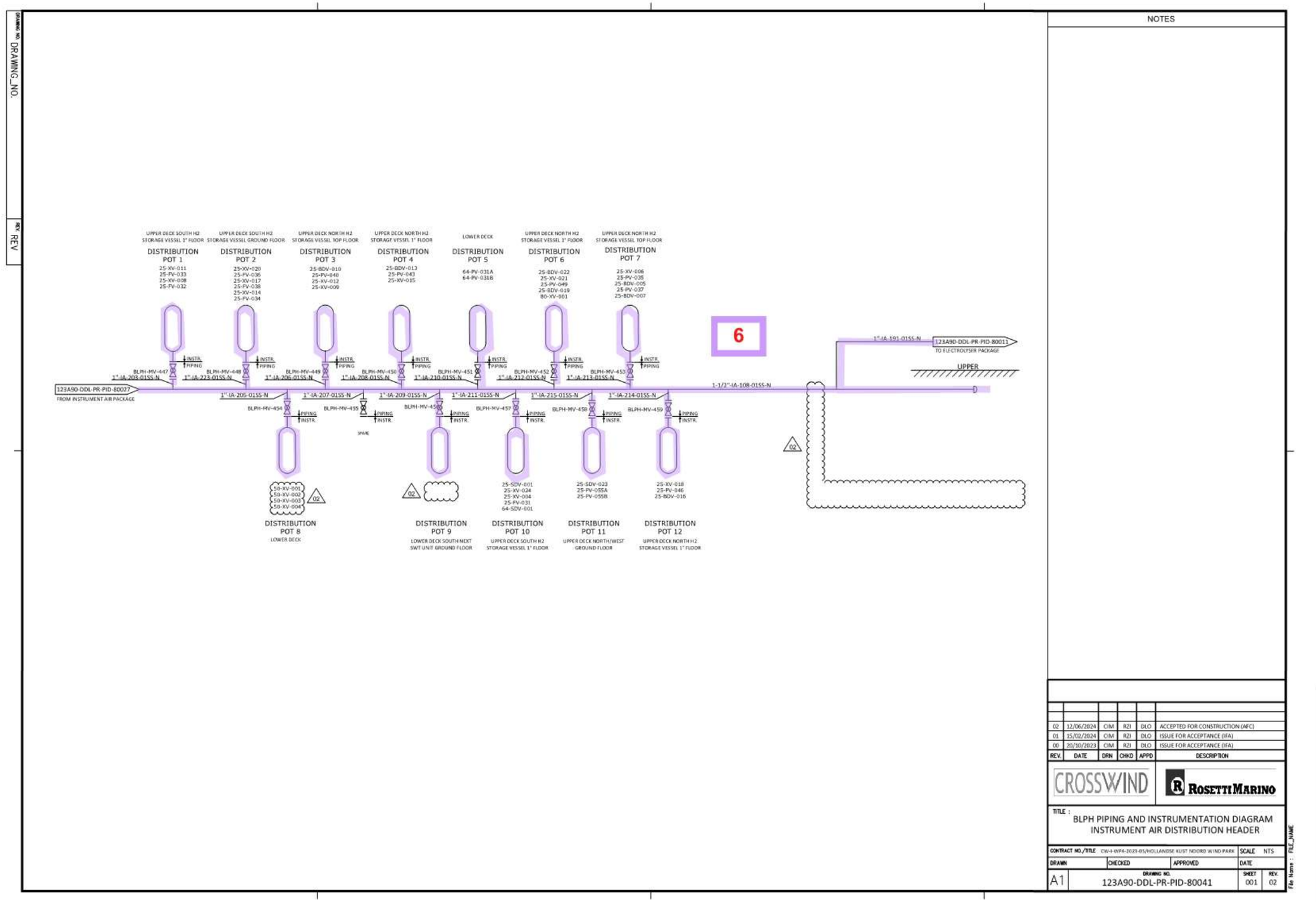

DRAWING NO.
REV
123A90-DDL-PR-PID-80022
FROM 50-TI-001
123A90-DDL-PR-PID-80027
FROM INSTRUMENT AIR PACKAGE
1"-WW-079-01CS-H
123A90-DDL-PR-PID-80017
FROM FUEL CELL PACKAGE
1"-DI-012-01CS-H
123A90-DDL-PR-PID-80011
FROM ELECTROLYSER PACKAGE
1"-DM-005-01CS-H
123A90-DDL-PR-PID-80023
FROM WATER TREATMENT PACKAGE
1"-SWR-045-01CS-H
123A90-DDL-PR-PID-80029
FROM HYDROGEN VENT KO DRUM
1"-WW-071-01CS-H
NNF
1"-WW-071-01CS-H
B-50014
BRINE DISCHARGE CAISSON
MATERIAL : DUPLEX STEEL
NOTES
1. CAISSON IS OPEN TOPPED.
2. ALL LINES TO TERMINATE APPROXIMATLEY 0.00 mm BELOW SEAWATER LEVEL (LAT)
HOLDS
1. (DELETED)
INSTR. PIPING
BLPH-MV-411
BLPH-MV-412
BLPH-NRV-028
1-1/2"-WW-073-01CS-H
DECK HOOK-UP 005
DECK HOOK-UP 004
8
4
B-50014
ELEVATION
0.00m (L.A.T.)
02 12/06/2024 CIM RZI DLO ACCEPTED FOR CONSTRUCTION (AFC)
01 15/02/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
WATER DISPOSAL SHEET 1
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO.
123A90-DDL-PR-PID-80025
SHEET 001
REV. 02
File Name : FILE_NAME

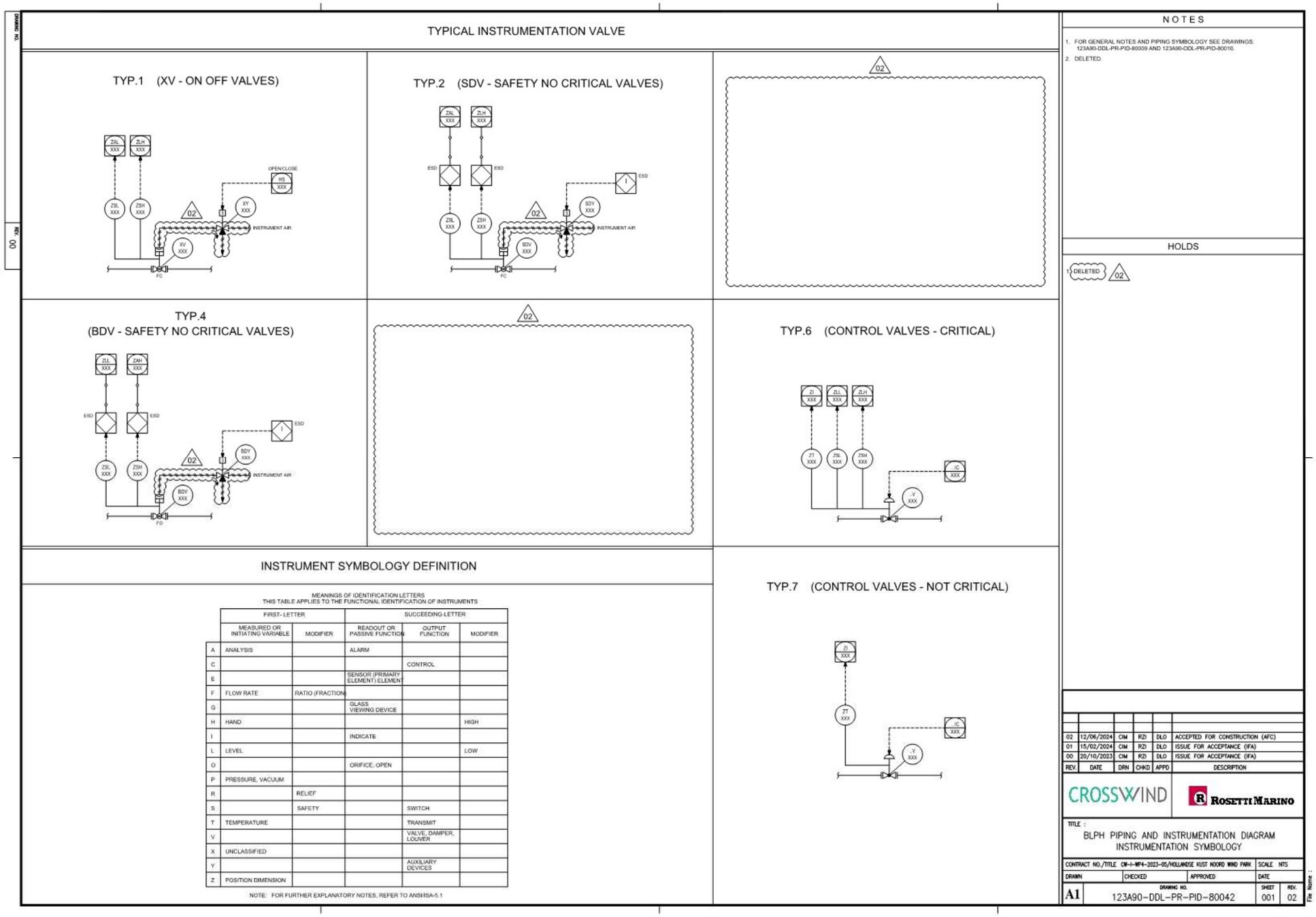

T-55001
WASTE WATER TANK
CAPACITY : 16 m3
DESIGN P/T : 0.005 barg / 80°C
MATERIAL : CARBON STEEL
123A90-DDL-PR-PID-80022
BIOCIDE DOSING UNIT
1"-CI-043-01CP-E
12
123A90-DDL-PR-PID-80029
FROM LIQUID SEAL DRUM
1"-WW-202-01CS-H
123A90-DDL-PR-PID-80001
FROM ELECTROLYSER PACKAGE
1"-WW-004-01CS-H
DECK
HOOK-UP 001
WW-004
WW-081
1"-WW-081-01CS-H
2"-AV-256-01CS-N
HOOK-UP 002
9
T-55001
TRIM LINE
3"-WW-200-01CS-H
NOTE 4
NOTE 1, 5
123A90-DDL-PR-PID-80032
FROM WATER TREATMENT PACKAGE
1"-WW-038-01CS-H
BLPH-MV-400
BLPH-MV-401
SAMPLE CONNECTION
3"-WW-201-01CS-E
BLPH-MV-467
NOTES
1. ALL STILLING TUBES AND DIP PIPES SHALL BE SUPER DUPLEX.
2. DELETED.
3. DELETED.
4. DRAIN LINE TO SHIP DISPOSAL
5. PERFORATED STILLING TUBE.
6. DELETED.
7. FOR PERIODIC DOSING OF THE WASTE WATER TANK.
8. FOR DESCRIPTION AND SPECIFICATION OF VESSEL NOZZLE, REFERENCE SHALL BE MADE TO THE TECHNICAL DATA SHEET FOR WASTE WATER TANK - T-55001, DOC. N. "123A90-DDL-MAC-DS-50008"
HOLDS
1. DELETED.
2. DELETED.
3. DELETED.
4. DELETED.
5. DELETED.
02 12/06/2024 CIM RZI DLO ACCEPTED FOR CONSTRUCTION (AFC)
01 15/02/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
WATER DISPOSAL SHEET 2
CONTRACT NO./TITLE : CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE : NTS
DRAWN
CHECKED
APPROVED
DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80026
SHEET 001
REV. 02
DRAWING NO.
REV.
File Name : FILE_NAME

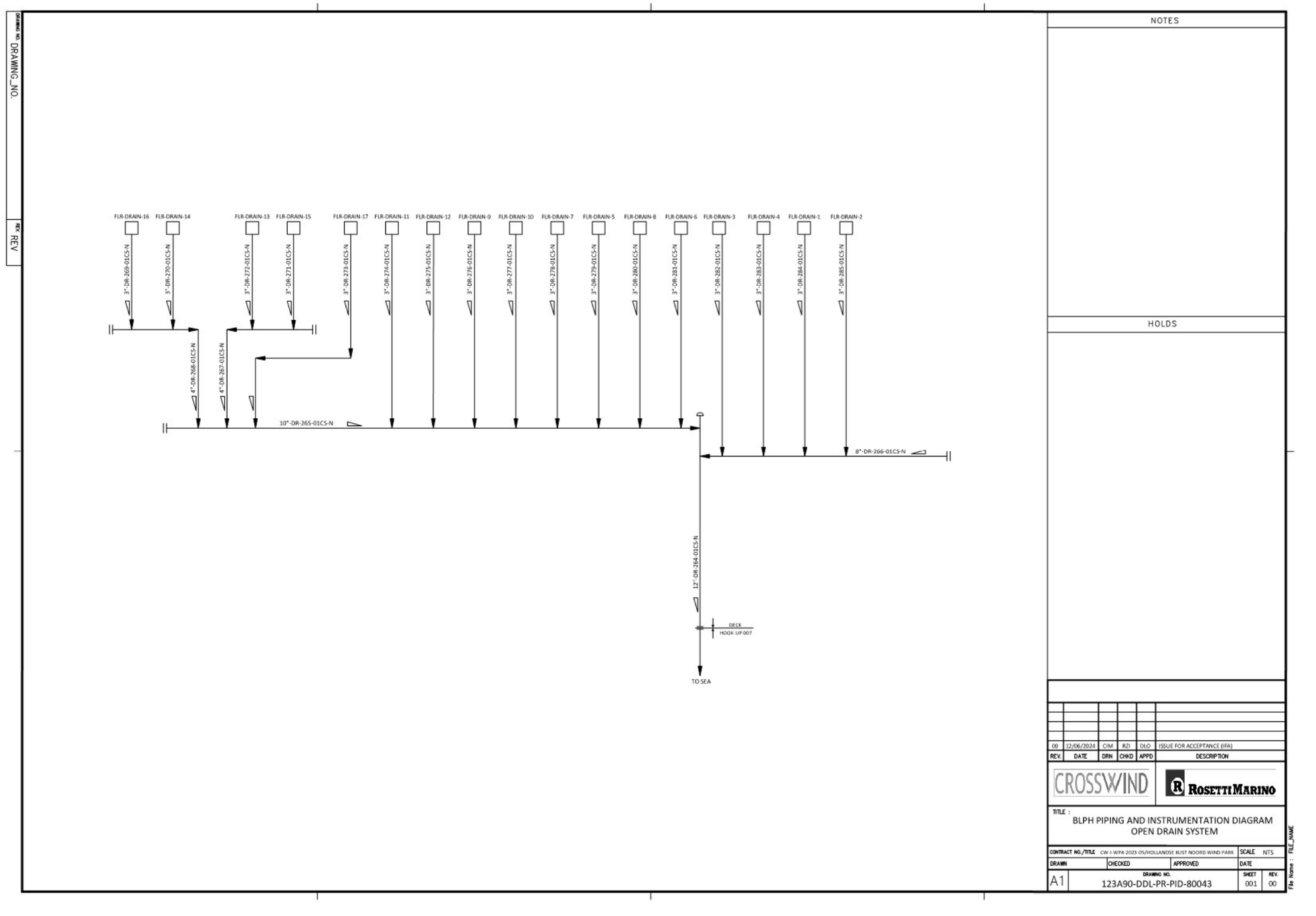

A-63000
INSTRUMENT AIR AND DRYER PACKAGE
A-64000
NITROGEN GENERATION SYSTEM
V-63001
AIR RECEIVER
A-63000
INSTRUMENT AIR AND DRYER PACKAGE
SEE VENDOR DIAGRAM
1-1/2"-IA-263-01SS-N
1-1/2"-IA-108-01SS-N
123A90-DDL-PR-PID-80041
TO INSTRUMENT AIR DISTRIBUTION HEADER
BLPH-MV-149
BLPH-MV-150
BLPH-MV-151
6
8
BLPH-MV-269
1"-WW-079-01CS-H
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
1-1/2"-IA-204-01SS-N
TO SAFE LOCATION
2"-AV-224-01CS-N
A-64000
NITROGEN SYSTEM
SEE VENDOR DIAGRAM
BLPH-MV-386
BLPH-MV-166
BLPH-MV-167
BLPH-MV-278
1"-N-158-01CS-N
1"-N-100-01CS-N
1-1/2"-N-197-01CS-N
2"-AV-160-01CS-N
TO ATM
7
1"-N-262-01CS-N
V-64001
NITROGEN RECEIVER
1"-N-301-01CS-N
123A90-DDL-PR-PID-80028
TO HYDROGEN VENT HEADER
1"-N-125-03HSS-N
123A90-DDL-PR-PID-80017
TO HYDROGEN STORAGE VESSEL C
1"-N-124-03HSS-N
123A90-DDL-PR-PID-80016
TO HYDROGEN STORAGE VESSEL B
1"-N-078-03HSS-N
123A90-DDL-PR-PID-80015
TO HYDROGEN STORAGE VESSEL A
1"-N-126-03HSS-N
123A90-DDL-PR-PID-80018
TO HYDROGEN STORAGE VESSEL D
1"-N-177-03HSS-N
123A90-DDL-PR-PID-80019
TO HYDROGEN STORAGE VESSEL E
1"-N-128-03HSS-N
123A90-DDL-PR-PID-80020
TO HYDROGEN STORAGE VESSEL F
1"-N-151-01CS-N
123A90-DDL-PR-PID-80011
TO ELECTROLYSER PACKAGE
NOTES
1. ONE UNINSTALLED SPARE PSV SHALL BE AVAILABLE.
2. COMPRESSORS AND DRIERS DESIGNED FOR 2 X 100% CONFIGURATION. INSTRUMENT AIR RECEIVER DESIGNED FOR 1 X 100%.
3. VENDOR TO PROVIDE NECESSARY CONTROLS, INSTRUMENTATIONS AND ISOLATIONS IN ORDER TO OPERATE THE PLANT IN SAFE MANNER.
4. COMPRESSORS WILL OPERATE ON THE BASIS OF ONE WORKING AND ONE ON STANDBY.
5. COMPRESSORS TO BE ROTARY SCREW TYPE OIL FREE.
6. AIR COMPRESSOR INLET TO BE LOCATED AWAY FROM ANY VENTS.
7. DELETED.
8. DELETED.
9. DELETED.
10. TO SAFE LOCATION, ROUTED AWAY FROM WALKWAYS.
11. DELETED
12. 64PSV001 SIZED FOR UPSTREAM CV FAILURE.
13. 64SDV001 IS NORMALLY CLOSED. IF REQUIRED THE OPERATOR CAN REMOTELY OPEN THE VALVE TO ALLOW PURGING OPERATION. VALVE 64SDV001 IS ALSO CONNECTED TO THE PCS SYSTEM.
14. SERIAL COMMUNICATION WITH CONTROL SYSTEM.
15. THE ALARM 64-PAL-002 WILL CLOSE 64-SDV-001 THROUGH SAFETY SYSTEM.
HOLDS
1. DELETED.
2. DELETED.
3. DELETED.
4. DELETED.
02 12/06/2024 CIM RZI DLO ACCEPTED FOR CONSTRUCTION (AFC)
01 15/02/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
INSTRUMENT AIR PACKAGE
CONTRACT NO./TITLE: CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80027
SHEET 001
REV. 02
DRAWING NO.
REV.
File Name : FILE_NAME


DRAWING NO.
REV
NOTES
1. FLOW METER 64-FG-001 SHALL BE READABLE FROM MANUAL VALVE MV-171.
2. VALVE BLPH-MV-171 TO BE LOCKED IN PLACE.
3. VERTICAL INSTALLATION.
HOLDS
1. DELETED.
2. DELETED
123A90-DDL-PR-PID-80017 FROM HYDROGEN STORAGE VESSEL C
123A90-DDL-PR-PID-80016 FROM HYDROGEN STORAGE VESSEL B
123A90-DDL-PR-PID-80015 FROM HYDROGEN STORAGE VESSEL A
123A90-DDL-PR-PID-80018 FROM HYDROGEN STORAGE VESSEL D
123A90-DDL-PR-PID-80019 FROM HYDROGEN STORAGE VESSEL E
123A90-DDL-PR-PID-80020 FROM HYDROGEN STORAGE VESSEL F
123A90-DDL-PR-PID-80012 FROM FUEL CELL PACKAGE
123A90-DDL-PR-PID-80014 FROM HYDROGEN STORAGE VESSEL (OFFSET)
123A90-DDL-PR-PID-80012 FROM FUEL CELL PACKAGE
123A90-DDL-PR-PID-80013 FROM HYDROGEN STORAGE VESSEL (OFFSET)
123A90-DDL-PR-PID-80011 FROM ELECTROLYSER PACKAGE
123A90-DDL-PR-PID-80022 FROM NITROGEN SYSTEM
6"-VL-172-01HSS-N
6"-VL-168-01HSS-N
8"-VL-145-01HSS-N
6"-VL-170-01HSS-N
6"-VL-181-01HSS-N
6"-VL-185-01HSS-N
1"-VL-136-01HSS-N
2"-VL-202-01HSS-N
6"-VL-010-01HSS-N
1"-VL-014-01HSS-N
2"-VL-005-01HSS-N
1"-N-501-01CS-N
7
BLPH-MV-171
BLPH-NRV-020
BLPH-NRV-021
BLPH-MV-172
1"-N-345-01HSS-N
10"-VL-123-01HSS-N
10"-VL-116-01HSS-N
123A90-DDL-PR-PID-80029
TO HYDROGEN VENT KO DRUM
4
02 12/06/2024 CIM RZI DLO ACCEPTED FOR CONSTRUCTION (AFC)
01 15/02/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN VENT HEADER
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80028
SHEET 001
REV. 02
File Name : FILE_NAME


V-43001
HYDROGEN VENT KO DRUM
Q-43004
HYDROGEN VENT
4
9
Q-43004
TRIM LINE: 1"-VL-261-01HSS-N
1"-WW-216-01CS-N
10"-VL-117-01HSS-N
10 Dmin STRAIGHT LENGHT
3 Dmin STRAIGHT LENGHT
BLPH-MV-419
BLPH-MV-462
BLPH-MV-463
BLPH-MV-417
BLPH-MV-418
1"-WW-260-01CS-E
1"-WW-202-01CS-H
123A90-DDL-PR-PID-80026
BLPH-MV-407
BLPH-MV-402
123A90-DDL-PR-PID-80028
FROM HYDROGEN VENT HEADER
10"-VL-116-01HSS-N
V-43001
TRIM LINE: 3"-VL-220-01HSS-N
NOTE 5
BLPH-MV-404
BLPH-MV-405
1"-WW-259-01CS-E
BLPH-MV-409
1"-WW-071-01CS-H
123A90-DDL-PR-PID-80025
TO BRINE DISCHARGE CAISSON
MW
INSTR
PIPING
REDUCING FLANGE
3"x1/2" THRD-F-NPT
1"x1/2" THRD-F-NPT
NOTES
1. VENT TO SAFE LOCATION SEGREGATED FROM OTHER VENTS.
2. VENT TO BE EQUIPPED WITH FLAME ARRESTOR AND BIRD SCREEN.
3. LIQUID SEAL DRUM IS PART OF THE VENT SYSTEM.
4. LIQUID DRAIN LINES TO BE ROUTED TO ENSURE GRAVITY DRAIN.
5. HYDROGEN VENT KO DRUM AND LIQUID SEAL DRUM TO BE HEAT TRACING. V-43001 HEAT TRACED FROM B.T.L. UP TO 600 mm, BOTTOM HEAD ALSO TO BE HEAT TRACED.
6. SEAL LEG WILL BE DETERMINATED ON THE MAXIMUM BACK PRESSURE IN THE VENT.
7. SEAL VENT TO BE PLACED INTO A SAFE POSITION.
8. FILLING LINE TO BE PLACED IN AN ACCESSIBLE POSITION.
9. TRACED FROM NOZZLE N3 UP TO SWAN NECK.
10. DELETED.
11. INLET DIP LEG SUBMERSION HEIGHT OF 0.6 m.
12. DELETED.
13. FOR DESCRIPTION AND SPECIFICATION OF VESSEL NOZZLE, REFERENCE SHALL BE MADE TO THE TECHNICAL DATA SHEET FOR H2 VENT KOD.
14. LIQUID INSIDE SEAL DRUM IS A WATER - GLYCOL MIXTURE WITH 40% VOLUME OF GLYCOL.
15. TOP OF TIP OF H2 VENT SHALL BE AT AS MINIMUM 6.2 m FROM HIGHEST REACHABLE PLATFORM.
HOLDS
1. DELETED.
2. DELETED.
3. DELETED.
02 12/06/2024 CIM RZI DLO ACCEPTED FOR CONSTRUCTION (AFC)
01 15/02/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
HYDROGEN VENT DRUM
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN CHECKED APPROVED DATE
A1
DRAWING NO. 123A90-DDL-PR-PID-80029
SHEET 001
REV. 02
File Name : FILE_NAME
DRAWING NO.
REV

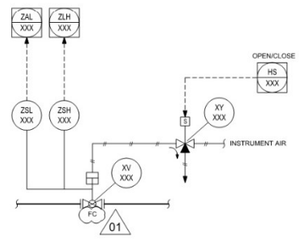

DRAWING NO.
REV
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DISTRIBUTION POT 1
DISTRIBUTION POT 2
DISTRIBUTION POT 3
DISTRIBUTION POT 4
DISTRIBUTION POT 5
DISTRIBUTION POT 6
DISTRIBUTION POT 7
DISTRIBUTION POT 8
DISTRIBUTION POT 9
DISTRIBUTION POT 10
DISTRIBUTION POT 11
DISTRIBUTION POT 12
6
123A90-DDL-PR-PID-80027
FROM INSTRUMENT AIR PACKAGE
1-1/2"-IA-108-01SS-N
1"-IA-191-01SS-N
123A90-DDL-PR-PID-80031
TO ELECTROLYSER PACKAGE
UPPER
02
BLPH-MV-447
BLPH-MV-448
BLPH-MV-449
BLPH-MV-450
BLPH-MV-451
BLPH-MV-452
BLPH-MV-453
BLPH-MV-454
BLPH-MV-455
BLPH-MV-456
BLPH-MV-457
BLPH-MV-458
BLPH-MV-459
INSTR.
PIPING
SPARE
50-XV-001
50-XV-002
50-XV-003
50-XV-004
25-SDV-001
25-XV-024
25-XV-034
25-PV-031
64-SDV-001
25-SDV-023
25-PV-055A
25-PV-055B
25-XV-018
25-PV-046
25-BDV-016
02 12/06/2024 CIM RZI DLO ACCEPTED FOR CONSTRUCTION (AFC)
01 15/02/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
INSTRUMENT AIR DISTRIBUTION HEADER
CONTRACT NO./TITLE : CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN
CHECKED
APPROVED
DATE
A1
DRAWING NO.
123A90-DDL-PR-PID-80041
SHEET 001
REV. 02
File Name : FILE_NAME


TYPICAL INSTRUMENTATION VALVE
TYP.1 (XV - ON OFF VALVES)
TYP.2 (SDV - SAFETY NO CRITICAL VALVES)
TYP.4
(BDV - SAFETY NO CRITICAL VALVES)
TYP.6 (CONTROL VALVES - CRITICAL)
TYP.7 (CONTROL VALVES - NOT CRITICAL)
INSTRUMENT SYMBOLOGY DEFINITION
MEANINGS OF IDENTIFICATION LETTERS
THIS TABLE APPLIES TO THE FUNCTIONAL IDENTIFICATION OF INSTRUMENTS
FIRST- LETTER
SUCCEEDING-LETTER
MEASURED OR INITIATING VARIABLE
MODIFIER
READOUT OR PASSIVE FUNCTION
OUTPUT FUNCTION
MODIFIER
A ANALYSIS
ALARM
C
CONTROL
E
SENSOR (PRIMARY ELEMENT) ELEMENT
F FLOW RATE
RATIO (FRACTION)
G
GLASS VIEWING DEVICE
H HAND
HIGH
I
INDICATE
L LEVEL
LOW
O
ORIFICE, OPEN
P PRESSURE, VACUUM
R
RELIEF
S
SAFETY
SWITCH
T TEMPERATURE
TRANSMIT
V
VALVE, DAMPER, LOUVER
X UNCLASSIFIED
Y
AUXILIARY DEVICES
Z POSITION DIMENSION
NOTE: FOR FURTHER EXPLANATORY NOTES, REFER TO ANSI/ISA-5.1
NOTES
1. FOR GENERAL NOTES AND PIPING SYMBOLOGY SEE DRAWINGS: 123A90-DDL-PR-PID-80009 AND 123A90-DDL-PR-PID-80010.
2. DELETED.
HOLDS
1 DELETED
02 12/06/2024 CIM RZI DLO ACCEPTED FOR CONSTRUCTION (AFC)
01 15/02/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
00 20/10/2023 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
INSTRUMENTATION SYMBOLOGY
CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN
CHECKED
APPROVED
DATE
A1
DRAWING NO.
123A90-DDL-PR-PID-80042
SHEET 001
REV. 02
File Name :

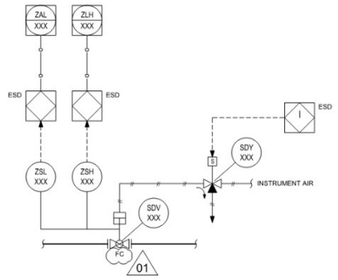

DRAWING NO.
REV
NOTES
HOLDS
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FLR-DRAIN-14
FLR-DRAIN-13
FLR-DRAIN-15
FLR-DRAIN-17
FLR-DRAIN-11
FLR-DRAIN-12
FLR-DRAIN-9
FLR-DRAIN-10
FLR-DRAIN-7
FLR-DRAIN-5
FLR-DRAIN-8
FLR-DRAIN-6
FLR-DRAIN-3
FLR-DRAIN-4
FLR-DRAIN-1
FLR-DRAIN-2
3"-DR-269-01CS-N
3"-DR-270-01CS-N
3"-DR-272-01CS-N
3"-DR-271-01CS-N
3"-DR-273-01CS-N
3"-DR-274-01CS-N
3"-DR-275-01CS-N
3"-DR-276-01CS-N
3"-DR-277-01CS-N
3"-DR-278-01CS-N
3"-DR-279-01CS-N
3"-DR-280-01CS-N
3"-DR-281-01CS-N
3"-DR-282-01CS-N
3"-DR-283-01CS-N
3"-DR-284-01CS-N
3"-DR-285-01CS-N
4"-DR-268-01CS-N
4"-DR-267-01CS-N
10"-DR-265-01CS-N
8"-DR-266-01CS-N
12"-DR-264-01CS-N
DECK
HOOK UP 007
TO SEA
00 12/06/2024 CIM RZI DLO ISSUE FOR ACCEPTANCE (IFA)
REV. DATE DRN CHKD APPD DESCRIPTION
CROSSWIND
ROSETTI MARINO
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
OPEN DRAIN SYSTEM
CONTRACT NO./TITLE CW I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK
SCALE NTS
DRAWN
CHECKED
APPROVED
DATE
A1
DRAWING NO.
123A90-DDL-PR-PID-80043
SHEET 001
REV. 00
File Name : FILE_NAME

TYPICAL INSTRUMENTATION VALVE

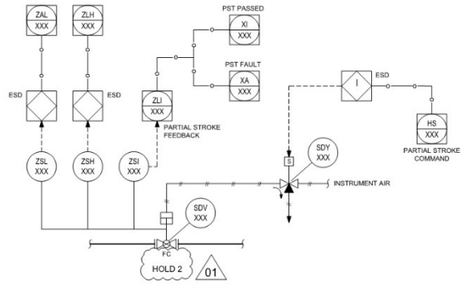
TYP.1 (XV - ON OFF VALVES)



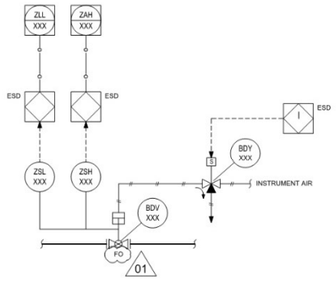
TYP.2 (SDV - SAFETY NO CRITICAL VALVES)



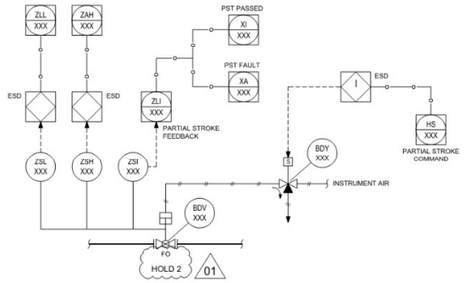
TYP.3 (SDV - SAFETY CRITICAL VALVES WITH PARTIAL STROKE)



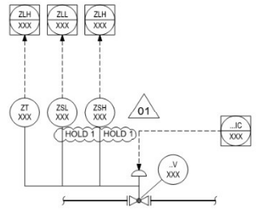
TYP.4 (BDV - SAFETY NO CRITICAL VALVES)



TYP.5 (BDV - SAFETY CRITICAL VALVES WITH PARTIAL STROKE)



TYP.6 (CONTROL VALVE WITH POSITION TRANSMITTER)



INSTRUMENT SYMBOLOGY DEFINITION

MEANINGS OF IDENTIFICATION LETTERS
THIS TABLE APPLIES TO THE FUNCTIONAL IDENTIFICATION OF INSTRUMENTS

	FIRST- LETTER		SUCCEEDING-LETTER		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
C				CONTROL	
E			SENSOR (PRIMARY ELEMENT) ELEMENT		
F	FLOW RATE	RATIO (FRACTION)			
G			GLASS VIEWING DEVICE		
H	HAND				HIGH
I			INDICATE		
L	LEVEL				LOW
O			ORIFICE, OPEN		
P	PRESSURE, VACUUM				
R		RELIEF			
S		SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
V				VALVE, DAMPER, LOUVER	
X	UNCLASSIFIED				
Y				AUXILIARY DEVICES	
Z	POSITION DIMENSION				

NOTE: FOR FURTHER EXPLANATORY NOTES, REFER TO KBR STANDARDS AND ANSI/ISA-5.1

01

NOTES

1. FOR GENERAL NOTES AND PIPING SYMBOLOGY SEE DRAWINGS: 123A90-DDL-PR-PID-80009 AND 123A90-DDL-PR-PID-80010.
2. DELETED.

01

HOLDS

1. THE LIMIT SWITCHES (OPEN AND CLOSED POSITION) WILL BE REQUIRED ONLY FOR THE CRITICAL CONTROL VALVES.
   IF SOME CONTROL VALVES WILL RESULT CRITICAL (SIL REQUIRMENT) DURING LOPA STUDY, THEN THE LIMIT SWITCHES WILL BE ADDED.
2. THE TYPICAL WILL BE CONFIRMED.

01

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
01	24/11/2023	CIM	RZI	DLO	ISSUE FOR HAZOP (IFA)
00	20/10/2023	CIM	RZI	DLO	ISSUE FOR ACCEPTANCE (IFA)

CROSSWIND — ROSETTI MARINO

TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
INSTRUMENTATION SYMBOLOGY

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK			SCALE NTS
DRAWN	CHECKED	APPROVED	DATE
A1	DRAWING NO. 123A90-DDL-PR-PID-80042	SHEET 001	REV. 01

File Name :

DRAWING_NO.

REV.

GENERAL NOTES

1. ALL VENTS AND DRAINS SHOWN BY THE FOLLOWING SYMBOLS REPRESENT A 3/4" VALVE.
   EXCEPT AS NOTED.
   VENT/DRAIN WITH BLIND FLANGE
2. ALL VALVED CONNECTION TO ATMOSPHERE IN PROCESS SERVICE WILL BE PLUGGED OR BLIND FLANGED.
3. HIGH POINT VENTS AND LOW POINT DRAINS USED FOR HYDROTEST PURPOSES ONLY ARE PROVIDED BUT ARE NOT SHOWN ON P&Ids.
4. FOR GENERAL PIPING REQUIREMENTS SEE THE RELEVANT DESIGN SPECIFICATION.
5. DEFINITIONS:
   SLOPE → ELEVATION CHANGES ARE CONSTANTLY DOWNWARD ONLY, NO POCKETS ARE PERMITTED. SPECIFIC SLOPES REQUIRED ARE SHOWN BY SYMBOLS.
   WHERE NO GRADIENT IS SHOWN IT IS ASSUMED THAT THE MINIMUM PREFERED GRADIENT OF 1:100 IS USED.
   WHERE X HAS UNITS THE SAME AS I
   GRAVITY DRAINING ELEVATION CHANGES ARE DOWNWARD ONLY. NO POCKETS ARE PERMITTED.
6. INLET LINES TO PRESSURE RELIEF DEVICES EXCEEDING 15 m IN LENGTH OR HAVING MORE THAN TWO ELBOWS, UNLESS OTHERWISE NOTED, MUST BE APPROVED BY PROCESS ENGINEERING.
7. ALL CLOSED PRESSURE RELIEF VALVE DISCHARGE LINES SHALL BE FREE DRAINING FROM THE PRESSURE RELIEF VALVE TO THE TOP OF THE DISCHARGE HEADER. EACH LINE IS TO BE CHECKED FOR A DOWNWARD SLOPE AFTER CONSTRUCTION.
8. ALL PRESSURE RELIEF VALVES DISCHARGING TO ATMOSPHERE AT SAFE LOCATION SHALL CONFORM TO THE RELEVANT DESIGN SPECIFICATION.
9. FOR UNSPARED PRESSURE RELIEVING DEVICES, WHEN AN INLET BLOCK VALVE IS PROVIDED BETWEEN A VESSEL AND ITS PRESSURE RELIEVING DEVICE OR WHEN A DISCHARGE BLOCK VALVE IS PROVIDED BETWEEN A PRESSURE RELIEVING DEVICE AND A COMMON DISCHARGE HEADER, THE BLOCK VALVE SHALL BE ARRANGED SO THAT IT CAN BE LOCKED OR SEALED OPEN. UNDER NO CONDITION SHALL A DISCHARGE BLOCK VALVE BE CLOSED, WHILE THE VESSEL IS IN OPERATION, BEFORE THE INLET BLOCK VALVE IS CLOSED. THE OWNER ASSUMES RESPONSIBILITY FOR ADMINISTRATIVE CONTROL OF THESE VALVES IN STRICT ACCORDANCE WITH ASME SECTION VIII, APPENDIX M.
10. SPACE AND ACCESS IS REQUIRED FOR ON-LINE SET-POINT VERIFICATION (OLSPV) OF ALL PSV's.
11. WHEN PIPE STRAINERS ARE INDICATED, THE STRAINER BODY, SCREEN AND SIZE OF OPENINGS ARE AS SPECIFIED BY THE RELEVANT SPECIFICATION.
12. FOR PRESSURE RELIEF VALVE AND RUPTURE DISC DISCHARGING TO ATMOSPHERE 6 MM WEEP HOLES ARE PROVIDED AT LOW POINTS OF THE DISCHARGE LINES 01
13. REDUCERS IN PRESSURE RELIEF VALVE INLET OR OUTLET PIPING SHALL BE MINIMUM DISTANCE FROM THE PRESSURE RELIEF VALVES.
14. DOCUMENTED ADMINSTRATIVE PROCEDURES SHALL ENSURE THAT WHENEVER SELECTED EQUIPMENT ITEMS (FOR EXAMPLE, EXCHANGERS OR FILTERS) ARE ISOLATED FOR MAINTENANCE, THEY SHALL BE VENTED AND DRAINED IMMEDIATELY.
15. LOCAL START-STOP SWITCH AT THE MOTOR ARE NOT SHOWN. DCS START-STOP FUNCTIONS ARE SHOWN AS REQUIRED.
16. TSO FOR A CONTROL VALVE WILL RESULT IN CLASS V MINIMUM SHUT OFF. ON-OFF VALVES WILL MEET API598.
17. OWNER AND ROSETTI MARINO CONTRACTOR SHALL DESIGN THE SAFETY INSTRUMENTED SYSTEM (SIS) IN ACCORDANCE WITH APPLICABLE PROCESS INDUSTRY STANDARDS, SUCH AS ISA S84, IEC 61511 AND IEC 61508. OWNER AND ROSETTI MARINO CONTRACTOR SHALL ALSO BE RESPONSIBLE FOR DEVELOPING AND IMPLEMENTING THE SAFETY INSTRUMENTED FUNCTIONS (SIF) AND PERFORMING SAFETY INTEGRITY LEVEL (SIL) DETERMINATION TO ALL SAFETY INSTRUMENTED FUNCTIONS IN ACCORDANCE WITH OWNER'S RISK MANAGEMENT POLICY. 01
18. DELETED. 01
19. THE OWNER IS RESPONSIBLE FOR ESTABLISHING ADMINISTRATIVE CONTROLS AND PROCEDURES OF USE OF ANY SHUTDOWN SYSTEM BYPASS FEATURES FOR TESTING OR MAINTENANCE OF THE SYSTEM. ANY PROCESS INTERLOCK OF SAFETY INTEGRITY LEVEL SIL-3 SHALL NOT BE BYPASSED UNDER ANY CIRCUMSTANCES.
20. ALL THERMOWELL CONNECTIONS ARE FLANGED CONNECTIONS UNLESS OTHERWISE NOTED.
21. DELETED. 01

LINE SERVICE

AV	ATMOSPHERIC VENT
CB	CONCENTRATED BRINE
CI	CHEMICAL INJECTION
DI	DEIONISED WATER
DM	DEMINERALIZED WATER
HY	HYDROGEN
IA	INSTRUMENT AIR
N	NITROGEN GAS
SWR	SEA WATER RETURN
SWS	SEA WATER SUPPLY
VL	LP VENT
WW	WASTE WATER

ABBREVIATIONS

ATM.	ATMOSPHERE
BDV	BLOWDOWN VALVE
BRS	BIRDSCREEN
CCS	CENTRAL CONTROL SERVICE
DIFF.	DIFFERENTIAL
DWG	DRAWING
ESD	EMERGENCY SHUTDOWN
FB	FULL BORE
FC	FAIL CLOSED ON LOSS OF MOTIVE POWER OR SIGNAL
FO	FAIL OPEN ON LOSS OF MOTIVE POWER OR SIGNAL
FGS	FIRE & GAS SYSTEM
GVC	GOOSENECK VENT
HH	HIGH HIGH ALARM TRIP
H	HIGH ALARM
ID	INSIDE DIAMETER
IA	INSTRUMENT AIR
L	LOW ALARM
LIP	LOCKED IN PLACE
LL	LOW LOW ALARM AND TRIP
LO	LOCKED OPEN
LP	LOW PRESSURE
M	ELECTRIC MOTOR
MCC	MOTOR CONTROL CENTER
NC	NORMALLY CLOSED
NNF	NORMALLY NO FLOW 01
NO	NORMALLY OPEN
NPS	NOMINAL PIPE SIZE
PSV	PRESSURE SAFETY VALVE
P/T	PRESSURE/TEMPERATUE
RO	RESTRICTION ORIFICE
RS	REMOVABLE SPOOL
SAM	SAMPLE CONNECTION
SP	SPECIALITY PIPING ITEM
SPB	SPECTACLE BLIND
STR	STRAINER
TSO	TIGHT SHUT-OFF
T/T	TANGENT TO TANGENT
VB	VORTEX BREAKER

EQUIPMENT

PUMPS

01
CENTRIFUGAL PUMP

LIFT INLINE

STORAGE TANK

TANK

VESSEL

HORIZONTAL VESSEL 01

MISCELLANEOUS

M
MOTOR

MOTOR

PACKAGE ITEM

OTHERS

CAISSON

CAISSON

VENT STACK

NOTES

1. FOR PIPING AND INSTRUMENTATION SYMBOLOGY, SEE DRAWINGS 123A90-DDL-PR-PID-80010 AND 123A90-DDL-PR-PID-80042 RESPECTIVELY. 01

REV.	DATE	DRN	CHKD	APPD	DESCRIPTION
01	24/11/2023	CIM	RZI	DLO	ISSUE FOR HAZOP (IFA)
00	20/10/2023	CIM	RZI	DLO	ISSUE FOR ACCEPTANCE (IFA)

CROSSWIND ROSETTI MARINO

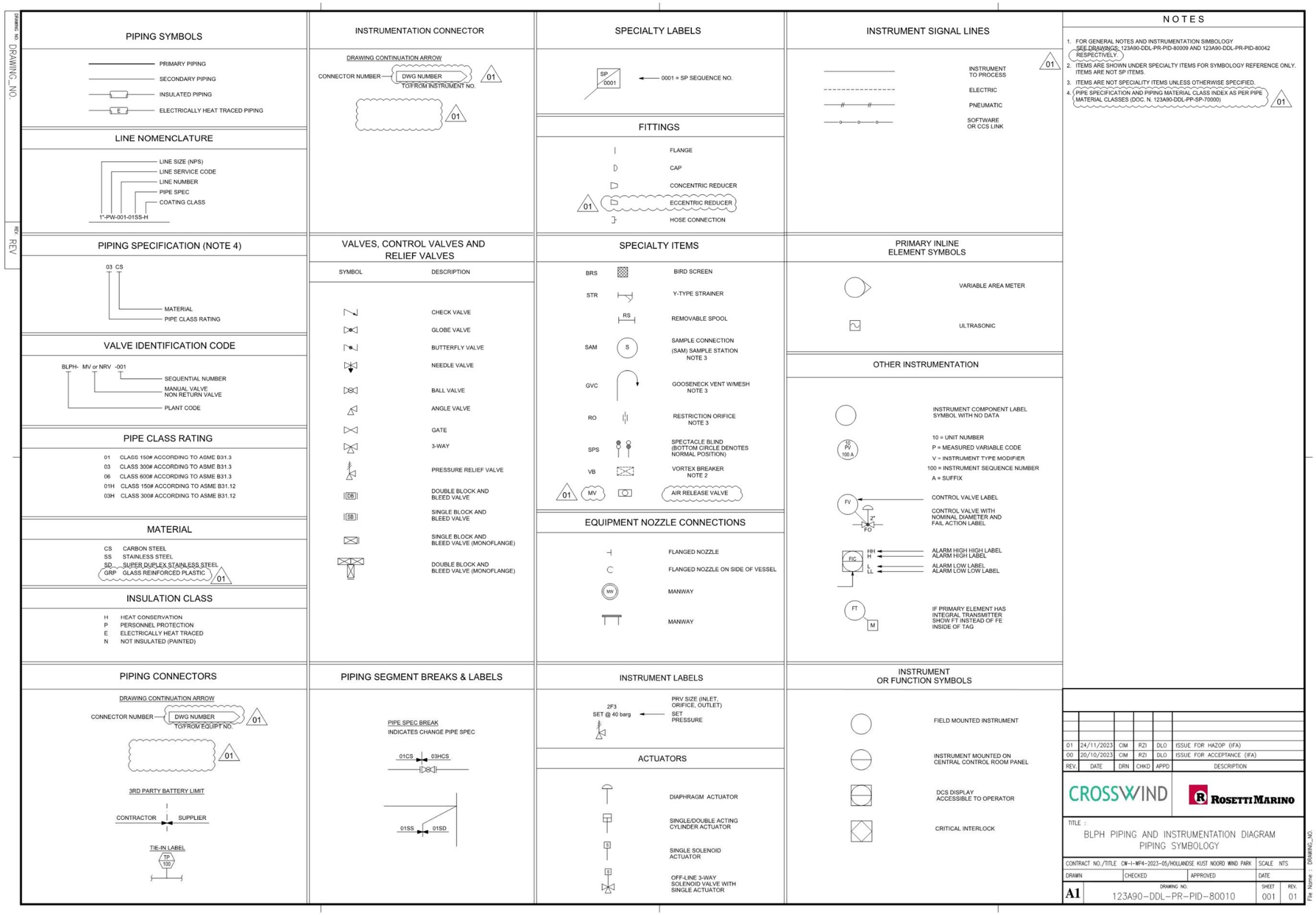
TITLE :
BLPH PIPING AND INSTRUMENTATION DIAGRAM
GENERAL NOTES

CONTRACT NO./TITLE CW-I-WP4-2023-05/HOLLANDSE KUST NOORD WIND PARK | SCALE NTS

DRAWN | CHECKED | APPROVED | DATE

A1 | DRAWING NO. 123A90-DDL-PR-PID-80009 | SHEET 001 | REV. 01

File Name : DRAWING_NO.



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ATTACHMENT 3 – HAZOP WORKSHEETS

Node: 1. Hydrogen (Filling Operation)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
1.1. Flow No/Less	1.1.1. No H2 from Electrolyser Package	1.1.1.1. No H2 from upstream any consequence leading to delay in fill up of H2 storage. No hazardous consequences.													
		1.1.1.2. Potential reverse flow from V-25001A to Electrolyser package leading to 30 barg H2 back into Electrolyser Package. Review with Elogen HAZOP. Refer to 3.3.1.													
	1.1.2. BLPH-MV-003 DBB Left in closed position	1.1.2.1. Upstream: Blocked outlet for Electrolyser package during start-up. Refer to Elogen HAZOP Node 6.													
		1.1.2.2. Downstream: No H2 from upstream any consequence leading to delay in fill up of H2 storage. No hazardous consequences. Vessel V-25001A maybe filled with N2 or H2 at 0barg.													
	1.1.3. 25SDV001 Fails closed Consequence: 1.1.6.1 Consequence: 1.1.7.1 Consequence: 1.1.8.1 Consequence: 1.13.1.1	1.1.3.1. Upstream: Blocked outlet for Electrolyser package during start-up. Refer to Elogen HAZOP Node 6.								25ZLH001[S]	Loss of 25ZLH001 High position indicator.				
										25ZAL001[S]	25ZAL001 Low position indicator alarm will be activated.				
		1.1.3.2. Upstream: High pressure in H2 manifold system, max pressure of 40barg, no hazardous consequences.								System DP	Design pressure of system is 40barg.				
		1.1.3.3. Downstream: No H2 from upstream any consequence leading to delay in fill up of H2 storage. No hazardous consequences. Vessel V-25001A maybe filled with N2 or H2 at 0barg.								25ZLH001[S]	Loss of 25ZLH001 High position indicator.				
										25ZAL001[S]	25ZAL001 Low position indicator alarm will be activated.				
	1.1.4. BLPH-MV-010 DBB Left in closed position on Hydrogen vent line	1.1.4.1. Normally open in filling operation.													
	1.1.5. 25XV003 fails closed on Hydrogen vent line	1.1.5.1. Normally closed in filling operation.													
	1.1.6. 25XV004 Fails closed	1.1.6.1. Refer to Cause 1.1.3 Cause: 1.1.3													
	1.1.7. BLPH-MV-029 DBB Left in closed position on Vessel inlet stream	1.1.7.1. Refer to Cause 1.1.3 Cause: 1.1.3													
	1.1.8. Spectacle Blind on Inlet Stream	1.1.8.1. Refer to Cause 1.1.3 Cause: 1.1.3													
	1.1.9. BLPH-MV-032 DBB Left in closed position on Hydrogen Vent	1.1.9.1. Loss of safeguard for pressure relief.								LO Valve	BLPH-MV-032 is a LO valve				
	1.1.10. BLPH-MV-034 DBB Left in closed position on Blowdown System	1.1.10.1. Unable to depressurise V25001A when required leading to a delay in maintenance, no hazardous consequences, but contrary to MAH operational philosophy for POB.								25PI004	Pressure indication would show that the vessel V25001A is not fully depressurised. Normal procedure to check pressure indication prior to deploying Maintenance to site. Indication should read 0barg.				
										25PIC005	Pressure indication would show that the vessel V25001A is not fully depressurised. Normal procedure to check pressure indication prior to deploying Maintenance to site. Indication should read 0barg.				
	1.1.11. 25PV005 Fails closed	1.1.11.1. Normally closed in filling operation, only used for purge operation. No hazardous consequences.													
	1.1.12. 25BDV005 Fails closed on Blowdown Stream	1.1.12.1. Normally closed in filling operation.													

Node: 1. Hydrogen (Filling Operation)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	1.1.13. Spectacle Blind on Discharge Line	1.1.13.1. No impact if closed during filling operation, no hazardous consequences.													
	1.1.14. BLPH-MV-086 DBB Left in closed position on Discharge Line	1.1.14.1. No impact if closed during filling operation, no hazardous consequences.													
	1.1.15. 25XV006 Failed closed on Discharge Line	1.1.15.1. No impact if closed during filling operation, no hazardous consequences.													
	1.1.16. Spectacle Blind on Waste Water Line	1.1.16.1. Normally closed in filling operation.													
	1.1.17. 25FV001 N2 valve	1.1.17.1. Normally closed in filling operation.													
	1.1.18. BLPH-MV-088 DBB Left in closed position on N2 Line	1.1.18.1. No impact if closed during filling operation, no hazardous consequences.													
	1.1.19. Spectacle Blind on N2 Line	1.1.19.1. No impact if closed during filling operation, no hazardous consequences.													
1.2. Flow More	1.2.1. 25SDV001 Driven Open when required to be closed by ESD	1.2.1.1. Failure of ESD valves in their none failure direction is not considered within this HAZOP.													
	1.2.2. 25BDV005 Fails open/inadvertently opened by operator	1.2.2.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen		P	5	A	5A	N	43FI001	High Flow indication on vent.	NV	1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B		25PI004	Reducing Pressure indication in V25001A.	NV	2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety	
					C	4	B	4B		25PT005	Reducing Pressure indication in V25001A	NV			
					E	3	B	3B		Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.				
										25ZLL005[B]	Position Indicator Low. Not valid as part of IE.	NV			
										25ZAH022[B]	Position Indicator High alarm. Not valid as part of IE.	NV			
	1.2.3. 25PIC005 failure opening 25PV005	1.2.3.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen		P	5	A	5A	N	43FI001	High Flow indication on vent.		1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B		25PI004	Reducing Pressure indication in V25001A.		2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety	
					C	4	B	4B		25PT005	Reducing Pressure indication in V25001A		3. Review if it is credible to implement an interlock on 25PIC005 to prevent 25PV005 being opened outside of a purge cycle operation.	Rosetti Process	
					E	3	B	3B		Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.				
										25ZLH005[P]	Position Transmitter. Not valid as part of IE.	NV			
										25ZLL005[P]	Position Indicator Low. Not valid as part of IE.	NV			
										25ZLH005[P]	Position Indicator High. Not valid as part of IE.	NV			

Node: 1. Hydrogen (Filling Operation)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	1.2.4. 25XV006 Driven open/inadvertently opened by operator	1.2.4.1. Pressurise downstream system to 25PV025A/B up to 30barg. Potential to exceed design pressure (3 times design pressure) downstream of 25PV025A/B, LOPC of H2 and explosion on ignition. 25PV025A/B are downstream pressure controlled and are potentially opened when fuel cell is not online.	Hydrogen		P	5	A	5A	Y	25ZAL006[X]	Not valid as operator action to open valve.	NV	4. Ensure that 80PSV001 is sized for failure of downstream isolation on H2 vessel during filling operation (i.e. 25XV006) with 25PV025A or B fully open.	Rosetti Process	Recommendation 46 eliminates consequence (ALARP by design). Alternatively recommendation 22 will reduce the risk to below the tolerable frequency.
					A	4	B	4B		25ZLH006[X]	Not valid as operator action to open valve.	NV	22. Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened. Consider the opening times of storage vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.	Rosetti/Crosswind (Interface)	
					C	4	B	4B		25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action.	NV	44. As fuel cell runs down 25PIC025A/B opens 25PV025A/B. Ensure that when restart occurs 25PV025A/B are fully closed and review how the downstream pressure can be slowly increased to the point where 25PIC025A/B can be given automatic control.	Rosetti Instrumentation	
					E	3	B	3B		80PI002	High High Pressure trip of PSD closing 25SDV023.	V			
										80PSV001	Pressure Safety Valve in clean service set point at 10barg. Valid, to be sized for this case as per recommendation.	V			
	1.2.5. 25FIC001 failure opening 25FV001 N2 valve	1.2.5.1. Potential for N2 (7barg) into H2 storage vessel V25001A during filling operation resulting in off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1). Consequence: 1.13.2.1									No barriers within Rosetti scope, refer to Fuel cell HAZOP.		6. Review if it is credible to implement an interlock to prevent 25FV001 being opened outside of a purge cycle operation.	Rosetti Process	
		1.2.5.2. Potential for H2 (up to 30barg) into N2 system resulting in H2 being used in place of N2 in Electrolyser systems. Refer to Elogen HAZOP node 10.													
		1.2.5.3. Overpressure of N2 system resulting in LOPC of H2 and N2.	Hydrogen		P	5	A	5A	N	BLPH-NRV-014	Non-return valve.	NV	7. Review the current design against for compliance with piping (utility connection DEP 31.38.01.11, version 2018) and overpressure (80.45.10.11) DEPs for connection of utility N2 to H2 storage vessels V25001A-F. If they are not compliant (and are not to be made compliant) review current design with LOPA.	Rosetti Process	To be determined / re-evaluated after closeout of recommendation.
					A	4	B	4B		64PIC001A	High Pressure alarm with operator action. Not valid as insufficient time.	NV	8. Ensure that 64PSV001 is verified for backflow of 30 barg H2 from storage vessels V25001A-F. Ensure that the vent from PSV is located in a safe location considering this flow will be H2. Also consider proximity of vent to N2 package which vents O2.	Rosetti Process	
					C	4	B	4B		64PIC001B	High Pressure alarm with operator action. Not valid as insufficient time.	NV			
					E	3	B	3B		64PSV001	Pressure Safety Valve set point at 10barg.	NV			
										25ZLH005[F]	Position Transmitter. Not valid as part of IE.	NV			
										25ZLL005[F]	Position Indicator Low. Not valid as part of IE.	NV			
										25ZLH005[F]	Position Indicator High. Not valid as part of IE.	NV			
		1.2.5.4. H2 reverse flow into N2 package U64000. Review consequences within HAZOP of N2 package. [Parking Lot; What: Review in N2 package HAZOP - Reverse flow of H2 into package]								64-SDV001	Shutdown valve closed outside of purging operation. Also closed down by PCS system				
1.3. Flow Misdirected	1.3.1. 25XV003 inadvertently open by operator	1.3.1.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent.	Hydrogen		P	5	A	5A	N	43FI001	High Flow indication on vent.		1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B		25PI004	Reducing Pressure indication in V25001A.		2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005)	Rosetti Tech Safety	
					C	4	B	4B		25PT005	Reducing Pressure indication in V25001A				
					E	3	B	3B		Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.				
										25ZAL003[X]	Position Indicator Low. Not valid as part of IE.	NV			

Node: 1. Hydrogen (Filling Operation)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
										25ZLH003[X]	Position Indicator High alarm. Not valid as part of IE.	NV	4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.		
	1.3.2. 25XV008/11/14/17/20 open when not required and V25001B-F is at low pressure. Consequence: 1.5.1.1	1.3.2.1. Rapid increase in Pressure in vessels V25001B-F from 0 to 30barg. Potential for exceeding design velocity or high vibration in piping and vessels V25001B-F leading to potential LOPC of H2.	Hydrogen		P	5	A	5A	N	None Identified			14. Determine if high DP across any valves (likely to be up to 30bar) has the potential for high velocity (outside of pipe spec) or high vibration with the potential to damage pipework. If so consider how purging cycle can be performed without using SDV.	Rosetti Process	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B							
					C	4	B	4B							
					E	3	B	3B							
1.4. Flow As Well As	1.4.1. No additional causes.														
1.5. Flow Reverse	1.5.1. 25XV008/11/14/17/20 open when not required and V25001B-F is at High pressure (30barg).	1.5.1.1. Refer to 1.3.2: Cause: 1.3.2													
1.6. Pressure Low	1.6.1. No additional causes.														
1.7. Pressure High	1.7.1. External Fire Consequence: 3.7.1.1	1.7.1.1. Potential overpressure of H2 storage vessel V25001A resulting in LOPC of H2 and explosion on ignition.	Hydrogen		P	5	A	5A	N	25PSV001	Pressure Safety Valve designed for fire case.	V	9. Review the ESD logic for activation of ESD 1D on activation of 25PI004 HH and F&G detection system. Consider under which circumstances a single vessel should be depressurised and when all vessels should be depressurised.	Rosetti Tech Safety	ALARP by HSSE Standards and Practices. Assessment based on: Shell overpressure DEP.
					A	4	B	4B		25PI004	High High pressure trip of ESD 1D with blowdown valve 25BDV005.				
					C	4	B	4B		F&G Detection	F&G Detection system will trigger ESD 1D and open all BDV valves on V25001A-F.				
					E	3	B	3B							
	1.7.2. High pressure from Electrolyser	1.7.2.1. 36 barg (set point of PSV on Electrolyser) H2 from Electrolyser. Design pressure of storage system is 40barg, no hazardous consequences.								Elogen HPP700 PAH	High pressure alarm in Electrolyser package. TBC by Elogen HAZOP node 6.				
										Elogen HPP700 PAHH	High High pressure trip in Electrolyser package of Electrolyser Package. TBC by Elogen HAZOP node 6.				
										Elogen PSV631	Pressure Safety Valve set point at 36barg. Sized for blocked outlet case.				
										25PI001	High Pressure alarm				
										25PI002	High High pressure trip of PSD isolating H2 storage from Electrolyser by closing 25SDV001.				
										25PI004	High High pressure trip of ESD 1D with blowdown valve 25BDV005.				
1.8. Temperature Low	1.8.1. Low ambient temperature	1.8.1.1. No hazardous consequences.													
1.9. Temperature High	1.9.1. No additional causes.														
1.10. Level No/Low	1.10.1. No credible causes														
1.11. Level High	1.11.1. No credible causes														
1.12. Phase	1.12.1. No credible causes														
1.13. Composition/Contamination	1.13.1. Moisture due to failure of HPP	1.13.1.1. Potential for ice formation within H2 system under cold ambient conditions. Potential blocked discharge of Electrolyser. Refer to cause 1.1.3: Cause: 1.1.3								Elogen DPT800A/B	Dew Point Analysers divert H2 stream to vent if above moisture specification within Elogen Package.				
	1.13.2. N2 due to passing of 25FV001 during initial filling	1.13.2.1. Refer to consequence 1.2.5.1: Consequence: 1.2.5.1													

Node: 1. Hydrogen (Filling Operation)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	1.13.3. N2 from Electrolyser Package	1.13.3.1. Potential for N2 into H2 storage vessel V25001A during filling operation resulting in off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1).								Elogen Timed Purge	Elogen Purge H2 stream to vent for timed period following cold start-up to ensure all N2 is removed from the H2 stream.				
	1.13.4. O2 contamination of H2 in the storage system	1.13.4.1. O2 contamination of H2 in the storage system. Potential for explosion in H2 storage vessel. For flammable concentration to be formed within the H2 storage vessel O2 would have to accumulate within the vessel and not be flushed out.	Hydrogen		P	5	A	5A	N	Elogen stack	Maximum concentration that can be produced by stack is 500ppm O2.		24. Review with Fuel Cell suppliers what the consequence of 500ppm of O2 in the H2 stream will be on the Fuel Cell. Will this be only be an impact on performance or likely to create a hazard? If credible hazard consider LOPA for Elogen OIHA800A/B.	Rosetti/Crosswind Project	To be determined / re-evaluated after closeout of recommendation.
					A	4	B	4B		Elogen OIHA800A/B	Oxygen Analyser divert H2 stream to vent if above Oxygen specification within Elogen Package.		25. Perform a calculation to determine how long/number of fill cycles it would require for a flammable concentration to be formed within the H2 storage vessel based on 500ppm O2 to determine if a flammable concentration is credible in the H2 storage vessel.	Rosetti Process	
					C	4	B	4B		Ignition Sources	No ignition sources within H2 Storage system. Static ignition sources suppressed with Earth bonding.				
					E	3	B	3B							
1.14. Operations	1.14.1. No additional causes.														
1.15. Maintenance	1.15.1. Maintenance of Relief Valves	1.15.1.1. Lifting of relief valves in to place during maintenance review requirement for accessibility and temporary lifting equipment.											46. As part of 3D / layout / HF reviews determine the requirements for lifting of relief valves into place during maintenance in terms of accessibility and use of temporary/permanent lifting equipment.	Rosetti/Crosswind Project	
1.16. Start up/ Shutdown	1.16.1. Re-start after trip	1.16.1.1. Potential for operators to board the platform while it is still pressurised with Gas.								Shutdown philosophy	For PSD and ESD1 remote start is available without POB. For ESD 1D and ASD platform is depressurised and personnel may board.				
1.17. Catalysts	1.17.1. No credible causes														
1.18. Utilities	1.18.1. Loss of Power Consequence: 3.18.1.1 Consequence: 2.18.1.1	1.18.1.1. Breakers can be reset remotely. If personnel are required to go to the platform following an ESD 1, blowdown valves can be opened using the UPS.													
	1.18.2. Loss of Instrument Air Consequence: 2.18.2.1	1.18.2.1. Section of line between 25SDV001 and 25XV004 will be blocked in during ESD scenario.											10. Review the requirement for a BDV (FO) with a bypass around (25XV003 and 25RO003) and (80XV001 and 80RO001) to allow emergency depressurisation on the manifold inlet line. See also recommendation 12.	Rosetti Process	
													11. Ensure that the trapped volume between 25SVD023 and 25PV025A/B is minimised such that it does not require blowdown.	Rosetti Process	
													12. Review the trapped volume between Fuel Cell Package and 25PV025A/B is minimised such that it does not require blowdown or consider providing a blowdown route. See also recommendation 10.	Rosetti Process	
	1.18.3. Loss of Nitrogen Supply	1.18.3.1. No hazardous consequences.													
1.19. Corrosion/Erosion	1.19.1. No additional causes.														
1.20. Other	1.20.1. DC systems	1.20.1.1. Potential for electrically induced corrosion.											13. Ensure that the potential for electrically induced corrosion and requisite earthing is considered in the SAFOP.	Crosswind Electrical	

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
2.1. Flow No/Less	2.1.1. No H2 from Electrolyser Package	2.1.1.1. Unable to pulse purge with H2 leading to a delay in start-up.													

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
		2.1.1.2. Potential for backflow of N2 to Electrolyser Package, small flow as N2 is at low pressure. No hazardous consequences.													
	2.1.2. BLPH-MV-003 DBB Left in closed position	2.1.2.1. Upstream: Blocked outlet for Electrolyser package during start-up. Refer to Elogen HAZOP Node 6.													
		2.1.2.2. Unable to pulse purge with H2 leading to a delay in start-up.													
	2.1.3. 25SDV001 Fails closed	2.1.3.1. Upstream: Blocked outlet for Electrolyser package during start-up. Refer to Elogen HAZOP Node 6.								25ZLH001[S]	Loss of 25ZLH001 High position indicator.				
										25ZAL001[S]	25ZAL001 Low position indicator alarm will be activated.				
		2.1.3.2. Upstream: High pressure in H2 manifold system, max pressure of 40barg, no hazardous consequences.								System DP	Design pressure of system is 40barg.				
		2.1.3.3. Unable to pulse purge with H2 leading to a delay in start-up.													
	2.1.4. BLPH-MV-010 DBB Left in closed position on Hydrogen vent line	2.1.4.1. Unable to purge inlet line of N2 leading to a delay in start-up, no hazardous consequence.													
	2.1.5. 25XV003 fails closed on Hydrogen vent line Consequence: 4.1.2.1 Consequence: 4.1.3.1	2.1.5.1. Unable to purge inlet line of N2 leading to a delay in start-up, no hazardous consequence.								25ZLH003[X]	Position Indicator High				
										25ZAL003[X]	Position Indicator Low alarm				
	2.1.6. 25XV004 Fails closed Consequence: 2.1.7.1 Consequence: 2.1.8.1	2.1.6.1. Unable to purge vessel V25001A of N2 leading to a delay in start-up, no hazardous consequence.								25ZLH004[X]	Position Indicator High				
										25ZAL004[X]	Position Indicator Low alarm				
	2.1.7. BLPH-MV-029 DBB Left in closed position on Vessel inlet stream	2.1.7.1. Refer to 2.1.6: Cause: 2.1.6													
	2.1.8. Spectacle Blind on Inlet Stream	2.1.8.1. Refer to 2.1.6: Cause: 2.1.6													
	2.1.9. BLPH-MV-032 DBB Left in closed position on Hydrogen Vent	2.1.9.1. Loss of safeguard for pressure relief.								LO Valve	BLPH-MV-032 is a LO valve				
	2.1.10. BLPH-MV-034 DBB Left in closed position on Blowdown System	2.1.10.1. Unable to purge V25001A when required leading to a delay in start-up, no hazardous consequences.								25PI004	Pressure indication would show that the vessel V25001A is not fully depressurised. Normal procedure to check pressure indication prior to deploying Maintenance to site. Indication should read 0barg.				
										25PIC005	Pressure indication would show that the vessel V25001A is not fully depressurised. Normal procedure to check pressure indication prior to deploying Maintenance to site. Indication should read 0barg.				
	2.1.11. 25PV005 Fails closed Consequence: 4.1.5.1	2.1.11.1. Unable to purge V25001A when required leading to a delay in start-up, no hazardous consequences.								25PI004	Pressure indication would show that the vessel V25001A is not fully depressurised. Normal procedure to check pressure indication prior to deploying Maintenance to site. Indication should read 0barg.				
										25PIC005	Pressure indication would show that the vessel V25001A is not fully depressurised. Normal procedure to check pressure indication prior to deploying Maintenance to site. Indication should read 0barg.				
										25ZLH005[P]	Position Transmitter				
										25ZLL005[P]	Position Indicator Low				

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
										25ZLH005[P]	Position Indicator High				
	2.1.12. 25BDV005 Fails closed on Blowdown Stream	2.1.12.1. Normally closed during purge operation.													
	2.1.13. Spectacle Blind on Discharge Line Consequence: 2.1.14.1 Consequence: 2.1.16.1	2.1.13.1. Unable to purge system downstream of vessel, delay in start-up, no hazardous consequences.													
	2.1.14. BLPH-MV-086 DBB Left in closed position on Discharge Line	2.1.14.1. Refer to 2.1.13: Cause: 2.1.13													
	2.1.15. 25XV006 Failed closed on Discharge Line during purge of vessel	2.1.15.1. Normally closed during purge operation.													
	2.1.16. 25XV006 Failed closed on Discharge Line during purge of Downstream line	2.1.16.1. Refer to 2.1.13: Cause: 2.1.13								25ZLH006[X]	Position Indicator High				
										25ZAL006[X]	Position Indicator Low alarm				
	2.1.17. Spectacle Blind on Waste Water Line	2.1.17.1. Normally closed during purge operation.													
	2.1.18. 25FV001 N2 valve	2.1.18.1. Normally closed during H2 purge operation.													
	2.1.19. Spectacle Blind on N2 Line	2.1.19.1. No impact if closed during purge operation, no hazardous consequences.													
	2.1.20. 25BDV022 fails closed	2.1.20.1. No impact if closed during purge operation, no hazardous consequences.								25ZLL022[B]	Position Indicator Low				
										25ZAH022[B]	Position Indicator High alarm				
	2.1.21. BLPH-MV-018 DBB Left in closed position on Downstream blowdown line	2.1.21.1. No impact if closed during purge operation, no hazardous consequences.													
	2.1.22. 25SDV023 Fails closed	2.1.22.1. Unable to purge system downstream of vessel, delay in start-up, no hazardous consequences.								25ZAL001[S]	Position Indicator Low alarm				
										25ZLH001[S]	Position Indicator High				
	2.1.23. 25PV025A/B Fails closed	2.1.23.1. Unable to purge system downstream of vessel, delay in start-up, no hazardous consequences.								25ZLH025[F]	Position Transmitter				
										25ZLL025[F]	Position Indicator Low				
										25ZLH025[F]	Position Indicator High				
	2.1.24. BLPH-MV-006 SB Left in closed position on Downstream Relief line	2.1.24.1. Loss of safeguard													
	2.1.25. BLPH-MV-007 SB Left in closed position on Downstream purge line	2.1.25.1. Unable to purge system downstream of vessel, delay in start-up, no hazardous consequences.													
	2.1.26. 80XV001 Fails closed	2.1.26.1. Unable to purge system downstream of vessel, delay in start-up, no hazardous consequences.								80ZLH001[X]	Position Indicator High				
										80ZAL001[X]	Position Indicator Low alarm				
	2.1.27. BLPH-MV-492 SB Left in closed position on Downstream line	2.1.27.1. Unable to purge system downstream of vessel, delay in start-up, no hazardous consequences. This is a dead leg in purge system and distance is minimised to Fuel Cell Package.													
2.2. Flow More	2.2.1. 25SDV001 Driven Open when required to be closed by ESD	2.2.1.1. Failure of ESD valves in their none failure direction is not considered within this HAZOP.													

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	2.2.2. 25BDV005 Fails open/inadvertently opened by operator	2.2.2.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen		P	5	A	5A	N	43FI001	High Flow indication on vent.		1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B		25PI004	Reducing Pressure indication in V25001A.		2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety	
					C	4	B	4B		25PT005	Reducing Pressure indication in V25001A				
					E	3	B	3B		Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.				
										25ZAH022[B]	Position Indicator High alarm. Not valid as part of IE.	NV			
										25ZLL005[B]	Position Indicator Low. Not valid as part of IE.	NV			
	2.2.3. 25PIC005 failure opening 25PV005	2.2.3.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen		P	5	A	5A	N	43FI001	High Flow indication on vent.		1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B		25PI004	Reducing Pressure indication in V25001A.		2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety	
					C	4	B	4B		25PT005	Reducing Pressure indication in V25001A		3. Review if it is credible to implement an interlock on 25PIC005 to prevent 25PV005 being opened outside of a purge cycle operation.	Rosetti Process	
					E	3	B	3B		Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.				
										25ZLH005[P]	Position Transmitter. Not valid as part of IE.				
										25ZLL005[P]	Position Indicator Low. Not valid as part of IE.				
										25ZLH005[P]	Position Indicator High. Not valid as part of IE.				
		2.2.3.2. Unable to achieve set point pressure for purge cycle. Unable to complete purge operation leading to a delay in start-up.											15. Review the requirement for a timer alarm on the H2 pressurisation section of the purge cycle in the control logic to determine if the purge valve 25PV005 has failed to close.	Rosetti Instrumentation	
	2.2.4. 25XV006 Driven open/inadvertently opened by operator	2.2.4.1. Small increase in volume pulse purge, no hazardous consequences.								25ZLH006[X]	Position Indicator High				
										25ZAL006[X]	Position Indicator Low alarm				
	2.2.5. Spectacle Blind on Waste Water Line left open following maintenance	2.2.5.1. Potential overpressure of waste water tank T55001 due to N2 pressurisation resulting in overpressure and rupture of waste water tank T55001. Potential impact on personal. This is performed as part of the re commissioning check prior to introduction H2.	Release of Pressure - Impact		P	4	B	4B	N		None		5. Review whether a permanent connection to the waste water tank T55001 is required from the hydrogen storage vessels. If so then review the potential for open waste water drain on storage vessel V25001A-F to result in overpressurisation of waste water tank during an N2 pressure test of the vessel following maintenance activity. Also consider the required vent sizing of waste water tank T55001 (to be calculated).	Rosetti Process	Recommendation eliminates cause (ALARP by design).
		2.2.5.2. H2 sent to Waste Water tank T55001 potential overpressure of waste water tank T55001 leading to LOPC of H2 and explosion on ignition. Not credible as this would imply N2 pressurisation has been carried out and consequence 1.2.5.1 would have already occurred.													

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
		2.2.5.3. Flammable atmosphere within waste water tank T55001 with potential for explosion on ignition. Not credible as this would imply N2 pressurisation has been carried out and consequence 1.2.5.1 would have already occurred.													
	2.2.6. 25FIC001 failure opening 25FV001 N2 valve	2.2.6.1. Potential for N2 (7barg) into H2 storage vessel V25001A during purge operation resulting in off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1).									No barriers within Rosetti scope, refer to Fuel cell HAZOP.		16. Implement 25FV001 as a Type 6 as it is critical to the operation of the fuel cell that N2 is excluded from the storage system.	Rosetti Instrumentation	
	2.2.7. 25BDV022 Fails open/inadvertently opened by operator	2.2.7.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen		P	5	A	5A	N	43FI001	High Flow indication on vent.		1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process	To be determined / re-evaluated after closeout of recommendation #2
					A	4	B	4B		25PI004	Reducing Pressure indication in V25001A.		2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety	
					C	4	B	4B		25PT005	Reducing Pressure indication in V25001A				
					E	3	B	3B		Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.				
										25ZLL022[B]	Position Indicator Low. Not valid as part of IE.				
										25ZAH022[B]	Position Indicator High alarm. Not valid as part of IE.				
		2.2.7.2. Failure to purge downstream system of N2 and off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1).													
	2.2.8. 25PV025A/B remain open during purge	2.2.8.1. Slow purging of lines around PV, no hazardous consequences.								25ZLH025[F]	Position Transmitter				
										25ZLL025[F]	Position Indicator Low				
										25ZLH025[F]	Position Indicator High				
	2.2.9. 80XV001 remains open at end of purge cycle	2.2.9.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen		P	5	A	5A	N	43FI001	High Flow indication on vent.		1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B		25PI004	Reducing Pressure indication in V25001A.		2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety	
					C	4	B	4B		25PT005	Reducing Pressure indication in V25001A				
					E	3	B	3B		Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.				
2.3. Flow Misdirected	2.3.1. 25XV008/11/14/17/20 open when not required and V25001B-F contains H2 at 5barg Consequence: 2.5.1.1	2.3.1.1. Additional H2 cycled into vessel under purge. Additional H2 is vented to atmosphere, loss of product. No hazardous consequences.													
	2.3.2. 25XV008/11/14/17/20 open when not required and V25001B-F contains N2 at low pressure	2.3.2.1. Potential for N2 into H2 storage vessel V25001A under purge operation resulting in off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1).									No barriers within Rosetti scope, refer to Fuel cell HAZOP.		16. Implement 25FV001 as a Type 6 as it is critical to the operation of the fuel cell that N2 is excluded from the storage system.	Rosetti Instrumentation	
2.4. Flow As Well As	2.4.1. No additional causes.														

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
2.5. Flow Reverse	2.5.1. 25XV008/11/14/17/20 open when not required and V25001B-F is at High pressure (30barg).	2.5.1.1. Refer to 2.3.1: Cause: 2.3.1											14. Determine if high DP across any valves (likely to be up to 30bar) has the potential for high velocity (outside of pipe spec) or high vibration with the potential to damage pipework. If so consider how purging cycle can be performed without using SDV.	Rosetti Process	
	2.5.2. 25XV009/12/15/18/21 open when not required and V25001B-F is at High pressure (30barg).	2.5.2.1. Potential reverse flow from H2 storage vessels back to purge vessel which will also contain H2. No hazardous consequences.													
2.6. Pressure Low	2.6.1. During purge cycle vessel pressure drops lower than intended (estimated 1.1barg)	2.6.1.1. Potential for air ingress from vent system and contamination of vent system								Liquid vent seal	Liquid seal on vent will prevent ingress into system.		32. Review the requirement for level transmitter and low level alarm to detect low level in H2 vent liquid seal Q43004.	Rosetti Instrumentation	
										Nitrogen Purge on vent	Continuous N2 purge on vent system will prevent air ingress into system.				
										25PI004	Pressure Indication				
2.7. Pressure High	2.7.1. During purge cycle vessel pressure raised higher than intended (>5barg)	2.7.1.1. Excess H2 used for purge cycle, loss of product, no hazardous consequences.								25PI004	Pressure Indication				
2.8. Temperature Low	2.8.1. Low ambient temperature	2.8.1.1. No hazardous consequences.													
2.9. Temperature High	2.9.1. No additional causes.														
2.10. Level No/Low	2.10.1. No credible causes														
2.11. Level High	2.11.1. No credible causes														
2.12. Phase	2.12.1. No credible causes														
2.13. Composition/Contamination	2.13.1. See Node 1 Composition/Contamination														
	2.13.2. N2 contamination of storage vessel	2.13.2.1. Potential to contaminate H2 tank during purge cycle with no means of detecting contamination before use in Fuel Cell resulting in poor functioning of Fuel Cell. Operational issue, no hazardous consequences.											17. Review the requirement for a separate header with an additional isolation on the N2 supply to the storage vessels to minimise the likelihood of N2 contamination of H2 storage vessels during purge cycle.	Rosetti Process	
2.14. Operations	2.14.1. Operating 25XV004 in pulse purge mode	2.14.1.1. Delta P across valve likely to be up to 30bar. Potential for high velocity (outside of pipe spec) or high vibration damaging pipework.											14. Determine if high DP across any valves (likely to be up to 30bar) has the potential for high velocity (outside of pipe spec) or high vibration with the potential to damage pipework. If so consider how purging cycle can be performed without using SDV.	Rosetti Process	
2.15. Maintenance	2.15.1. N2 purging in preparation for maintenance	2.15.1.1. Unable to purge pipework between tee off for 25XV003 and Electrolyser. Potential for H2 to remain in pipework when broken for maintenance. Small LOPC of H2 likely to be insufficient to cause significant hazard.	Hydrogen		P	5	A	5A	N	None Identified			18. Review where a N2 purge connection can be located close to Electrolyser discharge to enable N2 purging of H2 storage inlet system.	Rosetti Process	Recommendation eliminates cause (ALARP by design).
					A	4	B	4B							
					C	4	B	4B							
					E	3	B	3B							
	2.15.2. Fail closed of N2 valve 25FV001 when purging	2.15.2.1. Potential significant concentration H2 in vessel when breaking containment for maintenance.	Hydrogen		P	5	A	5A		None Identified			19. Review the requirement for a means to detect that the concentration of H2 within the H2 storage vessels is above the allowable level prior to breaking containment on the vessel.	Rosetti/Crosswind Project	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B							
					C	4	B	4B							
					E	3	B	3B							
2.16. Start up/ Shutdown	2.16.1. No additional causes.														
2.17. Catalysts	2.17.1. No credible causes														
2.18. Utilities	2.18.1. Loss of Power	2.18.1.1. See loss of Power in Node 1 Cause: 1.18.1													

Node: 2. Hydrogen (Purging)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	2.18.2. Loss of Instrument Air	2.18.2.1. See loss of Instrument Air in Node 1 Cause: 1.18.2													
	2.18.3. Loss of Nitrogen Supply	2.18.3.1. No hazardous consequences.													
2.19. Corrosion/Erosion	2.19.1. No additional causes.														
2.20. Other															

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
3.1. Flow No/Less	3.1.1. 25XV004 Fails closed	3.1.1.1. Normally closed during Fuel Cell operation. No hazardous consequences.													
	3.1.2. BLPH-MV-029 DBB Left in closed position on Vessel inlet stream	3.1.2.1. Not credible during Fuel Cell operation.													
	3.1.3. Spectacle Blind on Inlet Stream	3.1.3.1. Not credible during Fuel Cell operation.													
	3.1.4. BLPH-MV-032 DBB Left in closed position on Hydrogen Vent	3.1.4.1. Loss of safeguard for pressure relief.								LO Valve	BLPH-MV-032 is a LO valve				
	3.1.5. BLPH-MV-034 DBB Left in closed position on Blowdown System	3.1.5.1. Not credible during Fuel Cell operation.													
	3.1.6. 25PV005 Fails closed	3.1.6.1. Normally closed during Fuel Cell operation. No hazardous consequences.													
	3.1.7. 25BDV005 Fails closed on Blowdown Stream	3.1.7.1. Normally closed during Fuel Cell operation. No hazardous consequences.													
	3.1.8. Spectacle Blind on Discharge Line	3.1.8.1. Unable to line up vessel for Fuel Cell operation leading to delay in operation, no hazardous consequences.													
	3.1.9. BLPH-MV-086 DBB Left in closed position on Discharge Line	3.1.9.1. Unable to line up vessel for Fuel Cell operation leading to delay in operation, no hazardous consequences.													
	3.1.10. 25XV006 Failed closed on Discharge Line	3.1.10.1. Unable to line up vessel for Fuel Cell operation leading to delay in operation, no hazardous consequences.								25ZAL006[X]	Position Indicator Low alarm				
										25ZLH006[X]	Position Indicator High				
	3.1.11. Spectacle Blind on Waste Water Line	3.1.11.1. Normally closed during Fuel Cell operation.													
	3.1.12. 25FV001 N2 valve	3.1.12.1. Normally closed during Fuel Cell operation.													
	3.1.13. BLPH-MV-088 DBB Left in closed position on N2 Line	3.1.13.1. Not credible during Fuel Cell operation.													
	3.1.14. Spectacle Blind on N2 Line	3.1.14.1. Not credible during Fuel Cell operation.													
	3.1.15. 25SDV023 Fails closed	3.1.15.1. Unable to line up vessel for Fuel Cell operation leading to delay in operation, no hazardous consequences.								25ZLH023[S]	Position Indicator High				
										25ZAL023[S]	Position Indicator Low alarm				
	3.1.16. 25PIC025A/B fails closing 25PV025A/B	3.1.16.1. Unable to line up vessel for Fuel Cell operation leading to delay in operation, no hazardous consequences.								25ZLH025[P]	Position Transmitter. Not valid as part of IE.				
										25ZLL025[P]	Position Indicator Low. Not valid as part of IE.				

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
										25ZLH025[P]	Position Indicator High. Not valid as part of IE.				
	3.1.17. BLPH-MV-492 SB Left in closed position on Downstream line	3.1.17.1. Upstream: Potential overpressure of pipework downstream of 25PV025A/B. LOPC of H2 and potential explosion on ignition. Not included in recommendation 21/22 for LOPA as the likelihood of this cause will not be significant.	Hydrogen	80PI002	P	5	A	5A	Y	25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action.	NV	20. Ensure that 80PSV001 is verified for blocked discharge downstream of 25PV025A/B during fuel cell operation. No consideration is made of advantageous control from 25PCV025A/B as per Shell rule set.	Rosetti Process	PHA Team considers this scenario to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved.
					A	4	B	4B		80PI002	High High Pressure trip of PSD closing 25SDV023.	NV			
					C	4	B	4B		80PSV001	Pressure Safety Valve set point at 10barg. Valid, to be sized for this case as per recommendation.	NV			
					E	3	B	3B							
	3.1.18. Blockage in line within Fuel Cell Package, considered to be failure to reopen main isolation valve following maintenance.	3.1.18.1. Upstream: Potential overpressure of pipework downstream of 25PV025A/B. LOPC of H2 and potential explosion on ignition.	Hydrogen	80PI002	P	5	A	5A	Y	25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action.	NV	20. Ensure that 80PSV001 is verified for blocked discharge downstream of 25PV025A/B during fuel cell operation. No consideration is made of advantageous control from 25PCV025A/B as per Shell rule set.	Rosetti Process	PHA Team considers this scenario to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved.
					A	4	B	4B		80PI002	High High Pressure trip of PSD closing 25SDV023.	NV	21. Review the required response time (PST) of 80PI002/25SDV023 to ensure that they are able to react to prevent exceedance of hydrotest pressure of the downstream pipework and Fuel Cell if 25PCV025A/B are fully opened.	Rosetti/Crosswind (Interface)	
					C	4	B	4B		80PSV001	Pressure Safety Valve set point at 10barg. Valid, to be sized for this case as per recommendation.	V	22. Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened. Consider the opening times of storage vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.	Rosetti/Crosswind (Interface)	
					E	3	B	3B							
	3.1.19. BLPH-MV-006 SB Left in closed position on Downstream relief line	3.1.19.1. Loss of safeguard for pressure relief.								LO Valve	BLPH-MV-032 is a LO valve				
3.2. Flow More	3.2.1. 25PIC005 failure opening 25PV005	3.2.1.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen		P	5	A	5A	N	43FI001	High Flow indication on vent.		1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B		25PI004	Reducing Pressure indication in V25001A.		2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety	
					C	4	B	4B		25PT005	Reducing Pressure indication in V25001A		3. Review if it is credible to implement an interlock on 25PIC005 to prevent 25PV005 being opened outside of a purge cycle operation.	Rosetti Process	
					E	3	B	3B		Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.				
										25ZLH005[P]	Position Transmitter. Not valid as part of IE.				
										25ZLL005[P]	Position Indicator Low. Not valid as part of IE.				
										25ZLH005[P]	Position Indicator High. Not valid as part of IE.				
	3.2.2. 25FIC001 failure opening 25FV001 N2 valve	3.2.2.1. Potential for N2 (7barg) into H2 storage vessel V25001A at end of Fuel Cell operation resulting in off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1).									No barriers within Rosetti scope, refer to Fuel cell HAZOP.		6. Review if it is credible to implement an interlock to prevent 25FV001 being opened outside of a purge cycle operation.	Rosetti Process	
													17. Review the requirement for a separate header with an additional isolation on the N2 supply to the storage vessels to minimise the	Rosetti Process	

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
													likelihood of N2 contamination of H2 storage vessels during purge cycle.		
		3.2.2.2. Potential for H2 (up to 30barg) into N2 system resulting in H2 being used in place of N2 in Electrolyser systems. Refer to Elogen HAZOP node 10.													
		3.2.2.3. Overpressure of N2 system resulting in LOPC of H2 and N2.	Hydrogen		P	5	A	5A	N	BLPH-NRV-014	Non-return valve.		7. Review the current design against for compliance with piping (utility connection DEP 31.38.01.11, version 2018) and overpressure (80.45.10.11) DEPs for connection of utility N2 to H2 storage vessels V25001A-F. If they are not compliant (and are not to be made compliant) review current design with LOPA.	Rosetti Process	To be determined / re-evaluated after closeout of recommendation.
					A	4	B	4B		64PIC001A	High Pressure alarm with operator action. Not valid as insufficient time.		8. Ensure that 64PSV001 is verified for backflow of 30 barg H2 from storage vessels V25001A-F. Ensure that the vent from PSV is located in a safe location considering this flow will be H2. Also consider proximity of vent to N2 package which vents O2.	Rosetti Process	
					C	4	B	4B		64PIC001B	High Pressure alarm with operator action. Not valid as insufficient time.				
					E	3	B	3B		64PSV001	Pressure Safety Valve set point at 10barg.				
										25ZLH005[F]	Position Transmitter. Not valid as part of IE.				
										25ZLL005[F]	Position Indicator Low. Not valid as part of IE.				
										25ZLH005[F]	Position Indicator High. Not valid as part of IE.				
		3.2.2.4. H2 reverse flow into N2 package U64000. Review consequences within HAZOP of N2 package. [Parking Lot; What: Review in N2 package HAZOP - Reverse flow of H2 into package]								64-SDV001	Shutdown valve closed outside of purging operation. Also closed down by PCS system				
	3.2.3. 25BDV022 Fails open/inadvertently opened by operator	3.2.3.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen		P	5	A	5A	N	43FI001	High Flow indication on vent.		1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B		25PI004	Reducing Pressure indication in V25001A.		2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety	
					C	4	B	4B		25PT005	Reducing Pressure indication in V25001A				
					E	3	B	3B		Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.				
										25ZLL022[B]	Position Indicator Low. Not valid as part of IE.				
										25ZAH022[B]	Position Indicator High alarm. Not valid as part of IE.				
	3.2.4. 25PV025A and B both in operation	3.2.4.1. Both under downstream pressure control, no significant impact. No hazardous consequences.								25HS025	HS includes software interlock to prevent both valves to be online simultaneously.				
	3.2.5. 25PIC025A/B control failure opening 25PV025A/B	3.2.5.1. Potential overpressure of pipework downstream of 25PV025A/B. LOPC of H2 and potential explosion on ignition.	Hydrogen	80PI002	P	5	A	5A	Y	25PIC025A/B	High Pressure alarm. Not valid as insufficient time for operator action also part of IE.	NV	21. Review the required response time (PST) of 80PI002/25SDV023 to ensure that they are able to react to prevent exceedance of hydrotest pressure of the downstream pipework and Fuel Cell if 25PCV025A/B are fully opened.	Rosetti/Crosswind (Interface)	PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: 25PI002/25SDV003 at SIL 1
					A	4	B	4B		80PI002	High High Pressure trip of PSD closing 25SDV023.	NV	22. Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened. Consider the opening times of storage vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.	Rosetti/Crosswind (Interface)	
					C	4	B	4B		80PSV001	Pressure Safety Valve set point at 10barg. Valid, to be sized for this case as per recommendation.	V			
					E	3	B	3B		25ZLH025[P]	Position Transmitter. Not valid as part of IE.	NV			
										25ZLL025[P]	Position Indicator Low. Not valid as part of IE.	NV			
										25ZLH025[P]	Position Indicator High. Not valid as part of IE.	NV			

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	3.2.6. 80XV001 Fails open	3.2.6.1. H2 sent to H2 vent header and vented to atmosphere, loss of product. Potential for fire/explosion of continuously vented H2 at top of H2 vent. A single H2 storage vessel can be depressurised while maintaining pressure in the other vessels.	Hydrogen		P	5	A	5A	N	43FI001	High Flow indication on vent.		1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B		25PI004	Reducing Pressure indication in V25001A.		2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety	
					C	4	B	4B		25PT005	Reducing Pressure indication in V25001A				
					E	3	B	3B		Classification and Hazardous Zoning	Area classification and hazardous area zoning to minimise ignition potential.				
										80ZAH001[X]	Position Indicator High				
										80ZLL001[X]	Position Indicator Low				
3.3. Flow Misdirected	3.3.1. 25XV004 Open during Fuel Cell Operation	3.3.1.1. On cold stand-by Electrolyser depressurises and vents contents of H2 Storage vessel to Electrolyser vent stack. Operational issue, loss of product, no hazardous consequence.								Elogen PV633	On cold stand-by PV633 on discharge of Electrolyser system is close.				
										Elogen NRV CV633	Non return valve within discharge of Electrolyser system.				
										25ZLH004[X]	Position Indicator High				
										25ZAL004[X]	Position Indicator Low alarm				
		3.3.1.2. On hot stand-by Electrolyser maintains 30barg. Small potential for gas movement within H2 storage inlet header. No hazardous consequence.								25ZLH004[X]	Position Indicator High				
										25ZAL004[X]	Position Indicator Low alarm				
	3.3.2. 25XV009/12/15/18/21 open when not required and V25001B-F is at Low pressure H2.	3.3.2.1. Rapid increase in Pressure in vessels V25001B-F from 0 to 30barg. Potential for exceeding design velocity or high vibration in piping and vessels V25001B-F leading to potential LOPC of H2.	Hydrogen		P	5	A	5A	N	None Identified			14. Determine if high DP across any valves (likely to be up to 30bar) has the potential for high velocity (outside of pipe spec) or high vibration with the potential to damage pipework. If so consider how purging cycle can be performed without using SDV.	Rosetti Process	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B							
					C	4	B	4B							
					E	3	B	3B							
	3.3.3. 25XV009/12/15/18/21 open when not required and V25001B-F is at Low pressure N2.	3.3.3.1. Rapid increase in Pressure in vessels V25001B-F from 0 to 30barg. Potential for exceeding design velocity or high vibration in piping and vessels V25001B-F leading to potential LOPC of H2.	Hydrogen		P	5	A	5A	N	None Identified			14. Determine if high DP across any valves (likely to be up to 30bar) has the potential for high velocity (outside of pipe spec) or high vibration with the potential to damage pipework. If so consider how purging cycle can be performed without using SDV.	Rosetti Process	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B							
					C	4	B	4B							
					E	3	B	3B							
		3.3.3.2. Contamination of Feed stream to Fuel Cell and off spec H2 sent to the Fuel Cell leading to operational issue no hazardous consequences as per Fuel Cell HAZOP (Cause 1.13.1).													
	3.3.4. 25XV009/12/15/18/21 open when not required and V25001B-F is at High pressure (30barg).	3.3.4.1. No hazardous consequences.													
3.4. Flow As Well As	3.4.1. No additional causes.														
3.5. Flow Reverse	3.5.1. No additional causes.														
3.6. Pressure Low	3.6.1. Low Pressure at inlet to Fuel Cell	3.6.1.1. Potential damage of Fuel Cell and loss of Power generation. Operational issue, no hazardous consequences. Low pressure likely to occur during normal operation when storage tank is depleted.								25PIC025A/B	Low Pressure indication (No alarm)		23. Review the requirement for a low pressure alarm on 25PIC025A/B to indicate that the PCV no longer has control over the downstream pressure due to depletion (low pressure) of the H2 storage vessel and low low pressure trip on 80PI002 to shutdown the Fuel Cell Package.	Rosetti Process	
										80PI002	Low Pressure indication (No alarm)				
3.7. Pressure High	3.7.1. External Fire	3.7.1.1. Refer to Node 1 External Fire. Cause: 1.7.1													

Node: 3. Hydrogen (Electricity Production)

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
3.8. Temperature Low	3.8.1. Low ambient temperature	3.8.1.1. No hazardous consequences.													
3.9. Temperature High	3.9.1. No additional causes.														
3.10. Level No/Low	3.10.1. No credible causes														
3.11. Level High	3.11.1. No credible causes														
3.12. Phase	3.12.1. No credible causes														
3.13. Composition/Contamination	3.13.1. Moisture due to failure of HPP	3.13.1.1. Potential for moisture from the Electrolyser (failed HPP) to be sent through the storage system (where there is no moisture detection) to the Fuel Cell. Potential loss of performance in Fuel Cell, operational issue. No hazardous consequences.								Fuel Cell Performance	Loss of Performance within Fuel Cell will be detected and Feed stream can be vented to remove contaminated H2.				
										Elogen DPT800A/B	Dew Point Analysers divert H2 stream to vent if above moisture specification within Elogen Package.				
3.14. Operations	3.14.1. No additional causes.														
3.15. Maintenance	3.15.1. No additional causes.														
3.16. Start up/ Shutdown	3.16.1. Start up of Fuel Cell 135 times/year	3.16.1.1. Potential for overpressurisation of line and Fuel Cell downstream of 25PCV025A/B due to reaction speed of 25PIC025A/B. Insufficient time for control system to react to prevent downstream overpressure. Assumption is that as fuel cell runs down 25PIC025A/B opens 25PV025A/B such that when restart occurs 25PV025A/B are fully open.	Hydrogen		P	5	A	5A	Y	80PI002	High High Pressure trip of PSD closing 25SDV023. Potentially insufficient time to prevent rupture of pipework or Fuel Cell, however likely to be able to prevent large LOPC from loss of H2 vessel inventory. Review in Interface HAZOP for Rosetti/Fuel Cell [Parking Lot; What: Review in Interface HAZOP for Rosetti/Fuel Cell - potential overpressure / process safety time]	NV	44. As fuel cell runs down 25PIC025A/B opens 25PV025A/B. Ensure that when restart occurs 25PV025A/B are fully closed and review how the downstream pressure can be slowly increased to the point where 25PIC025A/B can be given automatic control.	Rosetti Instrumentation	Recommendation eliminates consequence (ALARP by design).
					A	4	B	4B		80PSV001	Pressure Safety Valve. May not be valid as potential insufficient time for spring operated PSV to react due to volumes in line. Review in Interface HAZOP for Rosetti/Fuel Cell [Parking Lot; What: Review in Interface HAZOP for Rosetti/Fuel Cell- potential overpressure / process safety time]	NV			
					C	4	B	4B							
					E	3	B	3B							
3.17. Catalysts	3.17.1. No credible causes														
3.18. Utilities	3.18.1. Loss of Power	3.18.1.1. Refer to Node 1. Cause: 1.18.1													
	3.18.2. Loss of Instrument Air	3.18.2.1. Section of line between 25SDV001 and 25XV004 will be blocked in during ESD scenario.											11. Ensure that the trapped volume between 25SVD023 and 25PV025A/B is minimised such that it does not require blowdown.	Rosetti Process	
													12. Review the trapped volume between Fuel Cell Package and 25PV025A/B is minimised such that it does not require blowdown or consider providing a blowdown route. See also recommendation 10.	Rosetti Process	
		3.18.2.2. 25XV006 Fails closed leading to low pressure of H2 to Fuel Cell when Fuel Cell is in operation, refer to Fuel Cell HAZOP. [Parking Lot; What: Review in Interface HAZOP for Rosetti/Fuel Cell - potential low pressure]													
	3.18.3. Loss of Nitrogen Supply	3.18.3.1. No hazardous consequences.													
3.19. Corrosion/Erosion	3.19.1. No additional causes.														
3.20. Other	3.20.1. No additional causes.														

Node: 4. Hydrogen Vent System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
4.1. Flow No/Less	4.1.1. BLPH-MV-002 SB Left in closed position	4.1.1.1. Upstream: No flow from Electrolyser Package into H2 vent. Blocked outlet on Electrolyser relief and vent systems. Review in Elogen HAZOP. [Parking Lot; What: Review in Interface HAZOP for Rosetti/Electrolyser - potential blocked outlet]								LO Valve	BLPH-MV-002 is a LO valve.		30. Review the requirement for BLPH-MV-002 in the H2 vent system as this is a potential isolation point within a relief route. Also review the piping specification around the tie in point and identify it on P&ID to ensure compatibility.	Rosetti Process	
		4.1.1.2. Downstream: No hazardous consequences.													
	4.1.2. 25XV003 fails closed on Hydrogen vent line	4.1.2.1. Upstream: Refer to 2.1.5: Cause: 2.1.5													
		4.1.2.2. Downstream: No hazardous consequences.													
	4.1.3. BLPH-MV-212 DBB Left in closed position	4.1.3.1. Upstream: Refer to 2.1.5: Cause: 2.1.5								LO Valve	BLPH-MV-212 is a LO valve.				
		4.1.3.2. Downstream: No hazardous consequences.													
	4.1.4. BLPH-MV-033 DBB Left in closed position	4.1.4.1. Upstream: Unable to relieve vessel V-25001A when required. Potential escalation of existing incident or unable to prepare installation for maintenance.								LO Valve	BLPH-MV-033 is a LO valve.		31. Review the location of the spec break downstream of: 1. 25PSV001A/BLPH-MV-033 2. 80PSV001/BLPH-MV-005 As pipework between PSV and manual valve will see upstream pressure if closed and a relief occurs.	Rosetti Process	
		4.1.4.2. Downstream: No hazardous consequences.													
	4.1.5. 25PV005 Fails closed	4.1.5.1. Upstream: Refer to 2.1.11: Cause: 2.1.11													
		4.1.5.2. Downstream: No hazardous consequences.													
	4.1.6. 25BDV005 Fails closed on Blowdown Stream	4.1.6.1. Upstream: Unable blowdown vessel V-25001A when required. Potential escalation of existing incident or unable to prepare installation for maintenance.								25ZAH022[B]	Position Indicator alarm high				
		4.1.6.2. Downstream: No hazardous consequences.													
	4.1.7. BLPH-MV-035 DBB Left in closed position on V-25001A relief	4.1.7.1. Upstream: Refer to 4.1.5.1								LO Valve	BLPH-MV-035 is a LO valve.				
		4.1.7.2. Downstream: No hazardous consequences.													
	4.1.8. 25BDV022 fails closed	4.1.8.1. Upstream: Unable blowdown discharge manifold of H2 storage vessels when required. Potential escalation of existing incident or unable to prepare installation for maintenance.								25ZAH022[B]	Position Indicator alarm high				
		4.1.8.2. Downstream: No hazardous consequences.													
	4.1.9. BLPH-MV-019 DBB Left in closed position on V-25001A relief	4.1.9.1. Upstream: Refer to 4.1.7.1								LO Valve	BLPH-MV-019 is a LO valve.				
		4.1.9.2. Downstream: No hazardous consequences.													
	4.1.10. BLPH-MV-005 DBB Left in closed position	4.1.10.1. Upstream: Unable to relieve when required. Potential escalation of existing incident or unable to prepare installation for maintenance.								LO Valve	BLPH-MV-005 is a LO valve.		31. Review the location of the spec break downstream of: 1. 25PSV001A/BLPH-MV-033 2. 80PSV001/BLPH-MV-005 As pipework between PSV and manual valve will see upstream pressure if closed and a relief occurs.	Rosetti Process	
		4.1.10.2. Downstream: No hazardous consequences.													
	4.1.11. No flow from N2 package to H2 vent Consequence: 4.18.2.1	4.1.11.1. Upstream: no impact on N2 system.													
		4.1.11.2. Downstream: Potential for air to be drawn into system via vent stack resulting in a flammable mixture within	Hydrogen		P	5	A	5A	N	64-PI001A/B	Low Pressure alarm on N2 system		32. Review the requirement for level transmitter and low level alarm to detect low level in H2 vent liquid seal Q43004.	Rosetti Instrumentation	PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly
					A	4	B	4B		64-PI002	Low Low Pressure alarm on N2 system will activate ESD 1D				

Node: 4. Hydrogen Vent System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
		the vent system. Potential explosion upon ignition in vent system.			C	4	B	4B		Liquid vent seal	Liquid seal on vent will prevent ingress into system.				disproportionate to the risk reduction achieved. Additional barriers considered: Automatic level control not implemented due to increased complexity.
					E	3	B	3B		Ignition Sources	No ignition sources within H2 vent system. Static ignition sources suppressed with Earth bonding.				
	4.1.12. BLPH-MV-171 Left in closed position on N2 system	4.1.12.1. Upstream: no impact on N2 system.													
		4.1.12.2. Downstream: Potential for air to be drawn into system via vent stack resulting in a flammable mixture within the vent system. Potential explosion upon ignition in vent system.	Hydrogen		P	5	A	5A	N	Liquid vent seal	Liquid seal on vent will prevent ingress into system.		32. Review the requirement for level transmitter and low level alarm to detect low level in H2 vent liquid seal Q43004.	Rosetti Instrumentation	PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: Automatic level control not implemented due to increased complexity.
					A	4	B	4B		Ignition Sources	No ignition sources within H2 vent system. Static ignition sources suppressed with Earth bonding.				
					C	4	B	4B		Commissioning Checks	Flow through BLPH-MV-171 set up using flow meter 64FG001 during commissioning.				
					E	3	B	3B							
	4.1.13. BLPH-MV-172 Left in closed position on N2 system	4.1.13.1. Upstream: no impact on N2 system.													
		4.1.13.2. Downstream: Potential for air to be drawn into system via vent stack resulting in a flammable mixture within the vent system. Potential explosion upon ignition in vent system.	Hydrogen		P	5	A	5A	N	Liquid vent seal	Liquid seal on vent will prevent ingress into system.		32. Review the requirement for level transmitter and low level alarm to detect low level in H2 vent liquid seal Q43004.	Rosetti Instrumentation	PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved. Additional barriers considered: Automatic level control not implemented due to increased complexity.
					A	4	B	4B		Ignition Sources	No ignition sources within H2 vent system. Static ignition sources suppressed with Earth bonding.				
					C	4	B	4B		Commissioning Checks	Flow through BLPH-MV-171 set up using flow meter 64FG001 during commissioning.				
					E	3	B	3B		LO Valve	BLPH-MV-172 is a LO valve.				
	4.1.14. BLPH-MV-409 SB Left in closed position on V-43001 drain	4.1.14.1. Upstream: Unable to drain liquid from KO Drum V-43001 leading to potential high level in KO Drum and liquid into H2 relief header resulting in high back pressure to relieving streams. Rupture of relief streams, LOPC of H2 and explosion on ignition. 90 Electrolyser starts/yr, 0.5 hr/start-up, 3.2kg/hr of water(worst credible scenario based on condensation of all water in stream), Platform visited for maintenance 2 times/yr where issue can be identified and rectified. 0.076 m3 of water within 2m3 KO drum overfill of vessel not considered credible.								43LIC001	High level alarm with sufficient time to stop production.	V	45. Review the requirement for 43LI002 High High activating ESD 1 as no scenarios were identified within the HAZOP which would activate the trip. Verify before removal that there is no requirement from project applicable standards and good practice (DEP) for this trip.	Rosetti Process	
										43LI002	High high level trip activating ESD 1.	V			
										43PI001	High pressure alarm, not valid as insufficient time to react.	NV			
	4.1.15. 43LIC001 control loop failure closing 43LV001	4.1.15.1. Upstream: Unable to drain liquid from KO Drum V-43001 leading to potential high level in KO Drum and liquid into H2 relief header resulting in high back pressure to relieving streams. Rupture of relief streams, LOPC of H2 and explosion on ignition. 90 Electrolyser starts/yr, 0.5 hr/start-up, 3.2kg/hr of water(worst credible scenario based on condensation of all water in stream), Platform visited for maintenance 2 times/yr where issue can be identified and rectified. 0.076 m3 of water within 2m3 KO drum overfill of vessel not considered credible.								43LIC001	High level alarm, not valid as part of IE.	V	45. Review the requirement for 43LI002 High High activating ESD 1 as no scenarios were identified within the HAZOP which would activate the trip. Verify before removal that there is no requirement from project applicable standards and good practice (DEP) for this trip.	Rosetti Process	
										43LI002	High high level trip activating ESD 1.	V			
										43PI001	High pressure alarm, not valid as insufficient time to react.	NV			
4.2. Flow More	4.2.1. Full production rate of H2 from Elogen Electrolyser sent to vent	4.2.1.1. Full production of wet H2 sent to H2 vent. Potential high back pressure on other vent users and high moisture content of stream. No hazardous consequences as this is the design case for the vent system.											27. Determine the back pressure on the vent system for full wet production H2 sent to H2 vent. Determine the effects of high back pressure on other vent users, consider the effect on relief valve set points and Electrolyser Oxygen in Hydrogen analysers due to back pressure. Review impacts with interface units. See also recommendation 31	Crosswind	
	4.2.2. Pressure venting from Elogen Electrolyser pressure control	4.2.2.1. Intermittent flow significantly less then full production, no significant impact. No hazardous consequences.													
	4.2.3. Flow from Elogen Electrolyser sample system	4.2.3.1. Very small continuous flow, no significant impact. No hazardous consequences.											29. Review the impact of back pressure in the H2 vent system on the Elogen product sample system. Consider that the Electrolyser may be in start-up and venting wet H2 and this is the critical time	Crosswind	

Node: 4. Hydrogen Vent System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
													for sampling of the product stream. See also recommendation 29		
	4.2.4. Flow from Elogen HPP RVs	4.2.4.1. Potential full production flow via HPP RVs (may be wet or dry). Review consequences based on close out recommendation 35 (potential for high O2 concentration from HPP vent resulting in flammable mixture in H2 vent).	Hydrogen		P	5	A	5A	N	Ignition Sources	No ignition sources within H2 vent system. Static ignition sources suppressed with Earth bonding.		33. Review with Elogen/HPP suppliers the upper limit of O2 concentration that can be relieved/ vented to the vent system from the HPP. Determine if this concentration will result in a flammable mixture within the vent system. If this is the case consider if this vent may require segregation from the main vent system.	Crosswind	To be determined / re-evaluated after closeout of recommendation.
					A	4	B	4B							
					C	4	B	4B							
					E	3	B	3B							
	4.2.5. Simultaneous Blowdown of all H2 storage vessels and Electrolyser (ESD 1D)	4.2.5.1. High flow through H2 vent system. No hazardous consequences, this is the design case for the H2 vent system.													
	4.2.6. BLPH-MV-171 open more than required on N2 system	4.2.6.1. Potential for impact on other N2 users resulting in an inability to purge. Loss of safeguard.											35. Ensure sizing of the Needle Valve BLPH-MV-171 prevents excessive N2 use which may impact other users by selecting the CV of the valve and hence maximum flowrate.	Rosetti Process	
	4.2.7. 43LIC001 control loop failure opening 43LV001 Above cause no longer credible as LIC/LV removed on Rev02 of PEFS, replaced by LC manual valve BLPH-MV-409 BLPH-MV-409 left open following maintenance draining of V43001	4.2.7.1. Loss of liquid level in KO drum V43001 and gas blow-by to the Brine Discharge Caisson B50014. LOPC of H2 into sea below installation.	Hydrogen		P	5	A	5A	N	43LI001	Low level alarm on V43001		36. Perform a dispersion calculation for release of H2 via the B50014 Caisson from a gas blow by from the V43001 KO drum. Consider the maximum pressure the KO drum may reach under all scenarios. If a hazard is created at the installation see action 39.	Rosetti Tech Safety	To be determined / re-evaluated after closeout of recommendation.
					A	4	B	4B		B50014 Caisson Location	Separation distance between Caisson discharge and main installation.		37. Review the requirement for an additional SDV in the KO drum water drain line activated by 43LI002 low low level to prevent gas blow-by to the Caisson. To be evaluated with LOPA if required. Note that the liquid level in KO drum V43001 may be lost due to evaporation over time and if a trip is fitted this may result in a spurious trip of 43LI002 low low level alarm. Review against recommendation 40.	Rosetti Instrumentation	
					C	4	B	4B		Ignition Sources	No ignition sources within Brine discharge system. Static ignition sources suppressed with Earth bonding.				
					E	3	B	3B							
	4.2.8. Liquid flow over top of vent Lute	4.2.8.1. Loss of liquid from liquid seal due to high gas flow through liquid seal potential for low level in liquid seal and loss of seal. Potential for air ingress in to system leading to a flammable mixture. Not considered credible as design basis is for maximum flow through system.													
		4.2.8.2. Gas breakthrough into lute leading to potential for flammable gas to be released onto installation.								Lute Vent	Lute vent is at safe location.				
4.3. Flow Misdirected	4.3.1. Reverse flow of H2 to N2 system during ESD 1D	4.3.1.1. Based on loss of N2 triggering ESD 1D (64PI002) the Back pressure within H2 vent system is > N2 feed pressure. Potential reverse flow resulting in H2 being used in place of N2 in Electrolyser systems. Refer to Elogen HAZOP node 10.								BLPH-NRV-020/021	Double Non return valves, non-class 1.		34. Review the requirement for BLPH-NRV-020/021 to be class 1 for N2 utility service considering that the life span of the installation is considered to be 2 years with no significant turnaround within that time.	Crosswind	
		4.3.1.2. H2 reverse flow into N2 package U64000. Review consequences within HAZOP of N2 package. [Parking Lot; What: Review in N2 package HAZOP - Reverse flow of H2 into package]													
	4.3.2. BLPH-MV-417 and BLPH-MV-418 inadvertently opened (1 action)	4.3.2.1. Loss of liquid seal. Potential for air ingress in to system leading to a flammable mixture.	Hydrogen		P	5	A	5A	N	LC valve	BLPH-MV-417 is locked close valve, not valid as part of IE.		32. Review the requirement for level transmitter and low level alarm to detect low level in H2 vent liquid seal Q43004.	Rosetti Instrumentation	PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved.
					A	4	B	4B							
					C	4	B	4B							
					E	3	B	3B							
	4.3.3. BLPH-MV-419 left open after liquid seal top up	4.3.3.1. LOPC of vent gases (likely to be H2) to deck area of installation. LOPC of H2 and potential explosion within stack.	Hydrogen		P	5	A	5A	N	Maintenance Procedure	Maintenance procedure to close valve after maintenance of Q43004.		41. Ensure that the seal liquid top up procedure is considered as a safety critical procedure as failure to close BLPH-MV-419 top up valve will allow LOPC of H2 on to deck area with potential for an explosion within the vent stack.	Crosswind	PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly
					A	4	B	4B		Ignition Sources	Area classification and hazardous area zoning to minimise ignition potential.				
					C	4	B	4B							

Node: 4. Hydrogen Vent System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
					E	3	B	3B							disproportionate to the risk reduction achieved.
4.4. Flow As Well As	4.4.1. No additional causes.														
4.5. Flow Reverse	4.5.1. No additional causes.														
4.6. Pressure Low	4.6.1. Hot relief or vent cooling down within vent system	4.6.1.1. Potential for air to be drawn in via the stack creating a flammable mixture within the H2 vent.	Hydrogen		P	5	A	5A	N	N2 Purge	Continuous N2 purge on vent system will prevent air ingress into system.				ALARP by HSSE Standards and Practices.
					A	4	B	4B		Liquid vent seal	Liquid seal on vent will prevent ingress into system.				
					C	4	B	4B							
					E	3	B	3B							
4.7. Pressure High	4.7.1. Blockage of Flame arrestor on vent Q43004	4.7.1.1. High back pressure within vent system.								Bird Screen	Bird screen to minimise the likelihood of blockage of the flame arrestor from Guano.				
4.8. Temperature Low	4.8.1. Low ambient temperature Consequence: 4.18.1.1	4.8.1.1. Freezing of liquid seal in Q43004 H2 vent resulting in blockage of vent relief system. LOPC of H2.	Hydrogen		P	5	A	5A	N	43PI001	High Pressure alarm on KO drum V43001				PHA Team considers this scenario to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved.
					A	4	B	4B		Seal Liquid	Seal liquid is glycol water mixture with FP of minimum ambient condition.				
					C	4	B	4B		Heat tracing	Q43004 is heat traced on seal section.				
					E	3	B	3B							
4.9. Temperature High	4.9.1. External Fire	4.9.1.1. Potential for failure of V43001 KO drum and release of additional H2. Escalation of incident potentially occurs as F&G system will initiate ESD 1D which will blowdown other systems through the vent system.								F&G Detection	F&G Detection system				
4.10. Level No/Low	4.10.1. Low level in Liquid boot of V43001	4.10.1.1. Low liquid level in KO drum V43001 is expected to be normal, potentially dropping below low low level alarm point overtime due to evaporation within KO drum.											38. Review how the liquid drain line from the KO drum V43001 can be safely routed for disposal considering that it may be subject to gas blow-by due to loss of liquid seal by evaporation. Review against recommendation 39.	Rosetti Process	
	4.10.2. Low level in H2 vent seal Q43004	4.10.2.1. Loss of liquid seal due to evaporation. Potential for air ingress in to system leading to a flammable mixture.	Hydrogen		P	5	A	5A	N				32. Review the requirement for level transmitter and low level alarm to detect low level in H2 vent liquid seal Q43004.	Rosetti Instrumentation	PHA Team considers this scenario, after implementation of recommendations, to be ALARP and that adding additional barriers would be grossly disproportionate to the risk reduction achieved.
					A	4	B	4B					39. Ensure that consideration of top up of the glycol seal in vent Q43004 is made in the design, and that there will be a 6 month period between maintenance interventions which will allow top up.	Rosetti Process	
					C	4	B	4B							
					E	3	B	3B							
4.11. Level High	4.11.1. Rain ingress into H2 vent stack Consequence: 4.18.1.1	4.11.1.1. Potential for high level in liquid seal Q43004 and overflow to drain resulting in dilution of glycol concentration and potential for freezing of liquid seal and blockage of relief route.	Hydrogen		P	5	A	5A		43PI001	High Pressure alarm on KO drum V43001		40. Ensure the design of the vent Q43004 exit minimises the potential for rain ingress which may dilute the seal liquid potentially resulting in blocked outlet for the H2 vent system due to freezing.	Rosetti Process	
					A	4	B	4B		Seal Liquid	Seal liquid is glycol water mixture with FP of minimum ambient condition. See also recommendation 42.				
					C	4	B	4B		Heat tracing	Q43004 is heat traced on seal section.				
					E	3	B	3B							
	4.11.2. Overfill of Q43004 glycol seal	4.11.2.1. Water with a high concentration glycol sent to wastewater tank, no hazardous consequences.													
4.12. Phase	4.12.1. No additional causes.														
4.13. Composition/Contamination	4.13.1. No additional causes.														
4.14. Operations	4.14.1. No additional causes.														
4.15. Maintenance	4.15.1. No additional causes.														
4.16. Start up/ Shutdown	4.16.1. No additional causes.														
4.17. Catalysts	4.17.1. No credible causes														

Node: 4. Hydrogen Vent System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
4.18. Utilities	4.18.1. Loss of Power	4.18.1.1. Loss of heat tracing to instrumentation and seal pot. See 4.8.1 and 4.11.1: Cause: 4.11.1 Cause: 4.8.1													
	4.18.2. Loss of Nitrogen Supply	4.18.2.1. See No flow from N2 system 4.1.11: Cause: 4.1.11													
	4.18.3. Loss of Instrument Air	4.18.3.1. 43LV001 moves to air fail position.											42. Make air fail position of 43LV001 fail closed and type 6 (critical).	Rosetti Process	
4.19. Corrosion/Erosion	4.19.1. No additional causes.														
4.20. Other	4.20.1. Lute provision on base of stack within Rosetti Package	4.20.1.1. Refer to Recommendation.											28. Review the requirement for a Lute within the Elogen Package H2 vent system as the package vent discharge is via a knockout pot V43001 within the Rosetti scope. If Elogen Lute not required consider removal of the Elogen package Lute.	Crosswind	

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
5.1. Flow No/Less	5.1.1. Blocked Caisson B-50013A (Marine debris or marine life)	5.1.1.1. Unable to pull seawater into system and damage to pump P-50001A or Caisson.	Asset Damage to Pump(s)		A	1	C	1C		50-XA001	Trip/Fault alarm on pump P-50001A				
										Spare Seawater Pump	2 x 100% capacity with automatic changeover.				
		5.1.1.2. No flow into seawater treatment system.													
	5.1.2. P-50001A pump tripped Consequence: 5.1.3.2 Consequence: 5.18.1.1	5.1.2.1. No flow into coarse filter package A-50003 resulting in failure of backwash cycle, operational issue requiring additional backwash cycles. No hazardous consequences.								50-XA001	Trip/Fault alarm on pump P-50001A		43. Update the control narrative to identify alternate seawater lift pump auto-start on 50-PI001/002 low pressure alarm or 50-XA001/003 trip/fault alarm.	Rosetti Instrumentation	
										50-PI001	Low Pressure alarm in discharge of P-50001A				
		5.1.2.2. No flow into T-50006 treated seawater tank leading to potential low level in tank resulting in loss of flow to desalination unit A-50007. No hazardous consequences.								50-XA001 / 50-XA003	Trip/Fault alarm on pump P-50001A/B				
										50-PI001	Low Pressure alarm in discharge of P-50001A				
										50-LI020L	Low level alarm on T-50006				
										50-LI020LL	Low low level trip on T-50006. Trips P-50002A/B and P-50003A/B				
	5.1.3. 50-XV001 fails closed / BLPH-MV-043 inadvertently closed	5.1.3.1. Block discharged of P-50001A leading to potential damage to pump.	Asset Damage to Pump(s)		A	1	C	1C		50-PI001	High Pressure alarm in discharge of P-50001A				
										50-PSV006	Relief valve on discharge of P-50001A				
		5.1.3.2. Loss of forward flow. See Cause: 5.1.2													
	5.1.4. 50-XV004 fails closed on return line on offline Pump / BLPH-MV-050 inadvertently closed	5.1.4.1. Loss of biocide dosed water to P-50001B leading to potential for bacterial growth and clogging of seawater system, operational issue. No hazardous consequences.													
	5.1.5. Inadvertent closure of MV-500	5.1.5.1. Potential deadheading of pumps P-50001A/B and exceeding DP of pipework with LOC of sea water. Potential flooding of WTP container. Damage to electrical equipment within container. Asset damage. Consequence: 5.1.6.1	Asset Damage to Electrical Equipment		A	1	B	1B		50-PSV011	Design for blocked outlet, set point 6 barg				
										50-PI020L	Low pressure alarm upstream of A-50003				
										50-FI020L	Low flow alarm upstream of S-50001				
					A	1	C	1C		50-PI020L	Low pressure alarm upstream of A-50003				
										50-FI020L	Low flow alarm upstream of S-50001				

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
		5.1.5.2. No flow to tank T-50006 potential low level in tank. Potential dry running of P-50002A/B resulting in damage to pump and asset damage to pump. Consequence: 5.1.6.1 Consequence: 5.2.3.1 Consequence: 5.2.4.1	Asset Damage to Pump (s)							50-LI020L	Low level alarm on T-50006				
										50-LI020LL	Low low level trip on T-50006. Trips P-50002A/B and P-50003A/B				
		5.1.5.3. No flow to tank T-50006 potential low level in tank. Potential dry running of P-50003A/B resulting in damage to pump and asset damage to pump. Consequence: 5.1.6.1 Consequence: 5.2.3.1 Consequence: 5.2.4.1	Asset Damage to Pump (s)		A	1	C	1C		50-PI020L	Low pressure alarm upstream of A-50003				
										50-FI020L	Low flow alarm upstream of S-50001				
										50-LI020L	Low level alarm on T-50006				
										50-LI020LL	Low low level trip on T-50006. Trips P-50002A/B and P-50003A/B				
		5.1.5.4. No flow through H-50001. Potential overheating of PVC pipework (DT 60 degC) with damage to pipework and interuption of operation. Consequence: 5.1.6.1 Consequence: 5.2.3.1 Consequence: 5.2.4.1	Asset damage		A	1	C	1C		50-PI020L	Low pressure alarm upstream of A-50003				
										50-FI020L	Low flow alarm upstream of S-50001				
										50-TAAH20	High temperature trip (110 degC) of H-50001. Trip setting is internal to heater and appropriate for heater design temperature.				
		5.1.5.5. Continued dosage of biocide into stagnant system, potential overdose of biocide to downstream system. No significant hazard as biocide is removed by reverse osmosis unit.													
	5.1.6. Closure of 50-XV020 out of sequence Consequence: 5.1.7.1 Consequence: 5.1.8.1 Consequence: 5.1.9.1 Consequence: 5.1.10.1 Consequence: 5.1.11.1 Consequence: 5.1.12.1 Consequence: 5.1.13.1 Consequence: 5.18.3.2	5.1.6.1. See Consequence: 5.1.5.2 Consequence: 5.1.5.1 Consequence: 5.1.5.3 Consequence: 5.1.5.4													
		5.1.6.2. Potential reverse flow of sea water to biocide dosing. Potential over flow of concentrated biocide into waste water tank. Potential over flow of waste water tank T-55001 to sea, potential environmental incident.	Ethylene Glycol		E	3	B	3B		NRV-504	NRV in WTP inlet line				
										NVR-606 / NRV-612	NRV in P-50007A/B discharge				
										55-LI001H	High level alarm on T-55001				
										50-FI020L	Low flow alarm upstream of S-50001				
	5.1.7. High DP on coarse filter A-50003 Failure to initiate cleaning sequence. PDI failed.	5.1.7.1. See Cause: 5.1.6													
	5.1.8. No flow when required through coarse filter drain valve	5.1.8.1. Failure in cleaning sequence with build up of solids in coarse filter. See Cause: 5.1.6								50-XAA50003	General alarm from A-50003 package				
	5.1.9. Inadvertent closure of MV-506	5.1.9.1. See Cause: 5.1.6													
	5.1.10. Internal valve closure within S-50001. Potential failure 50-PDI023	5.1.10.1. See Cause: 5.1.6													
		5.1.10.2. Potential reverse flow through P-50002A/B into T-50006 bypassing sand filter S-50001. High load on cartdrige filters S-50002A/B and S-50003A/B reducing operational lifetime. Operational issue potentially requring early replacement of cartdridge filters.								NRV-512 / NRV-515 / NRV-518	NRV on P-50002A/B discharge				
										50-PDI024H / 50-PDI029H	High DP across S-50002A/B and S-50003A/B				
										50-XAS-50001	General alarm from S-50001 package				

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	5.1.11. No flow when required through sand filter drain valve. Valve not shown on P&ID	5.1.11.1. Failure in backwash operation with build up of solids in sand filter. See Cause: 5.1.6								50-PDI023H	High DP across S-50001 unit				
		5.1.11.2. Deadheading of P-50002A/B. Potential damage to pumps and asset damage.	Asset Damage to Pump (s)		A	1	C	1C		50-FI020L	Low flow alarm upstream of S-50001				
										50-XAS-50001	General alarm from S-50001 package				
										50-PDI023H	High DP across S-50001 unit				
	5.1.12. High DP on sand filter S-50001. Failure of 50-PDI023 to initiate back wash sequence	5.1.12.1. Failure in backwash operation with build up of solids in sand filter. See Cause: 5.1.6								50-FI020L	Low flow alarm upstream of S-50001				
										50-LI020L	Low level alarm on T-50006				
										50-LI020LL	Low low level trip on T-50006. Trips P-50002A/B and P-50003A/B				
	5.1.13. Inadvertent closure of MV-509	5.1.13.1. Loss of forward flow through sand filter. See Cause: 5.1.6								50-FI020L	Low flow alarm upstream of S-50001				
										50-LI020L	Low level alarm on T-50006				
										50-LI020LL	Low low level trip on T-50006. Trips P-50002A/B and P-50003A/B				
	5.1.14. Inadvertent closure of MV-514 on backwash loop	5.1.14.1. Failure in backwash operation with build up of solids in sand filter and eventual blockage of sand filters. Operational issue								50-FI020L	Low flow alarm upstream of S-50001				
										P-50002A/B	Installed spare				
		5.1.14.2. Loss of NPSH to pumps P-50002A/B resulting in caviation and damage to pumps	Asset Damage to Pump (s)		A	1	C	1C		50-FI020L	Low flow alarm upstream of S-50001				
	5.1.15. P-50002A stopped	5.1.15.1. Failure in backwash operation with build up of solids in sand filter and eventual blockage of sand filters. Operational issue								50-FI020L	Low flow alarm upstream of S-50001				
										P-50002A/B	Installed spare				
	5.1.16. Inadvertent closure of MV-516 on backwash loop	5.1.16.1. Failure in backwash operation with build up of solids in sand filter and eventual blockage of sand filters. Operational issue								50-FI020L	Low flow alarm upstream of S-50001				
										P-50002A/B	Installed spare				
		5.1.16.2. Deadheading of pumps P-50002A/B resulting in damage.	Asset Damage to Pump (s)		A	1	C	1C		50-FI020L	Low flow alarm upstream of S-50001				
	5.1.17. Inadvertent closure of MV-xxx on backwash loop	5.1.17.1. Failure in backwash operation with build up of solids in sand filter and eventual blockage of sand filters. Operational issue								50-FI020L	Low flow alarm upstream of S-50001				
		5.1.17.2. Deadheading of pumps P-50002A&B resulting in damage.	Asset Damage to Pump (s)		A	1	C	1C		50-FI020L	Low flow alarm upstream of S-50001				
	5.1.18. 50-XV021 closed failure in filter change over operation	5.1.18.1. High level in T-50006 potential overflow of tank to sea water caisson. No hazardous consequences.								50-LI020H	High level alarm on T-50006				
		5.1.18.2. Dry running of pumps P-50003A/B and loss of flow to P-50004A/B. Damage to pumps P-50003A/B and P-50004A/B.	Asset Damage to Pump (s)		A	1	C	1C		50-PI025L / 50-PI027L	Low pressure alarm at discharge of P-50003A/B		49. 50-LI020LL should trip P-50004A/B on LL level in T-50006 to prevent pump damage	PSC	
										50-FI022L / 50-FI023L	Low flow alarm at discharge of P-50003A/B				
		5.1.18.3. Loss of pressure to RO units A-50007A/B. No hazardous consequences.								50-PIC030L / 50-PIC032L	Low pressure on discharge of P-50004A/B				
		5.1.18.4. Loss of flow into T-50008. Loss of level in T-50008. Operational issue.								50-LI021L	Low level alarm on T-50008				
										50-LI021LL	Low low level trip on T-50008. Trips P-50009A/B and P-50003A/B when in flushing mode.				
	5.1.19. P-50003A stopped	5.1.19.1. High level in T-50006 potential overflow of tank to sea water caisson. No hazardous consequences.								50-LI020H	High level alarm on T-50006				
					A	1	C	1C		50-PI025L / 50-PI027L	Low pressure alarm at discharge of P-50003A/B			PSC	

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
		5.1.19.2. Loss of pressure at inlet to P-50004A/B. Loss of forward flow through cartdrige filters. Asset damage to pumps and pipework.	Asset Damage to Pump (s)							50-FI022L / 50-FI023L	Low flow alarm at discharge of P-50003A/B		49. 50-LI020LL should trip P-50004A/B on LL level in T-50006 to prevent pump damage		
										50-PIC030L / 50-PIC032L	Low pressure alarm at discharge of P-50004A/B				
		5.1.19.3. Loss of pressure to RO units A-50007A/B. No hazardous consequences.								50-PIC030L / 50-PIC032L	Low pressure on discharge of P-50004A/B				
		5.1.19.4. Loss of flow into T-50008. Loss of level in T-50008. Operational issue.								50-LI021L	Low level alarm on T-50008				
										50-LI021LL	Low low level trip on T-50008. Trips P-50009A/B and P-50003A/B when in flushing mode.				
	5.1.20. MV-527 inadvertently closed Consequence: 5.1.21.1	5.1.20.1. Blocked discharge of P-50003A. Deadhead pressure of pump less than DP of pipework. No LOC. Potential damage to pump.	Asset Damage to Pump (s)		A	1	C	1C		50-PI025L / 50-PI027L	Low pressure alarm at discharge of P-50003A/B				
										50-FI022L / 50-FI023L	Low flow alarm at discharge of P-50003A/B				
		5.1.20.2. Loss of pressure at inlet to P-50004A/B. Loss of forward flow through cartdrige filters. Asset damage to pumps and pipework.	Asset Damage to Pump (s)		A	1	C	1C		50-PI025L / 50-PI027L	Low pressure alarm at discharge of P-50003A/B		49. 50-LI020LL should trip P-50004A/B on LL level in T-50006 to prevent pump damage	PSC	
										50-FI022L / 50-FI023L	Low flow alarm at discharge of P-50003A/B				
										50-PIC030L / 50-PIC032L	Low pressure alarm at discharge of P-50004A/B				
		5.1.20.3. Loss of pressure to RO units A-50007A/B. No hazardous consequences.								50-PIC030L / 50-PIC032L	Low pressure on discharge of P-50004A/B				
		5.1.20.4. Loss of flow into T-50008. Loss of level in T-50008. Operational issue.								50-LI021L	Low level alarm on T-50008				
										50-LI021LL	Low low level trip on T-50008. Trips P-50009A/B and P-50003A/B when in flushing mode.				
	5.1.21. S-50002A / S-50003A fouled	5.1.21.1. Reduced flow to RO cells. Similar but less impact. See Cause: 5.1.20								50-PDI024H / 50-PDI029H	High DP across S-50002A/B and S-50003A/B				
	5.1.22. MV-531 inadvertently closed	5.1.22.1. Blocked discharge of P-50003A. Deadhead pressure of pump less than DP of pipework. No LOC. Potential damage to pump.	Asset Damage to Pump (s)		A	1	C	1C		50-FI022L / 50-FI023L	Low flow alarm at discharge of P-50003A/B				
		5.1.22.2. Loss of pressure at inlet to P-50004A/B. Loss of forward flow through cartdrige filters. Asset damage to pumps and pipework.	Asset Damage to Pump (s)		A	1	C	1C		50-FI022L / 50-FI023L	Low flow alarm at discharge of P-50003A/B		49. 50-LI020LL should trip P-50004A/B on LL level in T-50006 to prevent pump damage	PSC	
										50-PIC030L / 50-PIC032L	Low pressure alarm at discharge of P-50004A/B				
		5.1.22.3. Loss of pressure to RO units A-50007A/B. No hazardous consequences.								50-PIC030L / 50-PIC032L	Low pressure on discharge of P-50004A/B				
		5.1.22.4. Loss of flow into T-50008. Loss of level in T-50008. Operational issue.								50-LI021L	Low level alarm on T-50008				
										50-LI021LL	Low low level trip on T-50008. Trips P-50009A/B and P-50003A/B when in flushing mode.				
	5.1.23. P-50004A stopped	5.1.23.1. Loss of inlet pressure to RO cells and loss of forward flow to T-50008. Operational issue. Forward flow continues through flushing valve and concentrate line. Water discharge to sea water caisson.								50-FI022L / 50-FI023L	Low flow alarm at discharge of P-50003A/B				
										50-PIC030L / 50-PIC032L	Low pressure alarm at discharge of P-50004A/B				
										50-FI024L	Low discharge flow from RO cells.				
	5.1.24. A-50007A fouled	5.1.24.1. Potential over pressure of RO cells with LOC from RO cells or inlet pipework into WTP container. Asset damage.	Asset Damage to Electrical Equipment		A	1	B	1B		50-PIC030	Discharge pressure control of P-50004A				
										50-PSV035	Pressure relief valve on P50004A. Designed for full flow relief				
	5.1.25. MV-xxx inadvertently closed Consequence: 5.1.26.1	5.1.25.1. Potential over pressure of RO cells discharge with LOC from PU pipework into WTP container. Asset damage.	Asset Damage to Electrical Equipment		A	1	B	1B		50-PSV036	Pressure relief valve designed for full flow relief downstream of A-50007A				
										50-FI024L	Low discharge flow from RO cells.				
	5.1.26. 50-XV025 closed	5.1.26.1. See Cause: 5.1.25													
	5.1.27. 50-XV026 fails to open when required. Failure of	5.1.27.1. Potential off spec water fed to Elogen water treatment. Potential fouling of Elogen RO cells and											48. Review the effect of out of spec water fed to Elogen RO cells based on a temperature at the PSC RO cells of 40 degC with the chloride concentration based on this temperature. Identify in the	Rosetti Process / Crosswind / PSC / Elogen	

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	conductivity control 50-AI024	loss of purified water to electrolysis unit. Operational issue.											Elogen HAZOP if it is credible that chloride is fed through to the electrolysis cells or if this is only an operational impact on RO cell performance (current assumption). If there is adverse impact on the cells, review if LOPA is required for this failure in the Rosetti HAZOP.		
	5.1.28. 50-XV027 closed whilst flushing	5.1.28.1. Low flushing flow through RO cells. Potential degradation of RO cells due to poor flushing. Operational issue. Forward flow continues through flushing valve and concentrate line. Water discharge to sea water caisson.								50-FI022L / 50-FI023L	Low flow alarm at discharge of P-50003A/B				
	5.1.29. MV-550 incorrectly set	5.1.29.1. Potential over pressure of RO cells with LOC from RO cells or inlet pipework into WTP container. Asset damage.	Asset Damage to Electrical Equipment		A	1	B	1B		50-PIC030	Discharge pressure control of P-50004A				
										50-PSV035	Pressure relief valve on P50004A. Designed for full flow relief				
	5.1.30. MV-561 inadvertently closed	5.1.30.1. Blocked inlet to P-50009A/B loss of NPSH to pumps and cavitation with potential for pump damage.	Asset Damage to Pump (s)		A	1	C	1C		50-PI047L	Low pressure alarm at discharge of P-50009A/B				
										50-FI028L	Low flow alarm on outlet of WTP unit				
		5.1.30.2. Loss of forward flow to electrolysis unit. Operational issue. No hazardous consequence.								50-FI028L	Low flow alarm on outlet of WTP unit				
		5.1.30.3. Potential overflow of T-50008 with overflow of fresh water to brine caisson. No hazardous consequences.								50-LI021H	High level alarm on T-50008				
	5.1.31. P-50009A/B not running	5.1.31.1. Loss of forward flow to electrolysis unit. Operational issue. No hazardous consequence.								50-FI026L	Low flow alarm on outlet of WTP unit				
		5.1.31.2. Potential overflow of T-50008 with overflow of fresh water to brine caisson. No hazardous consequences.								50-LI021H	High level alarm on T-50008				
		5.1.31.3. Potential reverse flow from electrolysis unit. Potential overflow of T-50008 with overflow of fresh water to brine caisson. No hazardous consequences.								NRV-562 / NRV-565	Non return valves on discharge of P-50009A/B				
		5.1.31.4. Potential overdose of caustic into fresh water system due to distance between dosing point and PH analysis								P-50005A/B stopped	Interlock of pump running signal with caustic dosing pump P-50005A/B				
	5.1.32. MV-563 / MV-566 inadvertently closed	5.1.32.1. Deadheading of P-50009A/B (7barg) potential overpressure of pump discharge pipe work (DP 6barg). Pump damage and potential LOC of fresh water within WTP container.	Asset Damage to Pump (s)		A	1	C	1C		50-FI026L	Low flow alarm on outlet of WTP unit		52. Determine how overpressure of fresh water system can be prevented should P-50009A/B be isolated on the downstream side as deadhead pressure of these pumps is 7barg and the design pressure of downstream system is 6barg.	PSC	
		5.1.32.2. Potential overflow of T-50008 with overflow of fresh water to brine caisson. No hazardous consequences.								50-LI021H	High level alarm on T-50008				
		5.1.32.3. Loss of forward flow to electrolysis unit. Operational issue. No hazardous consequence.								50-FI026L	Low flow alarm on outlet of WTP unit				
		5.1.32.4. Potential overdose of caustic into fresh water system due to distance between dosing point and PH analysis								None available	Interlock of pump running signal with caustic dosing pump P-50005A/B not a safeguard as pump is still running				
	5.1.33. S-50004 clogging not considered credible														
	5.1.34. MV-569 inadvertently closed Consequence: 5.1.35.1 Consequence: 5.1.36.1	5.1.34.1. Deadheading of P-50009A/B (7barg) potential overpressure of pump discharge pipe work (DP 6barg). Pump damage and potential LOC of fresh water within WTP container.	Asset Damage to Pump (s)		A	1	C	1C		50-FI026L	Low flow alarm on outlet of WTP unit		52. Determine how overpressure of fresh water system can be prevented should P-50009A/B be isolated on the downstream side as deadhead pressure of these pumps is 7barg and the design pressure of downstream system is 6barg.	PSC	
										50-PI046H	High pressure alarm on inlet to S-50004				
		5.1.34.2. Potential overflow of T-50008 with overflow of fresh water to brine caisson. No hazardous consequences.								50-LI021H	High level alarm on T-50008				
		5.1.34.3. Loss of forward flow to electrolysis unit. Operational issue. No hazardous consequence.								50-FI026L	Low flow alarm on outlet of WTP unit				

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
		5.1.34.4. Potential overdose of caustic into fresh water system due to distance between dosing point and PH analysis. Potential overpressure of system due to pressure of caustic dosing pump P-50005A/B. Potential LOC of fresh water / caustic (2% concentration) within WTP container.	Asset Damage to Electrical Equipment		A	1	B	1B		None available	Interlock of pump running signal with caustic dosing pump P-50005A/B not a safeguard as pump is still running				
										50-PI046H	High pressure alarm on inlet to S-50004				
										Multi-function valve downstream of P-50005A/B	Multi-function valve (also acting as relief valve) downstream of P-50005A/B				
	5.1.35. 50-XV031 closed	5.1.35.1. See Cause: 5.1.34													
	5.1.36. BLPH-MV-001 inadvertently closed	5.1.36.1. See Cause: 5.1.34													
5.2. Flow More	5.2.1. P-50009A & B both operating	5.2.1.1. Potential overfill of Elogen WTP-300 and further consequences to be determined in WTP HAZOP.											54. Ensure logic for control of P-50009A/B prevents simultaneous running A & B pumps.	Rosetti Process	
		5.2.1.2. Off spec purified water to Electrolyser leading to permanent damage of Electrolyser stacks. See Elogen HAZOP 1.13.									See Elogen Package for barriers against off spec water from WTP.				
	5.2.2. P-50001A & B both operating	5.2.2.1. High flowrate into T-50006 leading to potential overfill of T-50006 Filtered seawater tank and sending filtered chlorinated water overboard. Operational issue, no hazardous consequences.								50-LIC006A/B	High level alarm on filtered sea water tank.				
		5.2.2.2. Review within Seawater Coarse Filter package HAZOP A-50003 the consequences of high flow through the package when package is in operation.													
		5.2.2.3. Review within Electro-Chlorination package HAZOP A-50002 the consequences of high flow through the package when package is in operation.													
		5.2.2.4. Review within Ultra Filtration package HAZOP A50005 the consequences of high flow through the package when package is in operation.													
	5.2.3. Flow when not required through coarse filter drain valve	5.2.3.1. Loss of forward flow to T-50006. See Consequence: 5.1.5.2 Consequence: 5.1.5.3 Consequence: 5.1.5.4													
		5.2.3.2. Lift pump flow directed to water drain (brine discharge caisson). No significant hazard consequences													
	5.2.4. Flow when not required through sand filter drain valve	5.2.4.1. Loss of forward flow to T-50006. See Consequence: 5.1.5.2 Consequence: 5.1.5.3 Consequence: 5.1.5.4													
		5.2.4.2. Lift pump flow directed to water drain (brine discharge caisson). No significant hazard consequences													
	5.2.5. P-50002A/B running when not required (not on backwash sequence). Failure of back wash sequence	5.2.5.1. Deadheading of pumps P-50002A&B resulting in damage. Dead head pressure of pumps is less than pressure in main flow line from sea water lift pumps	Asset Damage to Pump (s)		A	1	C	1C		None Identified					
	5.2.6. P-50002A&B running when on backwash sequence	5.2.6.1. Higher flow through sand filters. No hazardous consequences								50-FI020H	High flow alarm upstream of sand filter				
	5.2.7. RO stream A and B both running. Not considered														

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	credible as this would require local override														
	5.2.8. 50-PIC030 failure running P-50004A faster than required	5.2.8.1. Potential over pressure of RO cells with LOC from RO cells or inlet pipe work into WTP container. Asset damage.	Asset Damage to Electrical Equipment		A	1	B	1B		50-PSV035	Pressure relief valve on P50004A. Designed for full flow relief				
	5.2.9. MV-550 incorrectly set	5.2.9.1. More flow than required through MV-550. Operational issue. Low forward flow continues through flushing valve and concentrate line. Water discharge to sea water caisson.								50-FI024L	Low flow alarm at RO discharge				
	5.2.10. P-50009A&B running	5.2.10.1. Loss of level in T-50008 with eventual dry running of pumps P-50009A/B and loss of flow to electrolysis unit. Damage to pumps P-50009A/B.	Asset Damage to Pump (s)		A	1	C	1C		50-LI021L	Low level alarm on T-50008		49. 50-LI020LL should trip P-50004A/B on LL level in T-50006 to prevent pump damage	PSC	
										50-LI021LL	Low low level trip on T-50008. Trips P-50009A/B				
5.3. Flow Misdirected	5.3.1. 50-XV002 Driven open on pump discharge	5.3.1.1. Restricted orifice behind valve will minimise flow no significant consequences.													
	5.3.2. 50-XV003 Driven open on offline pump discharge	5.3.2.1. Reduced forward flow with water recycled to offline caisson. Operational issue, no hazardous consequences.								BLPH-NRV-008	NRV restricts reverse flow.				
	5.3.3. 50-SV020 open during backwash sequence	5.3.3.1. Wash water directed to sea via lift pump caissons. Emptying of tank T-50006. Potential dry running of P-50003A/B resulting in damage to pump and asset damage to pump.	Asset Damage to Pump (s)		A	1	C	1C		50-FI020L	Low flow alarm upstream of S-50001				
										50-LI020L	Low level alarm on T-50006				
										50-LI020LL	Low low level trip on T-50006. Trips P-50002A/B and P-50003A/B				
										50-XZAL020	Loss of closed signal from limit switch				
	5.3.4. 50-XV022 open when not required on offline train	5.3.4.1. No significant consequences, insufficient pressure to forward flow of sea water to RO cell. No hazardous consequences. Offline train will be full of (flushing) water.													
	5.3.5. 50-XV026 open when not required	5.3.5.1. Reduced flow to T-50008 with water directed to brine caisson. No hazardous consequences.													
		5.3.5.2. Potential to drain T-50008 and run pumps P-50009A/B dry resulting in pump damage.	Asset Damage to Pump (s)		A	1	C	1C		50-LI021L	Low level alarm on T-50008				
										50-LI021LL	Low low level trip on T-50008. Trips P-50009A/B and P-50003A/B when in flushing mode.				
	5.3.6. 50-XV027 opening when not on flushing cycle	5.3.6.1. Reduced pressure within RO cells and reduced fresh water production. Water directed towards brine caisson. No hazardous consequences.								50-PIC030L	Low discharge pressure on discharge P-50004A		50. Ensure that where multiple trains are implemented within the WTP package remote changeover between trains is available to onshore operators on request.	Rosetti / CRW	
										50-FI024L	Low fresh water flow to T-50008				
										50-XZL027	Loss of closed signal from limit switch				
		5.3.6.2. Potential to drain T-50008 and run pumps P-50009A/B dry resulting in pump damage.	Asset Damage to Pump (s)		A	1	C	1C		50-LI021L	Low level alarm on T-50008				
										50-LI021LL	Low low level trip on T-50008. Trips P-50009A/B and P-50003A/B when in flushing mode.				
	5.3.7. 50-XV023 flushing valve open when not required	5.3.7.1. Linking of T-50006 and T-50008 with potential of contantamination of T-50008 with filtered sea water. Filtered sea water fed forward to electrolysis unit with potential damage to RO unit in electrolysis package.	Asset damage		A	1	C	1C		50-AI026H	High total hardness alarm		51. Add an NRV in the flushing water line between T-50008 and 50-XV023 / 50-XV024 to prevent reverse flow in the flushing line and potential contamination of T-50008 with filtered brine from T-50006.	PSC	
										50-AI026HH	High high total hardness trip diverts RO cell output to brine caisson. Closing 50-XV031 and opening 50-XV032.				
										50-XZL023	Loss of closed signal from limit switch				
	5.3.8. 50-XV032 open when not required. Potential failure of 50-AI026 / 50-AI027	5.3.8.1. Purified water directed to brine caisson. No hazardous consequences. Loss of purified water to electrolysis unit.								50-XZL032	Loss of closed signal from limit switch				
	5.3.9. Drain valve S-50004 package open when not required	5.3.9.1. Purified water directed to brine caisson. No hazardous consequences. Loss of purified water to electrolysis unit.								50-XAS50004	General package alarm				

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
5.4. Flow As Well As	5.4.1. No credible causes														
5.5. Flow Reverse	5.5.1. No additional causes.														
5.6. Pressure Low	5.6.1. No additional causes.														
5.7. Pressure High	5.7.1. No additional causes.														
5.8. Temperature Low	5.8.1. Low ambient temperature Consequence: 5.18.1.2	5.8.1.1. Potential freezing of stagnant lines resulting in rupture and LOPC of water. No hazardous consequences.								Winterisation	Winterisation of exposed lines consistent with winterisation philosophy.				
	5.8.2. H-50001 failure	5.8.2.1. Increased pressure drop across RO cells. Minor operational issue. No hazardous consequences.								50-TI022L	Low temperature alarm on inlet to S-50001				
	5.8.3. 50-TIC021 failure	5.8.3.1. Increased pressure drop across RO cells. Minor operational issue. No hazardous consequences.								50-TI022L	Low temperature alarm on inlet to S-50001				
5.9. Temperature High	5.9.1. 50-TIC021 failure	5.9.1.1. High temperature water fed forward to T-50006 and RO cells. Design temperature of RO cells cannot be exceeded. Potential off spec water fed to Elogen water treatment. Potential fouling of Elogen RO cells and loss of purified water to electrolysis unit. Operational issue.								50-AI024H	High conductivity alarm		48. Review the effect of out of spec water fed to Elogen RO cells based on a temperature at the PSC RO cells of 40 degC with the chloride concentration based on this temperature. Identify in the Elogen HAZOP if it is credible that chloride is fed through to the electrolysis cells or if this is only an operational impact on RO cell performance (current assumption). If there is adverse impact on the cells, review if LOPA is required for this failure in the Rosetti HAZOP.	Rosetti Process / Crosswind / PSC / Elogen	
										50-AI024HH	High high conductivity trip closes 50-XV025 and opens 50-XV026				
5.10. Level No/Low	5.10.1. RO units operating while filtration system offline resulting in loss of level in T-50006	5.10.1.1. Dry running of pumps P-50003A/B and loss of flow to P-50004A/B. Damage to pumps P-50003A/B and P-50004A/B.	Asset Damage to Pump (s)		A	1	C	1C		50-LI020L	Low level alarm on T-50006		49. 50-LI020LL should trip P-50004A/B on LL level in T-50006 to prevent pump damage	PSC	
										50-LI020LL	Low low level trip on T-50006. Trips P-50002A/B and P-50003A/B				
										50-PI025L / 50-PI027L	Low pressure alarm at discharge of P-50003A/B				
										50-FI022L / 50-FI023L	Low flow alarm at discharge of P-50003A/B				
		5.10.1.2. Loss of pressure to RO units A-50007A/B. No hazardous consequences.								50-PIC030L / 50-PIC032L	Low pressure on discharge of P-50004A/B				
		5.10.1.3. Loss of flow into T-50008. Loss of level in T-50008. Operational issue.								50-LI021L	Low level alarm on T-50008				
										50-LI021LL	Low low level trip on T-50008. Trips P-50009A/B				
	5.10.2. Fresh water pumps P-50009A/B operating while RO units offline resulting in loss of level T-50008	5.10.2.1. Dry running of pumps P-50009A/B and loss of flow to electrolysis unit. Damage to pumps P-50009A/B.	Asset Damage to Pump (s)		A	1	C	1C		50-LI021L	Low level alarm on T-50008		49. 50-LI020LL should trip P-50004A/B on LL level in T-50006 to prevent pump damage	PSC	
										50-LI021LL	Low low level trip on T-50008. Trips P-50009A/B				
										50-PI047L	Low pressure alarm at discharge of P-50009A/B				
										50-FI026L	Low flow alarm on outlet of WTP unit				
		5.10.2.2. Loss of flow to electrolysis unit. Operational issue.								50-LI021L	Low level alarm on T-50008				
										50-LI021LL	Low low level trip on T-50008. Trips P-50009A/B				
5.11. Level High	5.11.1. Filter section of WTP running while RO section shutdown (flushing mode)	5.11.1.1. Potential overflow of T-50006 with overflow of filtered seawater to brine caisson. No hazardous consequences.								50-LI020H	High level alarm on T-50006				
	5.11.2. RO section running while electrolysis unit shutdown	5.11.2.1. Potential overflow of T-50008 with overflow of fresh water to brine caisson. No hazardous consequences.								50-LI021H	High level alarm on T-50008				
5.12. Phase	5.12.1. No credible causes														
5.13. Composition/Contamination	5.13.1. Loss of performance in A-50003 or S-50001 filters	5.13.1.1. Particulates fed forward into RO cells and fouling of RO cells. Operational issue. No hazardous consequences.								S-50002A/B / S-50003A/B	Cartridge filters				
										50-PDI024H / 50-PDI029H	High pressure differential alarm across cartridge filters				
	5.13.2. Failure of RO membrane and not considered														

Node: 5. Seawater and Treated Water Systems

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	credible in operating period.														
	5.13.3. Failure of S-50004 regen cycle	5.13.3.1. Purified water exceeds hardness specification. Potential performance loss of electrolysis RO cells. Operational issue.								50-AI026H	High total hardness alarm				
										50-AI026HH	High high total hardness trip diverts RO cell output to brine caisson. Closing 50-XV031 and opening 50-XV032.				
5.14. Operations	5.14.1. No additional causes.														
5.15. Maintenance	5.15.1. Replenishment of consumables	5.15.1.1. Spillages during refilling of treatment chemical tanks	Environmental impact		E	1	C	1C		Containment	Drip pans around each chemical storage tank minimise potential for spillages to environment				
5.16. Start up/ Shutdown	5.16.1. No additional causes.														
5.17. Catalysts	5.17.1. No credible causes														
5.18. Utilities	5.18.1. Loss of Power	5.18.1.1. Loss of pumps refer to 5.1.2: Cause: 5.1.2													
		5.18.1.2. Loss of heat tracing refer to 5.8.1: Cause: 5.8.1													
	5.18.2. Loss of Instrument Air	5.18.2.1. No additional consequences.													
	5.18.3. Loss of electrical power to WTP package Consequence: 10.18.1.1	5.18.3.1. Loss of all pumps within package and production of purified water. Operational issue.								WTP UPS	On loss of main electrical power to WTP PLC powered by UPS will drive all valves to safe state				
		5.18.3.2. Potential continued running of sea water lift pumps P-50001A/B. See Cause: 5.1.6													
5.19. Corrosion/Erosion	5.19.1. No credible causes														
5.20. Other	5.20.1.	5.20.1.1.											47. Review the design basis operational time for the PSC units against the design requirements of the Rosetti scope and align the requirements. PSC design basis is 8-12 hours continuous twice a week for 6 months vs Rosetti requirements including purging and black start scenarios.	Rosetti Process / Crosswind / PSC / Elogen	

Node: 6. Instrument Air

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
6.1. Flow No/Less	6.1.1. A-63000 instrument air package tripped Consequence: 6.18.1.1	6.1.1.1. Loss of instrument air to all consumers. See loss of utilities in all nodes								63-PI003L	Low pressure alarm on instrument air system				
										63-PI004LL	Trips ESD1D shuts down all plant and packages				
		6.1.1.2. Loss of air feed to nitrogen system resulting in Nitrogen generator trip. See Cause: 7.1.1								63-PI003L	Low pressure alarm on instrument air system				
										63-PI004LL	Trips ESD1D shuts down all plant and packages				
6.2. Flow More															
6.3. Flow Misdirected															
6.4. Flow As Well As															
6.5. Flow Reverse															
6.6. Pressure Low															

Node: 6. Instrument Air

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
6.7. Pressure High															
6.8. Temperature Low															
6.9. Temperature High															
6.10. Level No/Low															
6.11. Level High															
6.12. Phase															
6.13. Composition/Contamination															
6.14. Operations															
6.15. Maintenance															
6.16. Start up/ Shutdown															
6.17. Catalysts															
6.18. Utilities	6.18.1. Loss of electrical power to WTP package	6.18.1.1. See Cause: 6.1.1													
6.19. Corrosion/Erosion															
6.20. Other															

Node: 7. Nitrogen

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
7.1. Flow No/Less	7.1.1. A-64000 nitrogen package tripped Consequence: 7.6.1.1 Consequence: 6.1.1.2 Consequence: 7.18.1.1 Consequence: 7.18.2.1	7.1.1.1. Loss of nitrogen to all consumers. See nodes 1 and 4, the electrolyser HAZOP Consequence: 7.1.2.1								64-PIC031AL	Low pressure alarm on nitrogen system				
										64-PIC031BL	Low pressure alarm on nitrogen system				
										64-PI002L	Low pressure trip closing 64-SDV001 closing feed to all hydrogen vessels to prioritise inerting of vent systems				
										64-PI002LL	Trips ESD1D shuts down all plant and packages				
	7.1.2. 64-PV031A/B driven closed by 64-PIC031A/B failure	7.1.2.1. Loss of nitrogen supply to all consumers. See Consequence: 7.1.1.1								64-PI002L	Low pressure trip closing 64-SDV001 closing feed to all hydrogen vessels to prioritise inerting of vent systems				
										64-PI002LL	Trips ESD1D shuts down all plant and packages				
										64-ZSL031A/B	Position monitor on PV alarm on discrepancy between required position and actual position (type 6). A & B PV valves are independent and auto changeover to other valves, operator can select other valve using 64-HS031				
		7.1.2.2. Blocked discharge from A-64000 nitrogen system. No potential for overpressure of internal or external systems. No hazardous consequences.													
	7.1.3. 64-SDV001 failed closed during purge operation	7.1.3.1. Failure to fully nitrogen purge the hydrogen storage tanks. Delay in start up. See node 2.													

Node: 7. Nitrogen

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
7.2. Flow More	7.2.1. 64-PV031A/B driven open by 64-PIC031A/B failure	7.2.1.1. High pressure nitrogen supply (8barg) to all consumers. Required supplied pressure is 7barg. No hazardous consequences.								64-ZSH031A/B	Position monitor on PV alarm on discrepancy between required position and actual position (type 6). A & B PV valves are independent and auto changeover to other valves, operator can select other valve using 64-HS031				
7.3. Flow Misdirected	7.3.1. 64-SDV001 open outside of purge cycle	7.3.1.1. Potential for reverse flow of hydrogen from storage tanks should downstream valves leak or fail. No direct hazardous consequence, loss of safeguard.													
7.4. Flow As Well As															
7.5. Flow Reverse															
7.6. Pressure Low	7.6.1. Failure within nitrogen package	7.6.1.1. See Cause: 7.1.1													
7.7. Pressure High															
7.8. Temperature Low															
7.9. Temperature High															
7.10. Level No/Low															
7.11. Level High															
7.12. Phase															
7.13. Composition/Contamination	7.13.1. Air contamination of N2 supply to Elogen Package	7.13.1.1. Potential for flammable atmosphere within H2 systems within Elogen Package. No barriers within Elogen Package. To be reviewed within A-64000 N2 package HAZOP and LOPA	Hydrogen		P A C E	5 4 4 3	A B B B	5A 4B 4B 3B		A-64000 oxygen analsyser	Oxygen analyser within nitrogen package will divert off spec nitrogen to atmosphere approximately 5 mins of nitrogen can be supplied via V-64001 nitrogen receiver when pressure drops ESD1D may be activated by low pressure in distribution system.		55. Review with Elogen the consequences of oxygen contamination of the N2 supply to the electrolysis unit and determine if consequences need to be considered in a LOPA analysis of the A-64000 oxygen analyser.	Crosswind	
	7.13.2. Air contamination of N2 supply to H2 storage	7.13.2.1. Potential for flammable atmosphere within H2 storage systems. To be reviewed within A-64000 N2 package HAZOP and LOPA	Hydrogen		P A C E	5 4 4 3	A B B B	5A 4B 4B 3B		A-64000 oxygen analsyser	Oxygen analyser within nitrogen package will divert off spec nitrogen to atmosphere approximately 5 mins of nitrogen can be supplied via V-64001 nitrogen receiver when pressure drops ESD1D may be activated by low pressure in distribution system.		56. Review with N2 package vendor the consequences of oxygen contamination of the N2 supply to the storage and vent systems and determine if consequences need to be considered in a LOPA analysis of the A-64000 oxygen analyser.	Rosetti Tech Safety	
	7.13.3. Air contamination of N2 supply to H2 vent	7.13.3.1. Potential for flammable atmosphere within H2 vent systems. To be reviewed within A-64000 N2 package HAZOP and LOPA	Hydrogen		P A C E	5 4 4 3	A B B B	5A 4B 4B 3B		A-64000 oxygen analsyser	Oxygen analyser within nitrogen package will divert off spec nitrogen to atmosphere approximately 5 mins of nitrogen can be supplied via V-64001 nitrogen receiver when pressure drops ESD1D may be activated by low pressure in distribution system.				
7.14. Operations															
7.15. Maintenance															
7.16. Start up/ Shutdown															
7.17. Catalysts															
7.18. Utilities	7.18.1. Loss of electrical power to WTP package	7.18.1.1. See Cause: 7.1.1													

Node: 7. Nitrogen

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	7.18.2. Loss of Instrument Air	7.18.2.1. See Cause: 7.1.1													
7.19 Corrosion/Erosion															
7.20. Other															

Node: 8. Brine Discharge System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
8.1. Flow No/Less	8.1.1. BLPH-MV-412 Caisson common inlet line left closed after maintenance	8.1.1.1. No outlet for discharges into Caisson. Discharge from Elogen RO cells potentially at high pressure (Elogen estimate 10barg). Potential pressurisation Caisson inlet header and reverse flow of RO discharge to other brine discharge streams.									No barrier on Elogen side.		26. Elogen to confirm to Rosetti the blocked in discharge pressure from the RO cells to the Brine Caisson Discharge system, i.e. the pressure in the line if the RO cell reject/discharge is blocked outside of the battery limit.	Crosswind	
8.2. Flow More															
8.3. Flow Misdirected															
8.4. Flow As Well As															
8.5. Flow Reverse															
8.6. Pressure Low															
8.7. Pressure High	8.7.1. High pressure from Elogen Package	8.7.1.1. Potential failure of pipe work leading to LOC of contaminated water.	Contaminated Wastewater		C	3	C	3C		Elogen Pressure Protection	Maximum pressure from Elogen Package defined as 6barg.				
8.8. Temperature Low															
8.9. Temperature High	8.9.1. High temperature liquid from Elogen package	8.9.1.1. Potential for high temperature discharge via Brine Caisson breaching Environmental consent.	Contaminated Wastewater		C	3	C	3C		Elogen Discharge Temperature	Worst case temperature discharge considered to be 2m3 per hr at 35degC for 20mins plus 0.5 m3 per hour at 35degC continuous while RO cells are in operation. This is not considered by the team capable of breaching the environmental consent.				
										50-TDI002	High Differential Temperature alarm between Seawater and Discharge brine.				
8.10. Level No/Low															
8.11. Level High															
8.12. Phase															
8.13. Composition/Contamination															
8.14. Operations															
8.15. Maintenance															
8.16. Start up/ Shutdown															
8.17. Catalysts															

Node: 8. Brine Discharge System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
8.18. Utilities															
8.19. Corrosion/Erosion															
8.20. Other															

Node: 9. Wastewater Discharge System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
9.1. Flow No/Less	9.1.1. Blocked Outlet of wastewater manifold from Elogen HPP	9.1.1.1. Not considered credible due to elevations and slope of pipe work towards Wastewater tank.													
9.2. Flow More															
9.3. Flow Misdirected															
9.4. Flow As Well As															
9.5. Flow Reverse															
9.6. Pressure Low															
9.7. Pressure High	9.7.1. High pressure from Elogen Package	9.7.1.1. Potential failure of pipe work leading to LOC of contaminated water.	Contaminated Wastewater		C	3	C	3C		Elogen Pressure Protection	Maximum pressure from Elogen Package defined as 6barg.				
9.8. Temperature Low															
9.9. Temperature High															
9.10. Level No/Low															
9.11. Level High	9.11.1. Overflow of wastewater tank	9.11.1.1. LOC of wastewater tank contents inside transition piece.	Contaminated Wastewater		C	3	C	3C	N	Elogen HPP Wastewater rate 55-LI001	Estimated Elogen HPP Wastewater rate based on predicted production rates is <1m3 per year. High level alarm in Wastewater tank.				
9.12. Phase															
9.13. Composition/Contamination															
9.14. Operations															
9.15. Maintenance															
9.16. Start up/ Shutdown															
9.17. Catalysts															
9.18. Utilities															
9.19. Corrosion/Erosion															
9.20. Other															

Node: 10. Caustic Soda System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
10.1. Flow No/Less	10.1.1. Tank T-50002 empty	10.1.1.1. Loss of caustic dosage to treated water, loss of PH control of treated water. Operational issue. No hazardous consequences.								50-AIC027L	Low pH alarm				
										50-AIC027LL	Low low pH trip diverts flow to brine caisson by closing 50-XV031 and opening 50-XV032				
										50-LI022L	Low level alarm T-50002				
										50-LI022LL	Low low level trip T-50002 will stop pumps P-50005A/B				
		10.1.1.2. Potential dry running of pumps P-50005A/B. No hazardous consequences. Potential pump damage.	Asset Damage to Pump (s)		A	1	C	1C		50-LI022L	Low level alarm T-50002				
										50-LI022LL	Low low level trip T-50002 will stop pumps P-50005A/B				
	10.1.2. MV-575 inadvertently closed	10.1.2.1. Loss of caustic dosage to treated water, loss of PH control of treated water. Operational issue. No hazardous consequences.								50-AIC027L	Low pH alarm				
										50-AIC027LL	Low low pH trip diverts flow to brine caisson by closing 50-XV031 and opening 50-XV032				
		10.1.2.2. Potential dry running of pumps P-50005A/B. No hazardous consequences. Potential pump damage.	Asset Damage to Pump (s)		A	1	C	1C		None Identified					
	10.1.3. MV-576 / MV-577 inadvertently closed Consequence: 10.1.4.1	10.1.3.1. Loss of caustic dosage to treated water, loss of PH control of treated water. Operational issue. No hazardous consequences.								50-AIC027L	Low pH alarm				
										50-AIC027LL	Low low pH trip diverts flow to brine caisson by closing 50-XV031 and opening 50-XV032				
										P-50005 spare	Auto changeover to spare pump initiated by 50-AIC027				
		10.1.3.2. Potential dry running of pumps P-50005A/B. No hazardous consequences. Potential pump damage.	Asset Damage to Pump (s)		A	1	C	1C		None Identified					
	10.1.4. SP-597 / SP-598 blocked	10.1.4.1. See Cause: 10.1.3													
	10.1.5. P-50005A/B stopped. Potential failure of PH 50-AIC027	10.1.5.1. Loss of caustic dosage to treated water, loss of PH control of treated water. Operational issue. No hazardous consequences.								None Identified					
	10.1.6. MV-582 / MV-583 inadvertently closed	10.1.6.1. Loss of caustic dosage to treated water, loss of PH control of treated water. Operational issue. No hazardous consequences. Consequence: 10.3.1.1								50-AIC027L	Low pH alarm				
										50-AIC027LL	Low low pH trip diverts flow to brine caisson by closing 50-XV031 and opening 50-XV032				
										P-50005 spare	Auto changeover to spare pump initiated by 50-AIC027				
		10.1.6.2. Deadheading of pumps P-50005A/B overpressure of pipe work with LOC of 2% caustic within WTP container.	Asset Damage		A	1	C	1C		Multi-function valve downstream of P-50005A/B	Multi-function valve (also acting as relief valve) downstream of P-50005A/B				
	10.1.7. MV-xxx upstream of tie in point inadvertently closed	10.1.7.1. Loss of caustic dosage to treated water, loss of PH control of treated water. Operational issue. No hazardous consequences.								50-AIC027L	Low pH alarm				
										50-AIC027LL	Low low pH trip diverts flow to brine caisson by closing 50-XV031 and opening 50-XV032				
		10.1.7.2. Deadheading of pumps P-50005A/B overpressure of pipe work with LOC of 2% caustic within WTP container.	Asset Damage		A	1	C	1C		Multi-function valve downstream of P-50005A/B	Multi-function valve (also acting as relief valve) downstream of P-50005A/B				
10.2. Flow More	10.2.1. P-50005A/B running. Failure of PH 50-AIC027	10.2.1.1. Overdosing of caustic resulting in high PH of treated water. Operational issue for electrolysis unit.								None Identified			53. Review with Elogen the consequences of loss of PH control within the water treatment package on the electrolysis. If consequences are significant for electrolyser package review if additional safeguards for PH protection are required within electrolyser package.	Crosswind	
10.3. Flow Misdirected	10.3.1. Failure of multi-function valve recycling flow to storage tank	10.3.1.1. Loss of caustic dosage. See Consequence: 10.1.6.1													

Node: 10. Caustic Soda System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
10.4. Flow As Well As	10.4.1. No additional causes.														
10.5. Flow Reverse															
10.6. Pressure Low	10.6.1. No additional causes.														
10.7. Pressure High	10.7.1. No additional causes.														
10.8. Temperature Low	10.8.1. No credible causes														
10.9. Temperature High	10.9.1. No credible causes														
10.10. Level No/Low	10.10.1. No additional causes.														
10.11. Level High	10.11.1. Overfilling of tank during refilling / maintenance	10.11.1.1. Loss of caustic to chemical drain and waste water tank T-55001. No hazardous consequences.								None Identified					
10.12. Phase															
10. Composition/C 13. ontamination	10.13.1. Incorrect chemical loaded into storage tank	10.13.1.1. Failure of chemical dosage systems leading to off spec treated water								50-AIC027L / H	pH alarm				
										50-AIC027LL / HH	pH trip diverts flow to brine caisson by closing 50-XV031 and opening 50-XV032				
										50-AI026H / L	Total hardness alarm				
										50-AI026HH / LL	Total hardness trip diverts RO cell output to brine caisson. Closing 50-XV031 and opening 50-XV032.				
10.14. Operations															
10.15. Maintenanc e															
10.16. Start up/ Shutdown															
10.17. Catalysts															
10.18. Utilities	10.18.1. Electrical power failure.	10.18.1.1. See Cause: 5.18.3													
10.1 Corrosion/Er 9. osion															
10.20. Other															

Node: 11. Antiscalant System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
11.1. Flow No/Less	11.1.1. Tank T-50003 empty	11.1.1.1. Loss of anti-scalant dosage to filtered water. Operational issue. No hazardous consequences.								50-LI023L	Low level alarm T-50003				
										50-LI023LL	Low low level trip T-50003 will stop pumps P-50006A/B				
		11.1.1.2. Potential dry running of pumps P-50005A/B. No hazardous consequences. Potential pump damage.	Asset Damage to Pump (s)		A	1	C	1C		50-LI023L	Low level alarm T-50003				
										50-LI023LL	Low low level trip T-50003 will stop pumps P-50006A/B				

Node: 11. Antiscalant System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	11.1.2. MV-587 inadvertently closed	11.1.2.1. Loss of anti-scalant dosage to filtered water. Operational issue. No hazardous consequences.								None Identified					
		11.1.2.2. Potential dry running of pumps P-50006A/B. No hazardous consequences. Potential pump damage.	Asset Damage to Pump (s)		A	1	C	1C		None Identified					
	11.1.3. MV-588 / MV-589 inadvertently closed	11.1.3.1. anti-scalant dosage to filtered water. Operational issue. No hazardous consequences. Consequence: 11.1.4.1 Consequence: 11.3.1.1 Consequence: 11.18.1.1								P-50006 spare	Auto changeover to spare pump				
		11.1.3.2. Potential dry running of pumps P-50005A/B. No hazardous consequences. Potential pump damage.	Asset Damage to Pump (s)		A	1	C	1C		None Identified					
	11.1.4. SP-599 / SP-600 blocked	11.1.4.1. See Consequence: 11.1.3.1													
	11.1.5. P-50006A/B stopped.	11.1.5.1. Loss of anti-scalant dosage to filtered water. Operational issue. No hazardous consequences.								None Identified					
	11.1.6. MV-594 / MV-595 inadvertently closed	11.1.6.1. Loss of anti-scalant dosage to filtered water. Operational issue. No hazardous consequences.								P-50006 spare	Auto changeover to spare pump				
		11.1.6.2. Deadheading of pumps P-50006A/B overpressure of pipework with LOC of anti-scalant within WTP container.	Asset Damage		A	1	C	1C		Multi-function valve downstream of P-50006A/B	Multi-function valve (also acting as relief valve) downstream of P-50006A/B				
	11.1.7. MV-523 upstream of tie in point inadvertently closed	11.1.7.1. Loss of anti-scalant dosage to filtered water. Operational issue. No hazardous consequences.								None Identified					
		11.1.7.2. Deadheading of pumps P-50006A/B overpressure of pipework with LOC of anti-scalant within WTP container.	Asset Damage		A	1	C	1C		Multi-function valve downstream of P-50006A/B	Multi-function valve (also acting as relief valve) downstream of P-50006A/B				
11.2. Flow More	11.2.1. P-50006A&B running.	11.2.1.1. Overdosing of anti-scalant. Operational issue for electrolysis unit.								None Identified					
11.3. Flow Misdirected	11.3.1. Failure of multi-function valve recycling flow to storage tank	11.3.1.1. Loss of anti-scalant dosage. See Consequence: 11.1.3.1													
11.4. Flow As Well As															
11.5. Flow Reverse															
11.6. Pressure Low															
11.7. Pressure High															
11.8. Temperature Low															
11.9. Temperature High															
11.10. Level No/Low															
11.11. Level High	11.11.1. Overfilling of tank during refilling / maintenance	11.11.1.1. Loss of anti-scalant to chemical drain and waste water tank T-55001. No hazardous consequences.								None Identified					
11.12. Phase															

Node: 11. Antiscalant System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
11. Composition/C 13. ontamination	11.13.1. Incorrect chemical loaded into storage tank	11.13.1.1. Failure of chemical dosage systems leading to off spec treated water								50-AIC027L / H	pH alarm				
										50-AIC027LL / HH	pH trip diverts flow to brine caisson by closing 50-XV031 and opening 50-XV032				
										50-AI026H / L	Total hardness alarm				
										50-AI026HH / LL	Total hardness trip diverts RO cell output to brine caisson. Closing 50-XV031 and opening 50-XV032.				
11.14. Operations															
11.15. Maintenanc e															
11.16. Start up/ Shutdown															
11.17. Catalysts															
11.18. Utilities	11.18.1. Electrical power failure.	11.18.1.1. See Consequence: 11.1.3.1													
11.1 Corrosion/Er 9. osion															
11.20. Other															

Node: 12. Biocide System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
12.1. Flow No/Less	12.1.1. Tank T-50004 empty	12.1.1.1. Loss of Biocide dosage to treated water. Operational issue. No hazardous consequences.								50-LI024L	Low level alarm T-50004				
										50-LI024LL	Low low level trip T-50004 will stop pumps P-50007A/B, P-50008A/B, P-50010A/B				
		12.1.1.2. Potential dry running of pumps P-50005A/B. No hazardous consequences. Potential pump damage.	Asset Damage to Pump (s)		A	1	C	1C		50-LI024L	Low level alarm T-50004				
										50-LI024LL	Low low level trip T-50004 will stop pumps P-50007A/B, P-50008A/B, P-50010A/B				
	12.1.2. MV-603 inadvertently closed	12.1.2.1. Loss of Biocide dosage to treated water. Operational issue. No hazardous consequences.								None Identified					
		12.1.2.2. Potential dry running of pumps P-50007A/B, P-50008A/B, P-50010A/B. No hazardous consequences. Potential pump damage.	Asset Damage to Pump (s)		A	1	C	1C		None Identified					
	12.1.3. MV-604/10/15/20/25/30 inadvertently closed	12.1.3.1. Loss of Biocide dosage to treated water. Operational issue. No hazardous consequences. Consequence: 12.1.4.1								P-50007A/B, P-50008A/B, P-50010A/B spare	Auto changeover to spare pump				
		12.1.3.2. Potential dry running of pumps ,P-50007A/B, P-50008A/B, P-50009A/B. No hazardous consequences. Potential pump damage.	Asset Damage to Pump (s)		A	1	C	1C		None Identified					
	12.1.4. SP-605/611/616/621/626/631 blocked	12.1.4.1. Loss of Biocide dosage See Consequence: 12.1.3.1													
	12.1.5. P-50007A/B, P-50008A/B, P-50010A/B stopped.	12.1.5.1. Loss of Biocide dosage to treated water. Operational issue. No hazardous consequences.								None Identified					

Node: 12. Biocide System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
	12.1.6. MV-607/613/618/624/628/634 inadvertently closed	12.1.6.1. Loss of Biocide dosage to treated water. Operational issue. No hazardous consequences. Consequence: 12.3.1.1 Consequence: 12.18.1.1								P-50007A/B, P-50008A/B, P-50010A/B spare					
		12.1.6.2. Deadheading of pumps P-50007A/B, P-50008A/B, P-50010A/B overpressure of pipework with LOC of Biocide within WTP container.	Asset Damage		A	1	C	1C		Multi-function valve downstream of P-50007A/B, P-50008A/B, P-50010A/B	Multi-function valve (also acting as relief valve) downstream of P-50007A/B, P-50008A/B, P-50010A/B				
	12.1.7. MV-503 upstream of tie in point inadvertently closed	12.1.7.1. Loss of Biocide dosage to treated water. Operational issue. No hazardous consequences.								None Identified					
		12.1.7.2. Deadheading of pumps P-50007A/B overpressure of pipework with LOC of Biocide within WTP container.	Asset Damage		A	1	C	1C		Multi-function valve downstream of P-50007A/B	Multi-function valve (also acting as relief valve) downstream of P-50007A/B				
12.2. Flow More	12.2.1. P-50007A/B, P-50008A/B, P-50010A/B both A&B running running.	12.2.1.1. Overdosing of Biocide. Operational issue. No hazardous consequences.								None Identified					
12.3. Flow Misdirected	12.3.1. Failure of multi-function valve recycling flow to storage tank	12.3.1.1. Loss of Biocide dosage. See Consequence: 12.1.6.1								P-50007A/B, P-50008A/B, P-50010A/B spare	Auto changeover to spare pump				
12.4. Flow As Well As															
12.5. Flow Reverse															
12.6. Pressure Low															
12.7. Pressure High															
12.8. Temperature Low															
12.9. Temperature High															
12.10. Level No/Low															
12.11. Level High	12.11.1. Overfilling of tank during refilling / maintenance	12.11.1.1. Loss of Biocide to chemical drain and waste water tank T-55001. No hazardous consequences.								None Identified					
12.12. Phase															
12. Composition/C 13. ontamination	12.13.1. Incorrect chemical loaded into storage tank	12.13.1.1. Failure of chemical dosage systems leading to off spec treated water								50-AIC027L / H	pH alarm				
										50-AIC027LL / HH	pH trip diverts flow to brine caisson by closing 50-XV031 and opening 50-XV032				
										50-AI026H / L	Total hardness alarm				
										50-AI026HH / LL	Total hardness trip diverts RO cell output to brine caisson. Closing 50-XV031 and opening 50-XV032.				
12.14. Operations															
12.15. Maintenance															
12.16. Start up/ Shutdown															
12.17. Catalysts															

Node: 12. Biocide System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
12.18. Utilities	12.18.1. Electrical power failure.	12.18.1.1. Loss of Biocide dosage. See Consequence: 12.1.6.1													
12.19. Corrosion/Erosion															
12.20. Other															

Node: 13. HVAC System

Deviation	Cause	Consequence	Hazard Register	SIF Summation - Threat	RAM Score				LOPA?	Barriers			Recommendation	Responsibility	ALARP Determination
					R	S	L	RR		Barrier Tag	Barrier Description	Validity			
13.1. Flow No/Less															
13.2. Flow More															
13.3. Flow Misdirected															
13.4. Flow As Well As															
13.5. Flow Reverse															
13.6. Pressure Low															
13.7. Pressure High															
13.8. Temperature Low	13.8.1. Low ambient temperature	13.8.1.1. Potential freezing of stagnant lines within WTP. Potential malfunction of control and analysis systems.								HHS-50003A/B	Container heating system				
13.9. Temperature High															
13.10. Level No/Low															
13.11. Level High															
13.12. Phase															
13. Composition/Contamination															
13.14. Operations															
13.15. Maintenance															
13.16. Start up/ Shutdown															
13.17. Catalysts															
13.18. Utilities															
13.19. Corrosion/Erosion															
13.20. Other															

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ATTACHMENT 4 – HAZOP RECOMMENDATIONS

Recommendation	Responsibility	Place(s) Used
1. Review the requirement for an alarm on 43FT001 and if required determine an appropriate set point to indicate continuous high pressure blowdown of H2 storage vessels.	Rosetti Process	Consequences: 1.2.2.1, 1.2.3.1, 1.3.1.1, 2.2.2.1, 2.2.3.1, 2.2.7.1, 2.2.9.1, 3.2.1.1, 3.2.3.1, 3.2.6.1
2. Perform vent radiation and dispersion study to confirm that dispersion from continuous blowdown or fail open of: 1. 25PV005 of any single H2 storage vessel 2. 25XV003 (25RO003) 3. 25BDV005 (25RO005) 4. 80XV001 (80RO001) 5. 25BDV022 (25RO022) does not create a fire or explosion risk to the installation.	Rosetti Tech Safety	Consequences: 1.2.2.1, 1.2.3.1, 1.3.1.1, 2.2.2.1, 2.2.3.1, 2.2.7.1, 2.2.9.1, 3.2.1.1, 3.2.3.1, 3.2.6.1
3. Review if it is credible to implement an interlock on 25PIC005 to prevent 25PV005 being opened outside of a purge cycle operation.	Rosetti Process	Consequences: 1.2.3.1, 2.2.3.1, 3.2.1.1
4. Ensure that 80PSV001 is sized for failure of downstream isolation on H2 vessel during filling operation (i.e. 25XV006) with 25PV025A or B fully open.	Rosetti Process	Consequences: 1.2.4.1
5. Review whether a permanent connection to the waste water tank T55001 is required from the hydrogen storage vessels. If so then review the potential for open waste water drain on storage vessel V25001A-F to result in overpressurisation of waste water tank during an N2 pressure test of the vessel following maintenance activity. Also consider the required vent sizing of waste water tank T55001 (to be calculated).	Rosetti Process	Consequences: 2.2.5.1
6. Review if it is credible to implement an interlock to prevent 25FV001 being opened outside of a purge cycle operation.	Rosetti Process	Consequences: 1.2.5.1, 3.2.2.1
7. Review the current design against for compliance with piping (utility connection DEP 31.38.01.11, version 2018) and overpressure (80.45.10.11) DEPs for connection of utility N2 to H2 storage vessels V25001A-F. If they are not compliant (and are not to be made compliant) review current design with LOPA.	Rosetti Process	Consequences: 1.2.5.3, 3.2.2.3
8. Ensure that 64PSV001 is verified for backflow of 30 barg H2 from storage vessels V25001A-F. Ensure that the vent from PSV is located in a safe location considering this flow will be H2. Also consider proximity of vent to N2 package which vents O2.	Rosetti Process	Consequences: 1.2.5.3, 3.2.2.3
9. Review the ESD logic for activation of ESD 1D on activation of 25PI004 HH and F&G detection system. Consider under which circumstances a single vessel should be depressurised and when all vessels should be depressurised.	Rosetti Tech Safety	Consequences: 1.7.1.1
10. Review the requirement for a BDV (FO) with a bypass around (25XV003 and 25RO003) and (80XV001 and 80RO001) to allow emergency depressurisation on the manifold inlet line. See also recommendation 12.	Rosetti Process	Consequences: 1.18.2.1

Recommendation	Responsibility	Place(s) Used
11. Ensure that the trapped volume between 25SVD023 and 25PV025A/B is minimised such that it does not require blowdown.	Rosetti Process	Consequences: 1.18.2.1, 3.18.2.1
12. Review the trapped volume between Fuel Cell Package and 25PV025A/B is minimised such that it does not require blowdown or consider providing a blowdown route. See also recommendation 10.	Rosetti Process	Consequences: 1.18.2.1, 3.18.2.1
13. Ensure that the potential for electrically induced corrosion and requisite earthing is considered in the SAFOP.	Crosswind Electrical	Consequences: 1.20.1.1
14. Determine if high DP across any valves (likely to be up to 30bar) has the potential for high velocity (outside of pipe spec) or high vibration with the potential to damage pipework. If so consider how purging cycle can be performed without using SDV.	Rosetti Process	Consequences: 1.3.2.1, 2.5.1.1, 2.14.1.1, 3.3.2.1, 3.3.3.1
15. Review the requirement for a timer alarm on the H2 pressurisation section of the purge cycle in the control logic to determine if the purge valve 25PV005 has failed to close.	Rosetti Instrumentation	Consequences: 2.2.3.2
16. Implement 25FV001 as a Type 6 as it is critical to the operation of the fuel cell that N2 is excluded from the storage system.	Rosetti Instrumentation	Consequences: 2.2.6.1, 2.3.2.1
17. Review the requirement for a separate header with an additional isolation on the N2 supply to the storage vessels to minimise the likelihood of N2 contamination of H2 storage vessels during purge cycle.	Rosetti Process	Consequences: 2.13.2.1, 3.2.2.1
18. Review where a N2 purge connection can be located close to Electrolyser discharge to enable N2 purging of H2 storage inlet system.	Rosetti Process	Consequences: 2.15.1.1
19. Review the requirement for a means to detect that the concentration of H2 within the H2 storage vessels is above the allowable level prior to breaking containment on the vessel.	Rosetti/Crosswind Project	Consequences: 2.15.2.1
20. Ensure that 80PSV001 is verified for blocked discharge downstream of 25PV025A/B during fuel cell operation. No consideration is made of advantageous control from 25PCV025A/B as per Shell rule set.	Rosetti Process	Consequences: 3.1.17.1, 3.1.18.1
21. Review the required response time (PST) of 80PI002/25SDV023 to ensure that they are able to react to prevent exceedance of hydrotest pressure of the downstream pipework and Fuel Cell if 25PCV025A/B are fully opened.	Rosetti/Crosswind (Interface)	Consequences: 3.1.18.1, 3.2.5.1
22. Review the required response time (PST) of 80PSV001 to ensure that it is able to react and depressurise the system quickly enough to prevent overpressure of the pipework and Fuel Cell if 25PCV025A/B are fully opened. Consider the opening times of storage vessels outlet XVs, e.g. 25XV006 and 25PV025A/B. If PSV reaction time criteria cannot be met LOPA for 25PI002 must be reviewed.	Rosetti/Crosswind (Interface)	Consequences: 1.2.4.1, 3.1.18.1, 3.2.5.1
23. Review the requirement for a low pressure alarm on 25PIC025A/B to indicate that the PCV no longer has control over the downstream pressure due to depletion (low pressure) of the H2 storage vessel and low low pressure trip on 80PI002 to shutdown the Fuel Cell Package.	Rosetti Process	Consequences: 3.6.1.1
24. Review with Fuel Cell suppliers what the consequence of 500ppm of O2 in the H2 stream will be on the Fuel Cell. Will this be only be an impact on performance or likely to create a hazard? If credible hazard consider LOPA for Elogen OIHA800A/B.	Rosetti/Crosswind Project	Consequences: 1.13.4.1
25. Perform a calculation to determine how long/number of fill cycles it would require for a flammable concentration to be formed within the H2 storage vessel based on 500ppm O2 to determine if a flammable concentration is credible in the H2 storage vessel.	Rosetti Process	Consequences: 1.13.4.1

Recommendation	Responsibility	Place(s) Used
26. Elogen to confirm to Rosetti the blocked in discharge pressure from the RO cells to the Brine Caisson Discharge system, i.e. the pressure in the line if the RO cell reject/discharge is blocked outside of the battery limit.	Crosswind	Consequences: 8.1.1.1
27. Determine the back pressure on the vent system for full wet production H2 sent to H2 vent. Determine the effects of high back pressure on other vent users, consider the effect on relief valve set points and Electrolyser Oxygen in Hydrogen analysers due to back pressure. Review impacts with interface units. See also recommendation 31	Crosswind	Consequences: 4.2.1.1
28. Review the requirement for a Lute within the Elogen Package H2 vent system as the package vent discharge is via a knockout pot V43001 within the Rosetti scope. If Elogen Lute not required consider removal of the Elogen package Lute.	Crosswind	Consequences: 4.20.1.1
29. Review the impact of back pressure in the H2 vent system on the Elogen product sample system. Consider that the Electrolyser may be in start-up and venting wet H2 and this is the critical time for sampling of the product stream. See also recommendation 29	Crosswind	Consequences: 4.2.3.1
30. Review the requirement for BLPH-MV-002 in the H2 vent system as this is a potential isolation point within a relief route. Also review the piping specification around the tie in point and identify it on P&ID to ensure compatibility.	Rosetti Process	Consequences: 4.1.1.1
31. Review the location of the spec break downstream of: 1. 25PSV001A/BLPH-MV-033 2. 80PSV001/BLPH-MV-005 As pipework between PSV and manual valve will see upstream pressure if closed and a relief occurs.	Rosetti Process	Consequences: 4.1.4.1, 4.1.10.1
32. Review the requirement for level transmitter and low level alarm to detect low level in H2 vent liquid seal Q43004.	Rosetti Instrumentation	Consequences: 2.6.1.1, 4.1.11.2, 4.1.12.2, 4.1.13.2, 4.3.2.1, 4.10.2.1
33. Review with Elogen/HPP suppliers the upper limit of O2 concentration that can be relieved/ vented to the vent system from the HPP. Determine if this concentration will result in a flammable mixture within the vent system. If this is the case consider if this vent may require segregation from the main vent system.	Crosswind	Consequences: 4.2.4.1
34. Review the requirement for BLPH-NRV-020/021 to be class 1 for N2 utility service considering that the life span of the installation is considered to be 2 years with no significant turnaround within that time.	Crosswind	Consequences: 4.3.1.1
35. Ensure sizing of the Needle Valve BLPH-MV-171 prevents excessive N2 use which may impact other users by selecting the CV of the valve and hence maximum flowrate.	Rosetti Process	Consequences: 4.2.6.1
36. Perform a dispersion calculation for release of H2 via the B50014 Caisson from a gas blow by from the V43001 KO drum. Consider the maximum pressure the KO drum may reach under all scenarios. If a hazard is created at the installation see action 39.	Rosetti Tech Safety	Consequences: 4.2.7.1
37. Review the requirement for an additional SDV in the KO drum water drain line activated by 43LI002 low low level to prevent gas blow-by to the Caisson. To be evaluated with LOPA if required. Note that the liquid level in KO drum V43001 may be lost due to evaporation over time and if a trip is fitted this may result in a spurious trip of 43LI002 low low level alarm. Review against recommendation 40.	Rosetti Instrumentation	Consequences: 4.2.7.1
38. Review how the liquid drain line from the KO drum V43001 can be safely routed for disposal considering that it may be subject to gas blow-by due to loss of liquid seal by evaporation. Review against recommendation 39.	Rosetti Process	Consequences: 4.10.1.1

Recommendation	Responsibility	Place(s) Used
39. Ensure that consideration of top up of the glycol seal in vent Q43004 is made in the design, and that there will be a 6 month period between maintenance interventions which will allow top up.	Rosetti Process	Consequences: 4.10.2.1
40. Ensure the design of the vent Q43004 exit minimises the potential for rain ingress which may dilute the seal liquid potentially resulting in blocked outlet for the H2 vent system due to freezing.	Rosetti Process	Consequences: 4.11.1.1
41. Ensure that the seal liquid top up procedure is considered as a safety critical procedure as failure to close BLPH-MV-419 top up valve will allow LOPC of H2 on to deck area with potential for an explosion within the vent stack.	Crosswind	Consequences: 4.3.3.1
42. Make air fail position of 43LV001 fail closed and type 6 (critical).	Rosetti Process	Consequences: 4.18.3.1
43. Update the control narrative to identify alternate seawater lift pump auto-start on 50-PI001/002 low pressure alarm or 50-XA001/003 trip/fault alarm.	Rosetti Instrumentation	Consequences: 5.1.2.1
44. As fuel cell runs down 25PIC025A/B opens 25PV025A/B. Ensure that when restart occurs 25PV025A/B are fully closed and review how the downstream pressure can be slowly increased to the point where 25PIC025A/B can be given automatic control.	Rosetti Instrumentation	Consequences: 1.2.4.1, 3.16.1.1
45. Review the requirement for 43LI002 High High activating ESD 1 as no scenarios were identified within the HAZOP which would activate the trip. Verify before removal that there is no requirement from project applicable standards and good practice (DEP) for this trip.	Rosetti Process	Consequences: 4.1.14.1, 4.1.15.1
46. As part of 3D / layout / HF reviews determine the requirements for lifting of relief valves into place during maintenance in terms of accessibility and use of temporary/permanent lifting equipment.	Rosetti/Crosswind Project	Consequences: 1.15.1.1
47. Review the design basis operational time for the PSC units against the design requirements of the Rosetti scope and align the requirements. PSC design basis is 8-12 hours continuous twice a week for 6 months vs Rosetti requirements including purging and black start scenarios.	Rosetti Process / Crosswind / PSC / Elogen	Consequences: 5.20.1.1
48. Review the effect of out of spec water fed to Elogen RO cells based on a temperature at the PSC RO cells of 40 degC with the chloride concentration based on this temperature. Identify in the Elogen HAZOP if it is credible that chloride is fed through to the electrolysis cells or if this is only an operational impact on RO cell performance (current assumption). If there is adverse impact on the cells, review if LOPA is required for this failure in the Rosetti HAZOP.	Rosetti Process / Crosswind / PSC / Elogen	Consequences: 5.1.27.1, 5.9.1.1
49. 50-LI020LL should trip P-50004A/B on LL level in T-50006 to prevent pump damage	PSC	Consequences: 5.1.18.2, 5.1.19.2, 5.1.20.2, 5.1.22.2, 5.2.10.1, 5.10.1.1, 5.10.2.1
50. Ensure that where multiple trains are implemented within the WTP package remote changeover between trains is available to onshore operators on request.	Rosetti / CRW	Consequences: 5.3.6.1
51. Add an NRV in the flushing water line between T-50008 and 50-XV023 / 50-XV024 to prevent reverse flow in the flushing line and potential contamination of T-50008 with filtered brine from T-50006.	PSC	Consequences: 5.3.7.1
52. Determine how overpressure of fresh water system can be prevented should P-50009A/B be isolated on the downstream side as deadhead pressure of these pumps is 7barg and the design pressure of downstream system is 6barg.	PSC	Consequences: 5.1.32.1, 5.1.34.1
53. Review with Elogen the consequences of loss of PH control within the water treatment package on the electrolysis. If consequences are significant for electrolyser package review if additional safeguards for PH protection are required within electrolyser package.	Crosswind	Consequences: 10.2.1.1
54. Ensure logic for control of P-50009A/B prevents simultaneous running A & B pumps.	Rosetti Process	Consequences: 5.2.1.1

Recommendation	Responsibility	Place(s) Used
55. Review with Elogen the consequences of oxygen contamination of the N2 supply to the electrolysis unit and determine if consequences need to be considered in a LOPA analysis of the A-64000 oxygen analyser.	Crosswind	Consequences: 7.13.1.1
56. Review with N2 package vendor the consequences of oxygen contamination of the N2 supply to the storage and vent systems and determine if consequences need to be considered in a LOPA analysis of the A-64000 oxygen analyser.	Rosetti Tech Safety	Consequences: 7.13.2.1

Table 10 - HAZOP Recommendations

ATTACHMENT 5 – WORKSHOP ATTENDANCE

Full Name	Company	Role	27/11/2023	28/11/2023	29/11/2023	30/11/2023	01/12/2023	17/06/2024	18/06/2024	19/06/2024
Dominik Sznajder	Crosswind	BLPH Project Manager	✓	✓	✓					
Esha Roy	Crosswind	Electrical & Integrator Lead			✓					
Hamant Patel	Crosswind	PSL Process	✓	✓	✓	✓	✓	✓	✓	✓
Jeroen van Loon	Crosswind	Comissioning Manager	✓	✓						
Jordi Alkemade	Crosswind									✓
Nicolas Le Brun	Crosswind	HSE Lead	✓	✓						
Omkar Sane	Crosswind	HSE Lead	✓	✓	✓					
Paul van Rossum	Crosswind							✓	✓	
Philip Robinson	Crosswind	I&C Leader	✓	✓	✓	✓	✓			
Stefan Otting	Crosswind	Technical Safety Leader	✓	✓	✓	✓	✓			
Stephen Bremmer	Crosswind	BLPH Package Lead	✓	✓	✓					
Thijs Philippo	Crosswind	Renewable Energy Eng.		✓	✓	✓	✓			
Tirso Leon	Crosswind	Operations Lead	✓	✓	✓	✓				
Augusto Acioly	Elogen	Project Manager			✓					
Leila Shamekhi	Elogen	Project Eng. Manager			✓					
Roberto Mussi	PSC	Project Manager						✓	✓×	
Walter Rigamonti	PSC	Process Engineer						✓	✓×	
Karia Trentini	PSC	Process Engineer						✓	✓×	
Harry Parker	Risktec	Scribe	✓	✓	✓	✓	✓			
Lucy Wordingham	Risktec	Scribe						✓	✓	✓
Steve Forster	Risktec	Facilitator	✓	✓	✓	✓	✓	✓	✓	✓
Alessandro Bucciero	Rosetti Marino	HSE Discipline Manager	✓	✓	✓	✓	✓			
Carolina Caracciolo	Rosetti Marino	HSE Leader	✓	✓		✓	✓	✓	✓	
Ciro Impradice	Rosetti Marino	Process Leader	✓	✓	✓	✓	✓	✓	✓	✓
Claudia Giunchi	Rosetti Marino	Project Engineer	✓	✓	✓	✓	✓	✓	✓	
Davide Lo Sterzo	Rosetti Marino	Project Engineer Manager	✓	✓	✓	✓	✓	✓	✓	
Hina Arshad	Rosetti Marino	HSE Engineer	✓	✓	✓	✓	✓	✓	✓	✓
Loredana Calabrese	Rosetti Marino	I&C Leader	✓	✓	✓	✓	✓	✓×	✓	✓

Table 11 - Workshop Attendance