INTERNAL USE ONLY

Notifiable incident

Incident ID	6374
Duty holder:	Shell Australia Pty Ltd
Facility/Activity:	Prelude FLNG
Facility type:	Floating liquefied natural gas facility

Incident details	
Division	Occupational Health and Safety
Notification type	Incident
Incident date	03/02/2020 12:00 PM (WST)
Notification date	07/02/2020 04:52 PM (WST)
NOPSEMA response date	07/02/2020 05:00 PM (WST)
Received by	[redacted]
Nearest state	WA
Initial category type *(based on notification)*	Dangerous Occurrence
Initial category *(based on notification)*	Damage to safety-critical equipment
3 Day report received	10/02/2020
Final report received	31/03/2020
All required data received	31/03/2020
Final category type *(based on final report)*	Dangerous Occurrence
Final category *(based on final report)*	Damage to safety-critical equipment
Brief description	OHSE - DSCE - Failure of Production train valves
Location	
Subtype/s	Valve failure
Summary *(at notification)*	Power Outage on the 3rd of February resulted in an ESD + EDP Post Shut Down and Depressurisation a critical valve status check was carried out Two valves did not close and remained 75% open One valve did not close in the time required in the PS Initial notification was overlooked due to continuing power issues and the fact that there was no production. Time of status check was nominally listed as 1200 hrs as exact time was not known 3 Day report to follow
Details *(from final report)*	Power Outage on the 3rd of February resulted in an ESD + EDP Post Shut Down and Depressurisation a critical valve status check was carried out Two valves did not close and remained 75% open One valve did not close in the time required in the PS Initial notification was overlooked due to continuing power issues and the fact that there was no production. Time of status check was nominally listed as 1200 hrs as exact time was not known 3 Day report to follow ** As Supplied by Duty Holder** Main power outage led to loss of instrument air. On loss of instrument air, Emergency Shut Down (ESD) and Emergency Depressurization (EDP) was initiated Post ESD / EDP assurance checks were completed on critical valves. This identified that 3 x critical

valves failed to meet performance standard. Valve details as follows:
100UZV-2496 on Condensate Stabiliser Train 1 - Valve failed to close – stuck at ~75% open
100UZV-2641 on Condensate Stabiliser Train 2 - Valve closed in ~59 seconds. Process Safety time is 60 seconds. Target closure time is 3 seconds for this valve size
130UZV-2054 on Regeneration Gas Heater Valve failed to close – Valve failed to close, stuck at ~75% open

Work or activity being undertaken at time of incident - Facility experienced main power outage and was preparing to re establish power to the facility. Production train was shut down at the time.

What are the internal investigation arrangements? Causal Reasoning Investigation.

Was there any loss of containment of any fluid (liquid or gas)? No

Immediate action taken/intended, if any, to prevent recurrence of incident - A Risk Assessment and Statement of Fitness will be issued prior to re-starting up operations. Responsible - OIM. Completion Date - 6 March 2020

What were the immediate causes of the incident? Currently under investigation.

** As Supplied by Duty Holder**

Has the investigation been completed? Yes

Root cause 1 System blow-down occurred several days after the cold-end trip.
Root cause 2 Heat ingress during period between trip and blow-down allowed cryogenic fluids to warm up
Root cause 3 Passing valves allowed fluid to migrate into Zone 5, section 1 (for Zone 5, section 1 only)

Full Report:
An investigation performed by Process engineering and technical safety shows that the extended depressurisation time for these segments are primarily due to the system heating up between the time of the cold end trip and the depressurisation event. These events were separated by approximately 39 hrs, during which time the contents of these cryogenic sections warmed up.

Following a shutdown, zone 4 section 1 would normally be mostly liquid-filled and zone 5 section 1 would be completely liquid-filled. From these conditions, depressurisation occurs quickly until vapour starts to form, after that point, depressurisation occurs more slowly.

When the EDP occurs immediately after shutdown from an operating state (this is the basis of the design), the system depressurises to target pressure within 15 minutes. However, if the EDP occurs after an extended duration from shut down, the system depressurises to the target pressure slower than the design.

With cold initial starting conditions, LNG vapourises at a pressure below the target pressure of 6.9 barg (point A on chart below) and so the relief is relatively fast due to orifice being designed for relief from a liquid LNG source.

When the system is shut-down, isolated and allowed to remain at pressure for an extended duration, the fluid in the system warms up by the heat ingress from ambient. Upon depressurisation from these conditions, when fluid is initially warmer, the pressure in the segment quickly drops to the point at which vapour is evolved (point B on the chart below), however this occurs at a higher system pressure than without warm up (point A on chart below), resulting a longer time to reach the target pressure of 6.9 barg since more of the depressurisation is relief from a partially vapourised source (slower) rather than liquid relief.

- See chart in report -

It was also found that the two blowdown sections were communicating via passing UZVs 140-UZV2113/2114). This had a secondary impact on Zone 5, section 1. A small leakage of liquid from the upstream segment, when combined with the warmer temperatures (flashing to vapour at a higher pressure during depressurisation) meant that this also had an impact on the time for Zone 5 section 1 to depressurise.

Zone 4, section 1 contains MCHE (E-14015), which is considered to be
criticality 2, along with its associated shutdown-valve and supporting structure, because of its size and

	the hydrocarbon content. As per the management of escalation risk, PFP (JF-30) has been applied on the equipment and the supports. This measure was deemed sufficient to manage escalation risk (see section 8.3.17 Prelude FLNG safety case). For Zone 5, section 1, a detailed heat-up calculation was conducted. If no depressurisation occurs, the time to rupture for this line under fire exposure is 12 mins, with the section starting from the worst-case pressure (TRV setpoint). As the line fail fails > 5mins, the failure has been considered to be 'tolerable' rupture as per the Prelude Acceptance criteria (see section 8.3.17 Prelude FLNG safety case). No further measures are required to manage the risk of escalation. Summary: This means rupture without blowdown is 'tolerable', as per rupture conditions referred to in Prelude Safety Case (section 8.3.17). However, it is proposed that operational alerts and relevant procedures be used to limit warm up of these sections. Other EDP sections have been analysed and the phenomena of delayed blowdown causing depressurisation to take longer than 15 minutes is only applicable to these two sections. Actions to prevent recurrence of same or similar incident: Determine means to warn operations, e.g. alarm on timer not to allow heat up beyond -130degC as measured on 14-TT1046. Note: This could be translated to approximately 22 hrs based on empirical evidence from the February event. Responsible - Process Engineering. Completion Date - 15 May 2020 (Intended)
Immediate cause/s	TBC
Root cause/s	
Root cause description	Root cause 1 System blow-down occurred several days after the cold-end trip. Root cause 2 Heat ingress during period between trip and blow-down allowed cryogenic fluids to warm up Root cause 3 Passing valves allowed fluid to migrate into Zone 5, section 1 (for Zone 5, section 1 only)

Duty inspector recommendation	
Date	07/02/2020
Duty inspector	[redacted]
Recommendation	Do not conduct Major Investigation
Reasoning	Does not meet MI threshold based on information received
Supporting considerations	

Major investigation decision	
Date	07/02/2020
Decision	Do not conduct Major Investigation
Reasoning	Does not meet MI threshold based on information received
Supporting considerations	

Non-major investigation review and recommendation	
Date	10/02/2020
Inspector	[redacted]
Risk gap	None
Type of standard	Established
Initial strategy	Inclusion in annual stats/data analysis

Recommended follow up strategy	
Recommended strategy	Investigate
Supporting considerations	There are approximately 750 shutdown valves on the Prelude facility and a failure rate of 3/742 = 0.004 (0.4%) is likely to be within expected failure rates. Due to the probability of failure of SDVs, most ESD events are likely to result in some failure of SDVs and this does not necessarily indicate a risk gap. There may be some merit in setting an appropriate threshold in the performance standard, that will provide better guidance for when NOPSEMA should be notified (rather than all failures), that is indicative of failures outside the assumptions of the SIL assessment (i.e. IEC 61511). Therefore I would like to investigate this occurrence to have that discussion with Shell.

Non-major investigation decision	
Date	10/02/2020
RoN	[redacted]
RoN review result	Agree with recommendation
Strategy decision	Investigate
Supporting considerations	

Associated inspection	
Inspection ID	2129