Notifiable incident

Incident ID	6360
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	02/02/2020 08:00 AM (WST)
Notification date	03/02/2020 10:34 AM (WST)
NOPSEMA response date	03/02/2020 10:45 AM (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	07/02/2020
Final report received	17/03/2020
All required data received	17/03/2020
Final category type *(based on final report)*	Dangerous Occurrence
Final category *(based on final report)*	Damage to safety-critical equipment
Brief description	OHSE - DSCE - Loss of Containment on HP stem System
Location	
Subtype/s	Facility integrity, Stored energy
Summary *(at notification)*	At 0800 on the 2nd February a leak was discovered in the HP steam system. The area was quarantined and after further investigation it was decided to shut down the HP steam boiler and depressurised the steam system. The system will remain shut down until inspection is completed and a Statement of Fitness can be issued.
Details *(from final report)*	At 0800 on the 2nd February a leak was discovered in the HP steam system. The area was quarantined and after further investigation it was decided to shut down the HP steam boiler and depressurised the steam system. The system will remain shut down until inspection is completed and a Statement of Fitness can be issued. ** As Supplied by Duty Holder** During line walks inside STG room located on 6th deck within machinery space, steam leak on High Pressure Steam (HPS) was identified Work or activity being undertaken at time of incident - Routine Operations What are the internal investigation arrangements? 5 Why Causal Reasoning Investigation Estimated quantity: Hole Area A - 1.26E-05m2 Mass Flow Rate - 0.0883 kg/s Quantity Released - 5678.12 kg = 5680.0kg LOPC mass released

Estimation details - Please specify: 52-inch line, crack of 25mm in length, within the heat effected zone and physically within the system. Pressure 69/70 bar with temp of approx. 450-degree C.

Composition Percentage and description - High Pressure Steam

Known toxicity to people and environment - None

How was the leak/spill detected? Visual

Did ignition occur? No

Has the release been stopped and/or contained? Yes

Duration of the release - 17 hours

What or where is the location of the release? Substructure – Steam Turbine Room

What equipment was involved in the release? STG30 HPS supply (deck 6 substructure). Leak is thought to have come from welded T at a 2 " nozzle.

Is this functional location listed as safety-critical equipment? Yes

Action taken to make the work-site safe - Plans were developed and approved to bring STG20 into service and to take STG30 out of service.
Isolation of STG30 would have required the closing of a main isolation valve on the supply line to STG30. The isolation valve is adjacent the leak location and is accessed via a vertical ladder.
Local restrictions and a monitoring program was in place to assure there was no deterioration of the leak.
At 2000hrs on Sunday 2nd it was assessed that leak rate had increased to a point where the increased leak rate would preclude access to the isolation valve whilst still live. Accordingly, a decision was been made to bring down the HPS to allow safe isolation of leak.

Details of any disturbance of the work site - Nil

How effective was the emergency response? Effective Response and full muster achieved.

Was anyone killed or injured? No

Equipment damaged - STG30 High Pressure Steam supply
Extent of damage - Crack of 25mm in length
Will the equipment be shut down? Yes
Will the facility be shut down? No (however Steam System Shut down)

Immediate action taken/intended, if any, to prevent recurrence of incident:

Action - STG shutdown. Includes shutdown on MR and PMR compressors. Responsible - Production Coordinator. Completion Date - Completed
Action - Boilers Shut down (led to Facility trip – see separate NOPSEMA reporting). Responsible - Production Coordinator. Completion Date - Completed

What were the immediate causes of the incident? Cause of the crack in HPS steam line is under investigation.

** As Supplied by Duty Holder**

Has the investigation been completed? Yes

Root cause 1: Stress Relaxation Cracking (SRC) during one of the Post Weld Heat Treatment (PWHT) cycles to which this section of piping was exposed.

Full report:
Investigator – Shell Principal Materials and Corrosion Engineer
Investigation methodology – Failure investigation on the retrieved sample, using Fractographic examination, microstructural analysis

The weld was done to the required standard. However, during second Post Weld Heat Treatment

	(PWHT) targeted at the field weld, the thermal effect of the adjacent DN 50 to weldolet weld was sufficient to allow some stress relaxation to occur which given the high degree of constraint to which the pipe section was subjected resulted in a crack forming. This joint will not have been re inspected by NDE (RT) after the second thermal cycle. The crack formed in the most susceptible location of the weld. The crack present as a planer non-volumetric defect was at approximate 90% through wall, this remained static until such time shortly (hours or days) before the leak was observed, at this time the final remaining ligament ruptured due to plastic overload result in a HP steam leak. The leaking steam further cut (steam cutting) the remaining ligament result in rapid escalation of the leakage rate. The piping materials fully meet the requirements of the specification. Actions to prevent recurrence of same or similar incident: Action - Repair damaged location. Responsible - Mechanical Materials and Integrity Lead. Completion Date - Completed Action - Test similar weld locations. Responsible - Mechanical Materials and Integrity Lead. Completion Date - Completed
Immediate cause/s	TBC
Root cause/s	
Root cause description	Root cause 1: Stress Relaxation Cracking (SRC) during one of the Post Weld Heat Treatment (PWHT) cycles to which this section of piping was exposed

Duty inspector recommendation	
Date	03/02/2020
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	03/02/2020
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	Substantial
Type of standard	Established
Initial strategy	IInvestigate within 45 days

Recommended follow up strategy	
Recommended strategy	Investigate ASAP
Supporting considerations	High pressure steam on the Prelude Facility is 475°C at 69 bara. A leak of this steam would result in a large superheated steam cloud that could lead to major disabling injury or death for any personnel in the area. Design, construction and maintenance of high pressure steam facilities SHOULD ensure catastrophic failure leading to LOC of high pressure steam facilities should not occur. Investigate ASAP to ensure there is no ongoing threat to personnel due to common modes of failure etc which could result in a reoccurrence of this incident. There has been a cascading series of General Alarms and Musters as a result of this event, and problems associated with the Emergency Diesel Generators (Notification 6361), therefore recommend to elevate to Investigate to ASAP.

Non-major investigation decision	
Date	04/02/2020
RoN	[redacted]
RoN review result	Agree with recommendation
Strategy decision	Investigate ASAP
Supporting considerations	

Associated inspection	
Inspection ID	2156