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Title:Major Investigation Report Angel Loss Of Containment Piping Failure On Coalescer B Vent Line Welev13060135

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**Major Investigation Report: Angel Loss of Containment :
Piping Failure on Coalescer B Vent Line -
WELEV13060135
Asset/Site: Angel Facility
Date of Occurrence : 20th June 2013**



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Controlled Ref No: T0000RG8957282

Revision: 0

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Page 1 of 31

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Key TAG No's:	XV11420; PSV11416

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14			

TABLE OF CONTENTS

1.	EXECUTIVE SUMMARY	4
1.1	Root Causes and Actions	4
1.2	Event Consequences – Actual and Potential	5
1.3	Details of Health & Safety Impact	5
1.4	Details of Environmental Impact	5
1.5	Details of Damage and Losses	5
1.6	Details of Reputation & Brand Impact	5
1.7	Details of Legal / Compliance Impact	5
1.8	Details of Social & Cultural Impact	6
1.9	Sequence of Events	6
1.10	Description of the Event	6
2.	SEQUENCE OF EVENTS	9
3.	RESULTS OF THE INVESTIGATION	10
3.1	Facility Actions Taken During & Post Event	10
3.2	Noise Source	11
3.3	PSV Piping System Design	11
3.4	PSV Type Selection	12
3.5	HAZOP	12
3.6	Gas Detection	12
3.7	PSV Recertification & Test Results	12
3.8	On/Off Ball Valve Exhaust Flow Regulators	13
3.9	XV11420 Design, Failure Cause and Test Results	13
3.10	XV11420 Command Disagree Alarm	15
3.11	Piping Failure and Test Results	15
3.12	Review of Similar Angel Pipe Support Issues Failures	16
3.13	Results of Analysis: Causal Factors	16
4.	OBSERVATIONS AND ADDITIONAL ACTIONS	17
5.	LESSONS LEARNED	19
6.	REFERENCES	20
	APPENDIX A – TERMS OF REFERENCE	21
	APPENDIX B – SUPPORTING EVIDENCE	23
	APPENDIX C – EVENT LESSONS BULLETIN	31

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 3 of 31

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1. EXECUTIVE SUMMARY

In line with Woodside Health and Safety and Environmental Policies, this investigation was conducted on the basis that all incidents are preventable. The purpose of the investigation was to fully understand the causes of the incident so that we can improve the risk management systems currently in place to assist preventing all incidents.

Incident Reference: WELEV13060135

Location, Date and Time: Angel Facility, 20th June 2013, 01.12 hrs

Angel platform had been restarted after a planned Emergency Shut Down (ESD) and was producing approximately 2 kT/day. During the restart of the condensate de-watering system valve XV11420 was opened via Central Control Room (CCR) to vent the gas cap on B Condensate Coalescer. Shortly after the opening, area operator heard a loud noise that resembled a Pressure Safety Valve (PSV) lifting. Operator believed the source of the sound was coming from the glycol package. After further investigation it was discovered to be from above the B Coalescer system.

The area operator instructed the NRA CCR to swap over Coalescers, which was done and resulted in the noise stopping. The area operator confirmed the status of the condensate system from the Angel CCR panel and then proceeded to visually inspect the package. Once in the area, the operator observed a mist and heard associated noise, which he believed to be a process leak. The instrument electrical technician with him verified the leak to be high pressure gas. The area operator immediately instructed the NRA CCR to ESD the platform. The Person in Charge (PIC) was informed and, once the facility had been de-pressured, the area was inspected for any escalation potential and to be assured that the facility was safe.

Total loss of containment has been pre calculated at approximately 62 kilograms of hydrocarbon [Ref 5]. No personnel were injured during this event.

1.1 Root Causes and Actions

The following table provides a high level summary of the necessary actions.

ROOT CAUSE	SUMMARY OF CORRECTIVE ACTION
Problem Not Anticipated	If not possible to remove Exhaust Flow Regulators and replace with small restriction devices, then conduct review with Biffi manufacturer to consider most appropriate way of supporting Exhaust Flow Regulators. Implement appropriate supports to the exhaust flow regulators on all on/off valves (~40 of) on the Angel facility.
	Considering scenario that developed for the relief valve lifting, review whether the correct type of PSV has been selected with PSV vendor Anderson Greenwood and Mechanical TA. Make appropriate changes if/as required.
	There are three locations on Angel facility in which this identical scenario can be repeated (PSV11230; PSV11316; PSV11416).
	IMMEDIATE ACTION :It is required that valves XV11239, 11320 and 11420 are isolated on the panel only under the "redtag" requirement under a long term permit and opened only when facility is manned and operator in attendance or under risk assessment.

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 4 of 31

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3 Day NOPSEMA Event Notification issued and thus event is reportable to regulator.

1.8 Details of Social & Cultural Impact

Not Applicable.

1.9 Sequence of Events

The evidence found during the investigation points to the following sequence of events that have led to loss of containment on the inlet piping to PSV11416 off Coalescer V1103B:

- XV11420 stuck open at 10% for 10 days prior to ESD causing initial vibration fatigue and partial failure of exhaust flow regulator (as can be depicted by the clearly 2 signs of fracture on nipple in Figure 4.3).
- XV11420 called to operate under normal conditions during Coalescer B startup.
- XV11420 exhaust flow regulator fails catastrophically allowing valve to fail to the close position rapidly (faster than design).
- Pressure spike in piping (liquid hammer) causes PSV11416 to lift. This is supported by the associated noise heard from outside operator at the time.
- PSV11416 fails to reseal and continues to relieve, chattering, potentially due to insufficient outlet line losses. This is supported by the ongoing noise heard in the system.
- Continuing chattering conditions for extended period, pipe eventually fails.
- Coalescer B isolated by CRO, pressure upstream of PSV subsides, PSV reseals (ie noise abates).
- Outside area walk identifies white mist, facility ESD.

1.10 Description of the Event

At approximately 0220 hrs on the 20th June 2013, during restart of Angel platform from a planned shutdown, a gas release was observed by the Area Authority on shift. The platform was immediately shut down and de-pressured. This event resulted in Angel platform being shut down for an additional 42hrs while an investigation and controls were put in place. This event has been classed as a C (actual) due to the approximate loss of containment value being calculated at 62 Kg [Ref 5]. No personnel were injured during this event.

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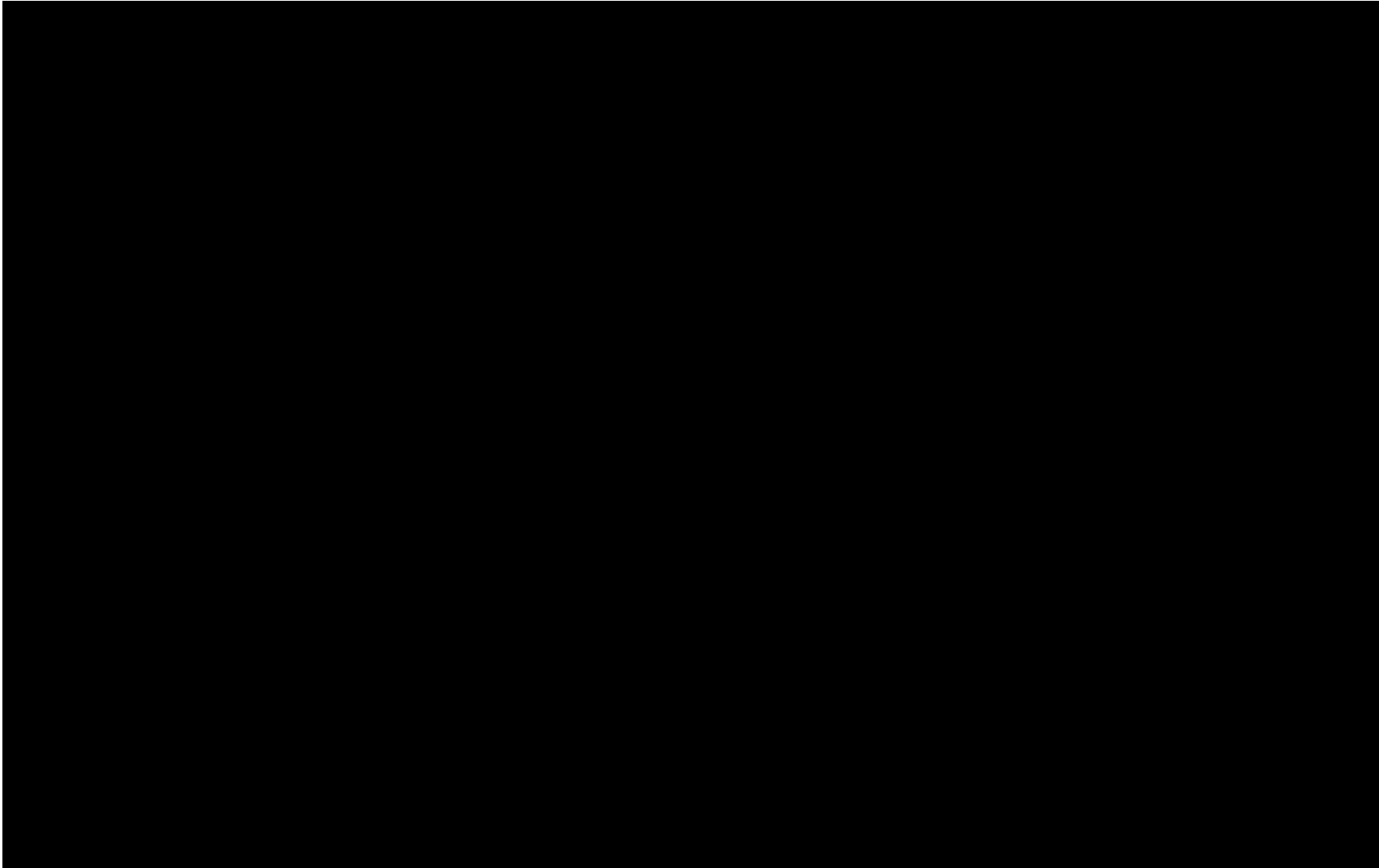
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Page 6 of 31

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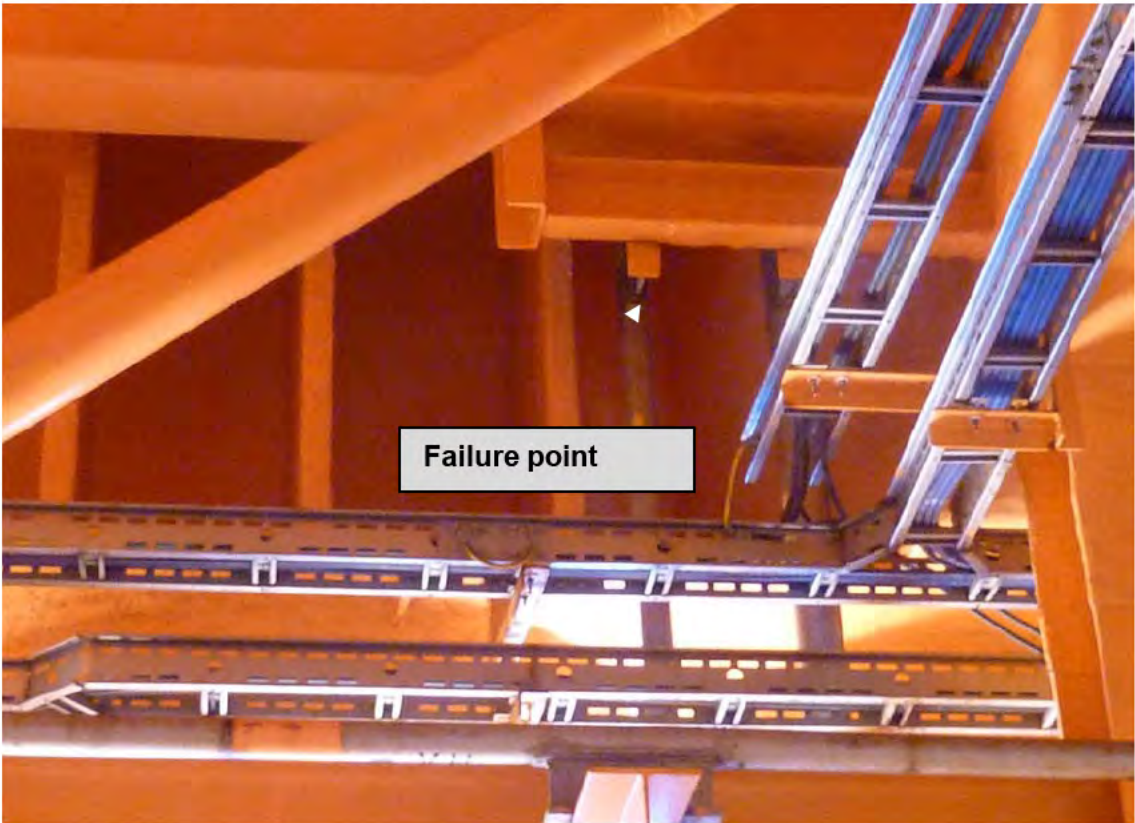
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Figure 1.2 – Images of Pipe Failure



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Page 8 of 31

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2. SEQUENCE OF EVENTS

Time	Date	Pre Event
12:10	07/06	XV11420 Stroked to assist with lighting of flare. On closure failed to reseal.
18:00	19/06	N2 leak test on A coalescer at approximately 13.4 MPag. <i>Preparation to equalise and commence restart procedure.</i>
23:40	19/06	Top sides pressured up to 12.1 MPag
00:01	20/06	Gas export commenced
00:40	20/06	B condensate coalescer pressured up to 12.1 MPag
Time	Date	Event
01:12	20/06	Manual opening of XV 11420 to blow of gas cap on Condensate Filter Coalescer B
01:13	20/06	Manual close of XV11420
01:15	20/06	Loud Noise/Vibration noticed by operator-location west cellar deck, floor to ceiling area. <i>Suspected glycol pumps, units swapped.</i>
01:16	20/06	Instrument Electrical technician investigated main deck. <i>Noticed pipe frosting/loud noise/heavy vibration on the flare line from Condensate Coalescer B XV11420.</i>
	20/06	Communicated with NRA CCR- that the coalescer start up was a probable cause. <i>Angel Operator suggested cause started around topside start up procedure on Condensate Coalescer and change over to A Coalescer should take place.</i>
		NRA CCR informed of level control issue on the HP Knock out drum. <i>Angel Area Authority went to investigate. Vibration and noise still ongoing.</i>
		Angel Operator witnessed LC50404 not functioning-stroke checked and confirmed ok. <i>Vibration and noise still ongoing.</i>
01:56	20/06	NRA CCR changed over from B Condensate Coalescer to A. <i>Vibration/noise issue stopped</i>
02:02	20/06	A & B Coalescer units were online B was being taken offline
02:04	20/06	A Coalescer was online at 12.1 MPag
02:04	20/06	B Coalescer was offline at 10.9 MPag. <i>Inlet/outlet valve closed pressure dropping unexpectedly.</i>
02:19	20/06	B Coalescer was offline at 9.9 MPag
02:19	20/06	Angel Operator did outside inspection noticed a gas cloud/mist
02:20	20/06	CCR contacted –ESD initiated
02:25	20/06	Angel PIC informed
Time	Date	Post Event
02:30	20/06	Area operator, Inlec & PIC checked process area. <i>No escalation potentials all safe.</i>
06:30	20/06	N2 leak test commenced on A coalescer. <i>Recently worked on considered the likely source of the leak.</i>
13:00	20/06	N2 leak testing commenced into B coalescer using remaining N2 in quads.
15:30	20/06	Leak identified on 50mm
06:30	21/06	B coalescer Isolated for spading. <i>Blinds and spade due on 07:00 helicopter.</i>
09:00	21/06	Rope access technicians arrived onboard to conduct inspection of failed line and A coalescer line for signs of damage.
11:30	21/06	Rope access technicians report split in spool. <i>Support bracket heel weld into primary pipe approximately 65mm long 2 mm wide.</i>
14:00	21/06	Mechanical fitter completed installation of spades and blinds.
14:15	21/06	Rope access technicians inspection of the A coalescer line complete. <i>No signs of stress or fatigue fit for service.</i>
14:30	21/06	NRA CCR informed it was safe to restart Angel platform. <i>Start up procedures commenced.</i>
19:10	21/06	Gas export recommenced from Angel platform.

CF1

CF2

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Page 9 of 31

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3. RESULTS OF THE INVESTIGATION

The Terms of Reference (Appendix A) for the investigation was issued on 20th June 2013 and the incident investigation team kicked off proceedings on Monday 24th June 2013. It was decided based in information at hand that site investigation would not be warranted.

The team consisted of the members as outlined in Table 1 below.

Table 4.1: Investigation Team

Name	Current Position	Investigation Training/Qualifications/Experience	Position on Team
[REDACTED]	[REDACTED]	Led 2 previous investigations/Process Engineer/16 years experience; Involved in Angel design, construction, commissioning and operation	Lead
[REDACTED]	[REDACTED]	Taproot trained/Mechanical Engineer/6 years experience. Involved in 1 previous investigation	Team Member

Note – [REDACTED] assisted with obtaining DCS information as requested.

Table 4.2: Interviewed Personnel

Name	Current Position	Experience
[REDACTED]	[REDACTED]	NRAOS
[REDACTED]	[REDACTED]	Angel Lead Inlec Technician
[REDACTED]	[REDACTED]	Angel construction, commissioning and startup experience
[REDACTED]	[REDACTED]	Involved in Angel instrumentation design and commissioning / Instrument TA
[REDACTED]	[REDACTED]	Process Engineering Advice
[REDACTED]	[REDACTED]	Angel OIM / Angel Campaign Coordinator
[REDACTED]	[REDACTED]	Inspection Specialist
[REDACTED]	[REDACTED]	Instrument TA
[REDACTED]	[REDACTED]	Piping TA
[REDACTED]	[REDACTED]	Process Engineer TA

3.1 Facility Actions Taken During & Post Event

Facility was restarted on Wednesday 23.40 in the evening post the planned ESD with oncoming new personnel arriving that day. An experienced operator and inlec technician were assigned nightshift duty to assist in the restart as soon as leak test on Coalescer A was finished (ie light flare etc).

Angel is a NNM facility and normal operations when manned are for daytime hours only.

During the restart there was issues that required troubleshooting that took the focus of the team away from the abnormal noise source. It was the extended duration of PSV chatter that would have resulted in the eventual pipe failure.

On indication of loss of containment the outside operator called to radio in to the CCR to ESD the facility rather than try to isolate the leak as has been the case within company and external. In this case the appropriate MAE safety critical element barriers worked, no ignition source, adequate blowdown time to remove inventory, and thus no escalation.

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Page 10 of 31

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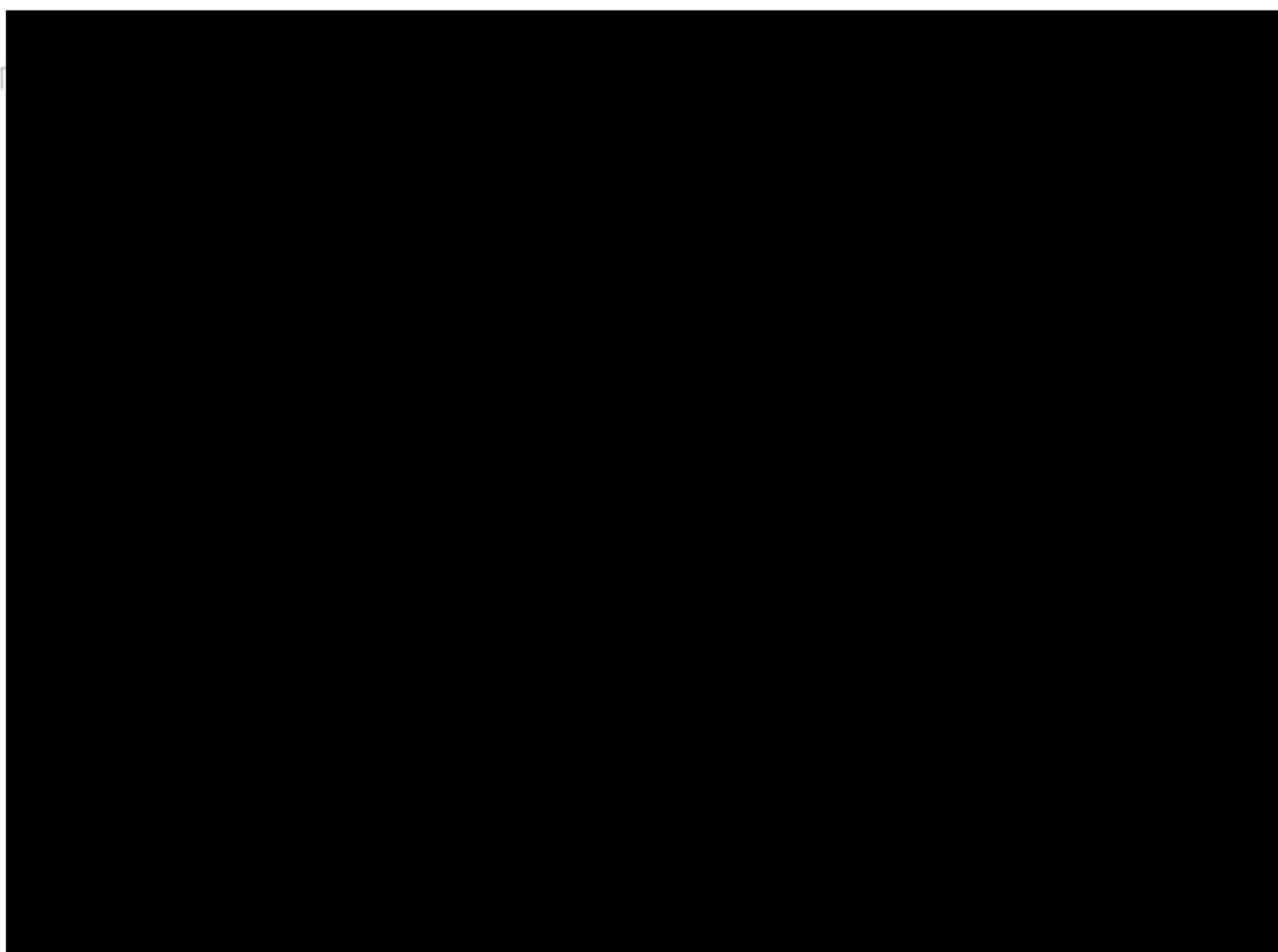
However it is important to note that this event is not attributable to a restart and could have occurred at any point in time when the XV11420 was called to open, such as when unmanned, in which case the noise and chatter would not have been heard. In this case fire and gas detection would have resulted final shutdown, but with potentially significantly more loss.

This event re-emphasises the importance of the facility walk around on mobilisation and the ability of NNM facilities to undertake nightshift operations.

Post event actions appear robust to ensure facility safe for restart.

3.2 Noise Source

PSV set point is 14.2 MPag. System pressure was not recorded to exceed 12.2 MPag. However to lift a PSV at a single point a pressure spike would be expected to occur. Plant historian data is not fast enough to pick up any spikes of pressure (max 60 second data records). Due to the observations made by outside operations team on the exact location of pipe external condensation and ice frosting, the noise was clearly emanating from the PSV.



On interview with operations team the ongoing noise was akin to hydraulic water hammer and not a high pitched squeal.
Both noises resonate with the lifting of a liquid spring operated PSV and associated chatter.

3.3 PSV Piping System Design

The type of valve installed is a conventional spring pressure safety valve.

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Revision: 0

Native file DRIMS No: 8957282

Page 11 of 31

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Chatter of this type of PSV can be caused by the following reasons:

- (1) Built up backpressure too high. <10% of set pressure.
- (2) Inlet pressure drop too high. <3% of set pressure.
- (3) Valve capacity is too large. The rule of thumb is required flow / rated capacity should be greater than 25% for vapour and 10% for liquid.

On investigation into the process calculation [Ref 4] for outlet line losses discovered that built up backpressure allowable is exceeded. However for the case where the PSV is called upon, jet fire, the PSV would only be asked to relieve for a short time, and a conscious design decision was taken to limit line sizes, as chatter for a small period could and can be tolerated.

The scenario encountered however was a result of the PSV failing to reseal after a pressure spike and the system being continually fed from a pressure source other than a short lived jet fire release of pressure to avoid BLEVE and escalation.

It is interesting to note under remote operations that the chattering of the relief valve would have continued until appropriate confirmed gas detection but this is balanced through less people being exposed to risk.

3.4 PSV Type Selection



3.5 HAZOP

It would not be expected for this scenario leading to loss of containment to be identified during the HAZOP, however for investigation completeness the HAZOP reports were reviewed.

The scenario as described under section 1.9, hydraulic pressure spike causing PSV to lift, was not described within any FEED or detailed design HAZOP reports for Angel. A recent 5 yearly review health check HAZOP of Angel also did not consider scenario.

3.6 Gas Detection

Facilities do not have 100% gas detection coverage. Fire and gas mapping occurs for areas of key risk [Ref 1, 2]. The source of the piping loss of containment was high in the piping rack system under a plated deck. It would not be expected that this source would be picked up by gas detection until heavy mist descended into gas detection on intermediate deck, or cellar deck.



3.7 PSV Recertification & Test Results

Site investigation indicates PSV was last recertified on September 2007 [Ref 8], prior to RFSU and introduction of hydrocarbons. SAP indicates PSV was last recertified on July 2008. As with fire case PSV's and due to good experience with the type of PSV in existing WEL assets, PSV recertification time was set to 6 years [Ref 6]. According to SAP Maintenance Plan, PSV is/was due for recertification in December 2013. Regardless PSV is within 6 yearly recertification timeframe.

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Revision: 0

Native file DRIMS No: 8957282

Page 12 of 31

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PSV11416 was sent to the KGP PSV test lab for analysis of lift pressure, reseal pressure, and analysis of any failed components.

The following key results of the test on PSV11416 carried out under W/O 2100133561 are:

HOLD 1

3.8 On/Off Ball Valve Exhaust Flow Regulators

All on/off ball valves on Angel have incorporated an exhaust flow regulator to ensure that with changing upstream source of instrument air pressure that the closure and or opening times performance standard is repeatable.

In 2012 all exhaust flow regulators were changed out on the BDV and SDV's under a planned maintenance requirement. None of the facility XV valves were touched in this campaign and have been unaltered since 2008.

The exhaust flow regulator for the XV11420 weighs ~5 kg (est.) and is supported by close coupled nipple to actuator body and associated instrument tubing. It is the opinion of investigation team and numerous interviewees that this is inadequate for fatigue vibration. However this XV11420 nipple has been the only recorded failure to date on the facility.

Figure 4.2 – Image of Exhaust Flow Regulator Supported on XV11420



Exhaust Flow
Regulator (~6
kg).

3.9 XV11420 Design, Failure Cause and Test Results

The function of XV11420 is to assist in bleeding off the gas cap of the coalescer to ensure it is liquid filled, maximising the flow area of the coalescers for maximum efficiency to assist in meeting the water in condensate specification. XV11420 has no requirement to meet and performance standard as the valve performs no safety function. XV11420 can be opened or closed any time during operation and the resultant impact is hydrocarbon loss to flare.

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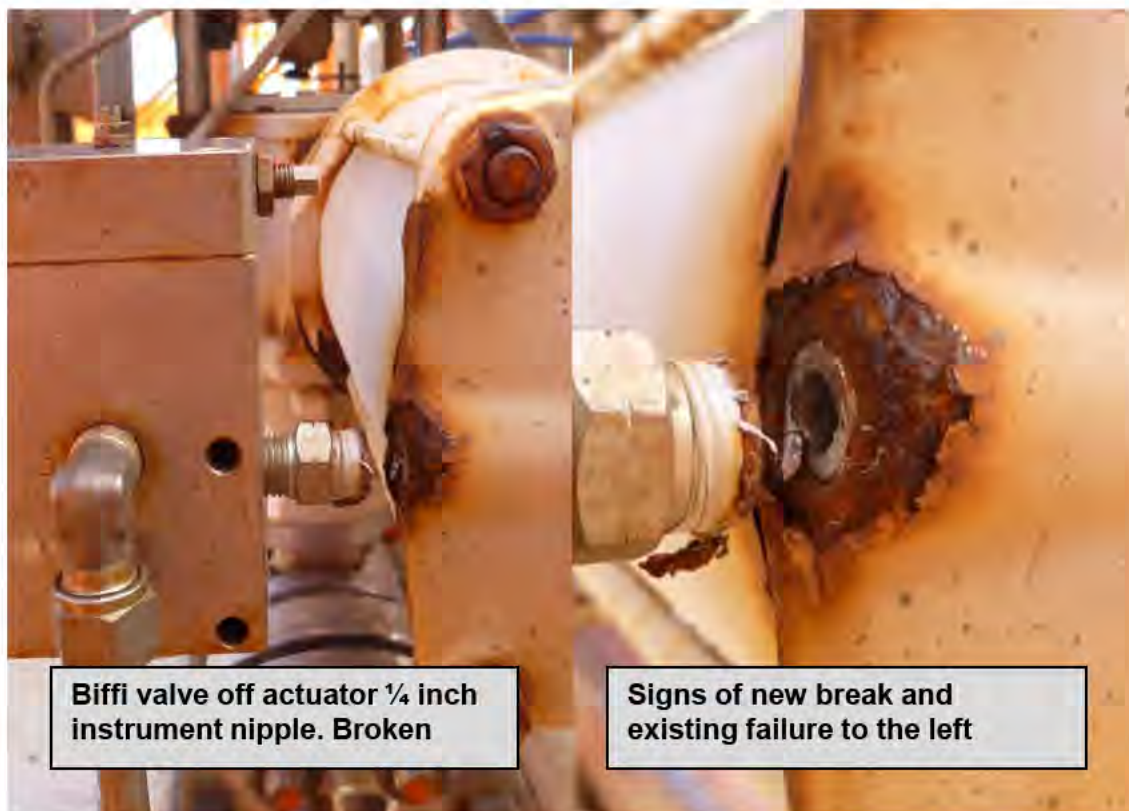
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XV11420 was identified through PHD trends on 7th June to be stuck in a 10% position for approximately 10 days. It was used to provide the flare some gas to ensure it was alight. Potential loss of flare was captured under WELEV13060040 at the time on 7th June. PHD indicates valve was again cycled assumed to see if it could return to 0%. It is believed that this is where the source of vibration has started that has led to fatigue cracking. There is clear evidence (as from image in figure 4.3) of 2 modes of failure on the nipple on the exhaust flow regulator of XV11420.

The first is fatigue cracking ("beachwaves" or "tidemarks") believed to be due to vibration of the valve over time, indicated by the numerous waves of cracking and dull appearance of the nipple.

The second is a catastrophic shear as can be seen by the bright shiny appearance on the nipple.

Figure 4.3 – Exhaust Flow Regulator Nipple Failure Images



On startup of the process train XV11420 was commanded to open and close 2 times. On the second closure it is assumed that exhaust air force catastrophically failed the nipple allowing the XV11420 to fail close in a much faster time than the normal 3 seconds. This would have resulted in a pressure spike in the piping and assume the cause of lifting of PSV11416.

Figure 4.4 – PHD Trend on XV11420 Openings

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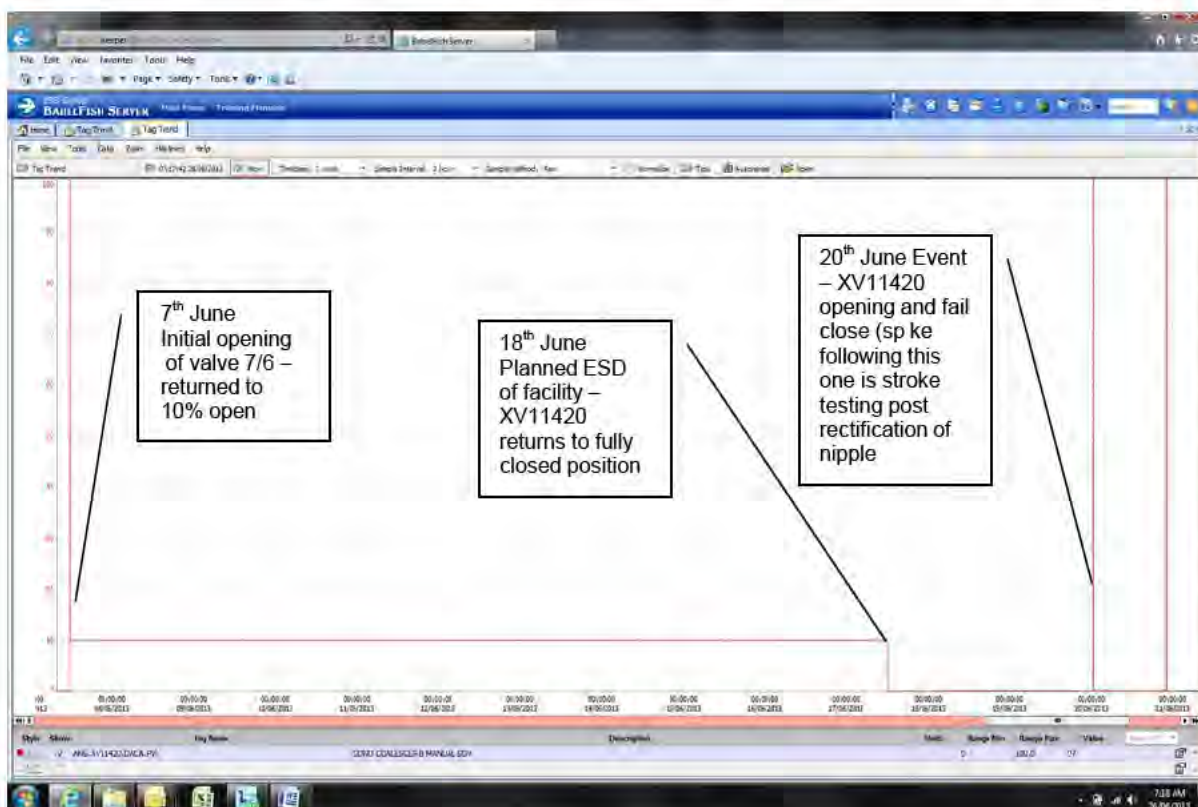
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XV 11420 was sent to [REDACTED] and to see if there is any indication of why valve was stuck at 10% open. The following key results of the test on XV11420 carried out under W/O 2100133561 are:

HOLD 2

3.10 XV11420 Command Disagree Alarm

XV11420 was opened to provide more gas to assist in ensuring flare was alight. As a result of the valve not making position when closing, an alarm was annunciate on the panel. Angel was manned at the time. NRA CCR recalls asking Angel field operator to check status of valve. Alarm should have been a standing alarm unless shelved from 7th June to 18th June.

There is no record of alarm being shelved from investigation, but appears not to be part of standing alarm count for duration while XV11420 was open.

Event logs were tried to be retrieved but there are gaps during this time believed to be due to the very high event rate from NRB commissioning.

3.11 Piping Failure and Test Results

As indicated in section 4.3 the pipe failed due to chatter of PSV causing excessive vibration for extended period of time.

It is the belief of the investigation team that no piping system should be expected to survive PSV chatter for extended periods. PSV chatter creates enormous energy waves and vibrations that eventually finds weak points in the system, be it in the PSV spring, flange, or in this case piping.

Angel pipe supports the pipe has been removed from site and sent for further inspection. The following key results of the test on XV11420 carried out under W/O 2100133561 are:

HOLD 3

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 15 of 31

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RAFT - FOR APPROVAL - T&E&R/0(1)/ Rev 6

3.12 Review of Similar Angel Pipe Support Issues Failures

Angel has had a history of pipe support welding issues:

- 1.) 2007 - Poor welding practices employed on thin walled DSS pipe supports at the Angel Topsides construction site led to burn-through, excessive oxidation of the pipe wall and cracks in pipe support fillet welds. An investigation into whether other piping systems could have been affected by these same problems was also conducted and concluded the problems were confined to the thin walled DSS system in question [Ref 3].
- 2.) 2011 – Angel Glycol LoC - In short, the crack was caused by poor welding. An incorrect welding procedure resulted in rapid cooling of the initial weld, which produced a highly undesirable microstructure and resulted in a number of shrinkage cracks. Internal visual examination of the sectioned pipe also showed that the initial weld between the trunnion support and vapour line had burnt through the wall in a number of locations. Burn though caused the weld root to oxidise (no backing gas present), which is also believed to have contributed to the undesirable (brittle) microstructure. Cross-sectioning of the burn-through locations, shows that the initial weld was aborted part-way through fabrication and the trunnion support cut-off and re-welded onto the pipe, with the new weld being deposited over the top of the original weld [Ref 7].

Findings from previous pipe support failures do not appear to apply to this pipe wall thickness or location. In the time available pipe support inspection test records in the MDR could not be located.

However regardless of findings from pipe inspection, piping should not be designed to meet PSV chatter for extended periods and a weak point will always fail.

3.13 Results of Analysis: Causal Factors

Until the following actions are resolved this scenario could eventuate on PSV11320 and PSV11316, PSV11420 is currently isolated. As a result an immediate action is required to be implemented.

IMMEDIATE ACTION [REDACTED]: It is required that valves XV11316, 11320 and 11420 are isolated on the panel only under the "redtag" requirement under a long term permit and opened only when facility is manned and operator in attendance or under risk assessment.

Basic Cause Category	Near root cause	Near Root cause explanation	Corrective Actions	Corrective Action Type Code	By Whom, When
Design Specs	Problem Not Anticipated	CF1: Vibration from abnormal operation caused fatigue cracking of nipple due to excessive weight of Exhaust Flow Regulator	If not possible to remove Exhaust Flow Regulators and replace with small restriction devices then conduct review with Biffi manufacturer to consider most appropriate way of supporting Exhaust Flow Regulators. Implement appropriate supports to the exhaust flow regulators on all on/off valves (~40 of) on the Angel facility.	PM	[REDACTED] 31 July 2014
		CF2: Hydraulic liquid hammer pressure spike causes lifting of PSV.	Considering scenario that developed for the relief valve lifting, review whether the correct type of PSV has been selected with PSV [REDACTED]. Take into consideration the inlet and outlet line loss calculations. Make appropriate changes if justified. There are three locations on Angel facility in which this identical scenario can be repeated (PSV11230; PSV11316; PSV11416).	PM	[REDACTED] 30 Nov 2013

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 16 of 31

Uncontrolled when printed. Refer to electronic version for most up to date information.

RAFT - FOR APPROVAL

		IMMEDIATE MITIGATION	It is required that valves XV11239, 11320 and 11420 are isolated on the panel only under the "redtag" requirement under a long term permit and opened only when facility is manned and operator in attendance or under risk assessment.	PM	ASAP
--	--	-------------------------	---	----	------

4. OBSERVATIONS AND ADDITIONAL ACTIONS

ACTION - CULTURE (NRA Asset Manager – August 30 2013):

- 1.) This event would have been traumatic to the personnel on board. Actions taken by the outside operator to first confirm gas detection with colleague and then ESD the facility should be clearly identified by leadership as the right culture to follow as opposed to the "super hero" culture previously seen on these incidents of trying to isolate the source first.
 - In addition to following the correct ER philosophy on Angel, follow up actions to mobilise rope access teams, isolate, remove pipe and restart the facility all under duress should be recognised.

ACTION - CULTURE (NRA Asset Manager – November 30 2013)

- 2.) Angel support organisation is significantly different to what was planned as part of design. Angel Support has been absorbed into the NRA Hub team. This loss of containment could be considered a warning sign for a High Reliability Organisation.
 - Review the organisational structure to ensure that NNM facility is adequately supported by onshore focal points.

OBSERVATION – CULTURE (NRA Asset Manager)

- 3.) NNM facilities require a robust defect elimination culture to ensure react visits are minimised. ORIP is used as the process but the discipline of all issues being recorded and followed up should be reviewed. On startup there was an event with LV50404. Event could have been recorded within ORIP as it would have potentially been a react visit requirement.

ACTION - INTEGRITY (██████████ – November 30 2013):

- 4.) SAP PM indicates PSV11416 is due for recertification starting in December 2013, based on the last recertification date of July 2008. However site investigation indicates that PSV was last recertified in July 2007 and is due in 1 month, July 2013, 6 yrs frequency based on Angel PSV Recertification Proposal [Ref 6].
 - Review site recorded certificates [Ref 8] against SAP required recertification periods to ensure no further anomalies.

ACTION – LESSON COMMUNICATION (██████████ – November 30 2013):

- 5.) Contact Biffi actuator vendor and inform of failure of unsupported Exhaust Flow Regulator for the greater learning across the community.

ACTION - EFFICIENCY (██████████ – November 30 2013):

- 6.) Exhaust Flow Regulators were installed to guarantee consistent opening and/or closure times due to the risk of varying upstream instrument air pressure [Ref 9]. Air pressure could now be monitored and be found to be steady and thus exhaust flow regulators could be challenged out of the design and replaced with a standard design. This would remove the defect and also remove a significant 4Yrly PM plan.
 - Raise a Technical Query to investigate opportunity of alternative methods of controlling actuator stroke timing with the benefit of Exhaust Flow Regulator removal.

ACTION – INVESTIGATION COMPLETENESS (██████████ – As information available)

- 7.) At time of report completion there are 3 inspection scopes still being undertaken which will add weight to the findings of this report. Outcomes of Root Cause Analysis on the 3 scopes below are not expected to affect the root cause finding. However report shall be updated for completeness when finalised findings are received on the following items:

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 17 of 31

Uncontrolled when printed. Refer to electronic version for most up to date information.

RAFT - FOR APPROVAL

Item	Tag	Scope	W/O	Responsible	Comment
HOLD 1	PSV11416	[REDACTED]	2100133561	[REDACTED] e	Key item is to determine reseal pressure and if there is any component damage.
HOLD 2	XV11420	[REDACTED]	2100133561	[REDACTED]	Key item is to identify if there is any defect on valve sticking in partially open position.
HOLD 3	Failed Pipe	NDT and RCA	2400004940	[REDACTED]	Key item is to identify if there is any weld penetration into internal wall surface which would impact pipe integrity.

If findings of scope in above table reveal different root causes then consideration shall be given to return to MER Forum.

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 18 of 31

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RAFT - FOR APPROVAL

5. LESSONS LEARNED

The lessons on liquid hammer from this incident will be shared across the process engineers for application to other Woodside facilities via KMS and at Production Learning's Meeting.

Piping design standard shall not be updated for the potential valve chatter scenario and is adequate for this design scenario.

The lessons on unsupported "heavy" exhaust flow regulators will be shared across the instrument community for application to other Woodside facilities through the KMS and at Production Learning's Meeting. Angel is unique in the application of these type of exhaust flow regulators.

Each instrument hook up is individual to location. Vibration is considered within the standards. There is no instrument design standard or specification that requires to be updated for the identification from the root cause.

The actuator vendor Biffi, who supplied the standard hook up will be contacted to learn if there has been any other failures of this nature due to large weighted Exhaust Flow Regulators.

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 19 of 31

Uncontrolled when printed. Refer to electronic version for most up to date information.

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6. REFERENCES

- 1.) Fire and Gas Detection Mapping for the Angel Facility – Final design, T3000RF1967519, DRIMS # 1967519.
- 2.) Angel File Note Fire and Gas Mapping Key Decisions
- 3.) Angel - Investigation into Transverse Cracking in Pipe Support Fillet Welds on TSA Coated Thin Walled Duplex Stainless Steel Pipe, T3000RQ4312671
- 4.) Condensate PSV Sizing PSV11230-11316-11416 [DRIMS 8955017].
- 5.) DRIMS-#8943952-v1-Estimate_of_Hydrocarbon_Loss_20_06_2013.XLS.
- 6.) Angel PSV recertification Proposal, T4000RG2508129.
- 7.) Investigation Report on Angel MMHE failures.
- 8.) Angel PSV data [DRIMS 8955335].
- 9.) DRIMS-#3530286-v1-Angel - KDL-175 (SIGNED) ESDV SDV BDV & XV Actuator Design Summary.
- 10.) Angel PSV Tyco IOM Manual, T3000EJ2716260
- 11.) PSV11416 Data Sheet, T3000QJ2219078
- 12.) Woodside Hydrocarbon Release Classification [DRIMS 4737006]

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 20 of 31

Uncontrolled when printed. Refer to electronic version for most up to date information.

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RAFT - FOR APPROVAL - T&R/0(1)/ Rev &

APPENDIX A – TERMS OF REFERENCE

Loss of Containment : Piping Failure on Coalescer Vent Line Piping.

Incident Reference: WELEV130XXXXXX

Angel Platform, North West Shelf, Australia. 20th June 2013, 02:02 hrs

Brief Description:

The Angel platform had been shut down for annual ESD testing. Included in this outage was despading o f condensate filter "A".

The platform restart operations commenced around 1830 hrs and continued into AP3 well testing activities with the condensate "B" filter system in service.

At approx 0112, as per procedure, the gas cap on condensate filter B and then A was bled off to flare via XV11420 and XV11320 respectively.

Soon thereafter a loud noise and vibration was noted on the flare line from Condensate coalescer "B".

Operators investigated and initial diagnosis was thought to be related to PSV chattering on the "B" condensate system.

After a brief discussion with the NRA CCR the system was and changed over to the "A" system.

The operators re-investigated and the noise/vibration had ceased but when they inspected the condensate system a fine mist of hydrocarbon was noticed high in the structure below the main deck.

The operators immediately contacted NRA CCR and initiated an ESD of the platform.

Incident Potential Consequence Rating: Significant hydrocarbon release (Category C)

Actual Incident Category: Actual Hazard – No injury or damage occurred.

Team Members:

Name	Position Title	Investigation Quals / training / experience	Position on Team (lead, facilitator, member)	
		Process Engineer	Investigation Team Lead	
		Mech Engineer	Investigation Member	Team
			Investigation Member	Team

Purpose:

In line with the Woodside Health and Safety and Environmental Policies, this investigation is to be conducted on the basis that all incidents are preventable and the purpose of the investigation is to fully understand the causes of this incident so that we can improve the risk management systems currently in place to facilitate preventing all incidents.

The investigation team shall commence immediately including conducting investigations at the site. The team should liaise with the facility Health & Safety Representatives and invite them to contribute to / participate in the investigation. The team leader should contact the Site/ Facility Manager should additional resources or time, be required to complete the process.

Areas to be Addressed and Reported:

Investigation to be carried in accordance with the Woodside event reporting and investigation procedure (WM1040PF7386000) to determine;

- Chronology of events leading up to the incident and recovery measures implemented subsequent to the incident.
- Technical investigation to determine the root cause of the leak.
- The contributing and causal factors leading to the incident.
- Highlight where warning signs may have been missed and through interviews and discussion identify any procedural or organisational issues that potentially contributed to the warning signs being missed.
- Report on the way the incident was managed.

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 21 of 31

Uncontrolled when printed. Refer to electronic version for most up to date information.

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- Review events leading up to the restart of the platform.
- Compliance with WEL standards and procedures on threaded fitting and unsupported mass on the actuated vent valve.

Timing:

A draft report is to be provided for correction no later than 13 July 2013. The final report is expected no later than 20 July 2013

Investigation Sponsor:



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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 22 of 31

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IMAGES



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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 24 of 31

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Biffi valve off actuator 1/4 inch instrument nipple. Broken

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 25 of 31

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Native file DRIMS No 8957282

Page 26 of31

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 27 of 31

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500 KPag N2 and water soap mix slowly poured from above.

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 28 of 31

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 29 of 31

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Controlled Ref No: **T0000RG8957282**

Revision: 0

Native file DRIMS No: 8957282

Page 30 of 31

Uncontrolled when printed. Refer to electronic version for most up to date information.

RAFT - FOR APPROVAL

APPENDIX C – EVENT LESSONS BULLETIN

Event Lessons Bulletin

Facility: Angel **Title:** Loss of Containment- Piping failure on Coalescer B vent line

Event #	WELEV13060135	Brief Description	At approximately 0220hrs on the 20th June 2013, during restart of the Angel platform from a planned shutdown, a gas release was observed by the Area Authority on shift. The platform was immediately shut down and de-pressured.
Date	Thursday, 20 June 2013	Outcome	No personnel were injured during this event. This event resulted in the Angel platform being shutdown for an additional 42hrs while an investigation was held and controls were put in place. The approximate loss of containment value is calculated at 62kg.
Event Type	Loss of Containment - Hydrocarbon	Root Causes	<ol style="list-style-type: none"> 1. On/Off Valve exhaust flow regulator fails catastrophically allowing valve to close rapidly resulting in pressure spike lifting PSV. 2. PSV fails to reseal with blowdown (reseal pressure) lower than operating pressure. 3. Extended duration PSV chatter attributable from 2 phase flow, led to eventual failure of system weak point (pipes support) and loss of containment. <p>ROOT CAUSE – Problem Not Anticipated</p>
Risk Rating	Potential B (H&S)	Actions	<p>IMMEDIATE MITIGATION: V11316, 11320 and 11420 are isolated on the panel only under the red tag requirement under a long term permit and opened only when facility is manned and operator in attendance.</p> <ol style="list-style-type: none"> 1. Provide adequate support to heavy Exhaust Flow Regulator. 2. Review selection of PSV type considering event scenario. <p>(Refer to Major Investigation Report for additional observations)</p>
GSR Involved	N/A	Lessons Points	Correct approach by outside operations to allow safety systems to manage event rather than try to intervene and isolate.



	Everyone	Supervisor	Manager
Identify	Identify ✓	Identify ✓	Identify ✓
Communicate	Communicate ✓	Communicate ✓	Communicate ✓
Control	Control ✗	Control ✓	Control ✓
Close	Close ✓	Close ✓	Close ✓

Contact for additional information: [REDACTED]
Removal Date from Notice Boards: 20 September 2013

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Controlled Ref No **T0000RG8957282**

Revision 0

Native file DRIMS No 8957282

Page 31 of 31

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