NOPSEMA

Safety alert 66

October 2017

Potential for fatalities from electrical incidents

What happened?

Recently, over a period of less than 90 days, NOPSEMA received three notifications of dangerous occurrences involving personnel performing electrical work which could have resulted in electric shock or electrocution:

1. Two electricians mistakenly cut through the incorrect 690 volt cable which was a supply for a temporary seawater lift pump. Fortunately, the pump was isolated at the time.
2. During an accommodation renovation an electrician cut through a live 240 volt cable while attempting to install a new light fitting which resulted in the circuit breaker tripping.
3. A well services field technician shorted out two of the 440 volt power supply phases of a cable from a control cabin which resulted in the main power supply breaker tripping.

What could go wrong?

Although no injuries or cardiac irregularities occurred during these three dangerous occurrences, each incident could have resulted in serious injury or fatality as a result of electric shock or electrocution.

Why did these incidents happen?

- There was a failure to positively identify the cables to be worked on in two of the incidents.
- There was a failure to positively confirm that electrical isolation had been undertaken prior to commencing work in two of the incidents.
- There was a failure to test that the cables were ‘de-energised’ and safe prior to commencing work in all three incidents.
- There was no Job Safety Analysis/Job Hazard Analysis for the task to be performed in one incident.
- The precautions identified in the Job Safety Analysis/Job Hazard Analysis were not complied with in one of the incidents i.e. hazards and their control measures were identified but not adhered to.
- There was no Permit To Work for the task to be performed in one incident.
- There were ineffective Permit To Work controls in two of the incidents i.e. inadequate review of permit prior to approval and issue.
- A work procedure didn’t have sufficient detail for the task being performed in one incident.
- A work procedure for the task wasn’t complied with in one incident.
- A non-competent person was working on electrical equipment in one incident.

Key lessons

The following are all necessary requirements for performing electrical work safely:

- Positive identification of cables and equipment prior to commencing work.
- Adherence to Permit To Work procedures and requirements.
- Adherence to Job Safety Analysis/Job Hazard Analysis procedures and requirements.
- Adherence to electrical isolation procedures and requirements.
- Adherence to work procedures and work instructions.
- Testing that cables and equipment are ‘de-energised’ and safe prior to commencing work.
- Ensure that only competent personnel work on electrical equipment.

The legislation

Clause 9 of Schedule 3 of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* places specific duties on the operator of a facility to take all reasonably practicable steps to ensure that the facility is safe and without risk to health of any person at or the near the facility. This includes an obligation to take all reasonably practicable steps to:

- Implement and maintain systems of work that are safe and without risk to health [Clause 9(2)(d)];
- Provide all members of the workforce with the information, instruction, training and supervision necessary for them to carry out their activities in a manner that does not adversely affect the health and safety of persons at the facility [Clause 9(2)(f)].

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NOPSEMA

Safety alert 67

24 November 2017

Understanding of light well intervention safety systems is critical for safe operation

Key message:

It is critical that facility operators and relevant members of the workforce fully understand the Light Well Intervention safety systems installed on their vessels, have an in-depth knowledge and understanding of the system's safety features and functionality, and know how the equipment will behave in abnormal conditions.

What happened?

Recently, the failure to fully understand a light well intervention safety system's functionality caused an incident which resulted in two 1.6kg dropped objects.

At the time of the incident, the vessel was in the process of recovering equipment from a well at a water depth of 200 metres. A winch guide wire was attached subsea and a 2-inch service hose was attached to the wire using clamps. The winch was set in the active heave compensation mode when a fault occurred on the winch which activated the winch brakes and deactivated the heave compensation system. An alarm sounded briefly and displayed on the control console however the fault remained undetected for approximately 30 minutes.

During this time, the wire detached subsea due to the load applied by the heave and movement of the vessel. Once the fault was finally detected, and believing the wire was still attached subsea, the console operator reset the winch system and slowly increased the winch tension. No visual check, using the ROV, was completed to ensure the guide wire was still attached.

The 2-inch service hose, which remained connected to the subsea stack, is believed to have stretched under load, reducing friction with the clamp and leading to a rapid retraction of the wire by approximately 20 metres before the winch shut down on over-speed and the wire came to a halt. During the retraction of the wire, the upper two clamps collided with the sheave at the top of the tower on the vessel and parted; one of which dropped 27 metres to the deck below.

What could go wrong?

Failure to appropriately verify and fully understand how safety critical systems operate can lead to unexpected consequences; in this case resulting in two dropped objects, one of which could have caused a fatality if it had struck a person.

Why did this happen?

NOPSEMA's investigation into this incident identified that:

- The winch system's commissioning procedure did not verify the system's automatic response to a winch fault.
- Multiple revisions of the winch manual were on-board which detailed differing automated safety system responses to a winch fault.
- Tower personnel believed the winch brakes would not engage immediately on detection of a winch fault during active heave compensation.
- The display panel on the control console detailed that the winch brakes would not engage on detection of a winch fault during active heave compensation, however, the system was actually configured to apply the brakes immediately.
- The console operator was not adequately alerted to the winch fault by the control console, which delayed the initial response to the fault. The audible alarm was not ideally positioned for hearing and only beeped twice before becoming silent. The main display of the control console only showed the latest alarm, while all previous alarms could only be accessed by opening another display window.

- There was no formal requirement to check that the winch wire had not parted subsea prior to the re-tensioning of the wire.
- The facility operator did not identify secondary retention of the hose clamps as a control in the hazard identification (HAZID) or Toolbox talk for the activity. Both the HAZID and Toolbox talk did not identify the risk of rapid winch retraction in active heave compensation mode.

Key lessons

Commissioning of safety-critical equipment systems should include verification of all safety features including actual configuration.

Facility operators need to ensure safety-critical system manuals are controlled and up-to-date.

Manufacturers need to ensure manuals related to safety-critical equipment have a robust quality control process to ensure the information they contain is accurate.

Facility operators need to have a clear process for alarm management to ensure suitable responses.

Alarm systems should be designed to effectively alert the console operator of any faults and provide the necessary information to allow the operator to respond in a timely and appropriate way.

Toolbox talks should provide a clear breakdown of the individual tasks for the activity, and identify the risks and controls specific to each task.

Secondary retention should be considered for all equipment (including temporary project related equipment) to be used at height and having the potential to cause harm.

Image 1: Damaged dropped clamp

Image 2: Secondary retention subsequently fitted to the guide wire clamps

The legislation

Schedule 3 of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* places a general duty on the operator of a facility to take all reasonably practicable steps to ensure that all work and other activities carried out on the facility are carried out in a manner that is safe and without risk to the health of any person at or near the facility.

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Safety Alert 64

April 2017

Collared Eyebolts as Lifting Equipment

What happened?

MODU crew were replacing the diverter on a MODU facility operating in Australian waters. The new diverter had been placed on its side in a cradle on the main deck for change-out of the flex-joint. Subsequently, the diverter was lifted with the intent of rotating it from the horizontal to its working, vertical axis. When the diverter had been lifted between 1.2 to 1.8 metres above its cradle, one of the two collared eyebolts used for lifting the diverter body sheared, see Figure 1 below. This caused the diverter to rotate and the second eyebolt to become dislodged from the diverter body. The diverter then fell back into the cradle on the main deck. The combined diverter and the running tool weighed approximately 21.7 tonnes and fell a distance of 1.2 to 1.8 metres. No persons were injured in the incident.

The primary immediate causes of the incident were found to be:

- The lifting equipment was configured such that the direction of pull was at an angle to the shaft of the eyebolt, so that a “fleet angle” from the vertical was created. An angular load such as this reduces the Working Load Limit (WLL) of the eyebolt significantly. See Figure 2 below;
- The collar of the eyebolt was not fully flush with the body of the diverter, causing a shearing force due to the fleet angle to be applied to the shaft of the eyebolt, instead of the load being spread across the eyebolt’s collar and the surface of the diverter as per design.

Amongst the root causes of this incident identified by the NOPSEMA investigation was ineffective lift planning.

Lift planning was previously addressed in NOPSEMA Safety Alert 59 in July 2014, which advised the industry that *“the detail required in the lifting and rigging plans should be proportional to the complexity and frequency of the operation. Frequent or simple tasks may only require a basic plan while infrequent or complex lifting or rigging operations may require significant engineering.”*

Fig. 1: Failed eyebolt

Assembly Safety:

- Never exceed load limits specified in Table I & Table 2.
- Never use regular nut eye bolts for angular lifts.
- Always use shoulder nut eye bolts (or machinery eye bolts) for angular lifts.
- For angular lifts, adjust working load as follows:

Direction of Pull (from In-Line)	Adjusted Working Load
45 degrees	30% of rated working load
90 degrees	25% of rated working load

Fig.2: Extract of manufacturer’s Application Instructions (courtesy of The Crosby Group LLC)

What could go wrong?

Failure of lifting equipment can potentially result in a dropped load or dropped object. Although in the example above there were no injuries, it is foreseeable that such an incident could result in serious injury or death. In addition, a dropped load may result in significant property damage, and/or a loss of hydrocarbon containment.

Key lessons

The following recommendations should be considered:

- Lifting plans should be completed in accordance with the facility safety management system;
- The detail required in lifting planning should be proportional to the complexity and frequency of the operation;
- Lifting arrangements such as spreader bars to ensure that the lifting force is applied in line with the axis of the threaded shaft of the eyebolts should be considered when planning lifts;
- All items of lifting equipment should be tested, certified, appropriately marked and inspected by a competent person prior to use;
- Extreme care should be taken to ensure that eyebolts are not screwed into threaded holes of a different size or type of thread;
- Eyebolts should be tightened fully down to the face of the lifted load. It should not be possible to fit a 0.04mm feeler gauge at any position between the collar of an eyebolt and the lifted load. However, eyebolts should not be over-tightened;
- A shim washer might be required to ensure that the direction of the load is aligned with the plane of the eye;
- Where the direction of the lifting force on the eyebolt is at an angle to the axis of the threaded shaft of the eyebolt that exceeds 5 degrees the Working Load Limit of the eyebolt will be significantly reduced. This must be taken into account when planning a lift using eyebolts;
- Collared eyebolts should only be used up to an angle of 45 degrees to the axis.

The legislation

Clause 9 of Schedule 3 to the Offshore Petroleum and Greenhouse Gas Storage Act 2006 requires that, "The operator of a facility must take all reasonably practicable steps to ensure that the facility is safe and without risk to the health of any person at or near the facility." This includes an obligation to take all reasonable practicable steps to:

- implement and maintain systems of work that are safe and without risk to health [Clause 9(2)(d)]; and
- provide all members of the workforce with the information, training and supervision necessary for them to carry out their activities in a manner that does not adversely affect the safety of persons at the facility [Clause 9(2)(f)].

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Reference

The Australian Standard that specifies requirements for forged collared eyebolts for lifting purposes is AS 2317 – 1998 "Collared Eyebolts".

NOPSEMA

Safety alert 65

July 2017

Well annulus leaks gas-lift inventory from failed instrument line

What happened?

Failure of an instrument tubing line connected to a wellhead gas lift line resulted in the release of a significant volume of hydrocarbon gas from the production annulus over a time period of 3.5 hours, elevating the risk on the facility during the release. Although initiation of the surface shutdown also closed the shutdown valve fitted to the gas lift line, this did not isolate the flow of hydrocarbon gas from the production annulus as the failed instrument line had been located on the gas lift line between the wellhead production annulus and gas lift line shutdown valve, see Figure 1.

Figure 2 provides an example P&ID that shows the instrument take-off point located downstream of the UV (Multivariable) shutdown valve.

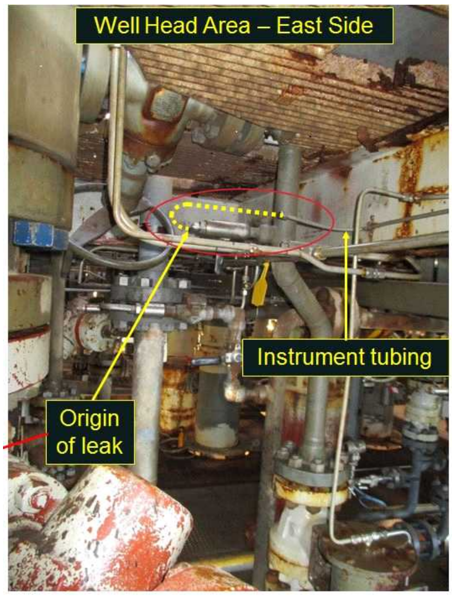

Figure 1 – Location of failed instrument line (dashed line) fitted to gas lift line between the production annulus wing valve and gas lift shutdown valve.

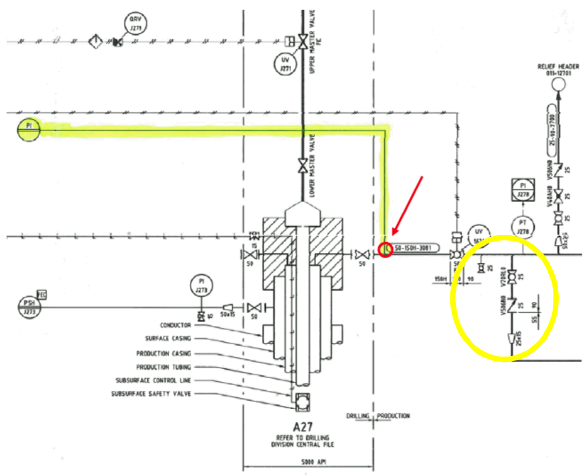

Figure 2 – Example P&ID drawing showing the instrument take-off point (arrow) incorrectly located downstream of the UV shutdown valve (circled).

Good design requires that the gas lift shutdown valve (SDV) should be as close as practicable to the wellhead with any fittings to the gas lift line on the upstream side of the gas lift SDV ensuring a barrier to gas in the production annulus in the event of any failure of fitting.

What could go wrong?

Locating the fitting for the instrument tubing line between the production annulus wing and gas lift shutdown valve created the potential for an unrestricted pathway from the failed instrument tubing line to the full volume of the production annulus. "This configuration is contrary to international guidelines and standards" (see References).

In this configuration, leaving the manually operated wing valve open to the production annulus to allow daily readings of the pressure in the production annulus resulted in an unrestricted pathway from the production annulus to the failed instrument tubing line as the shutdown valve was not able to safely isolate the gas inventory of the production annulus.

Key lessons

The following should be considered:

- The risk for an uncontrolled gas release of a significant volume of hydrocarbon gas from the production annulus of gas lift production wells requires that effective barrier controls are in place.

- Valve fittings, instrumentation and small bore tubing fitted to wells that may be subject to movement due to thermal change from production or wave motion have the potential to be damaged or suffer an integrity failure which may lead to an unrestricted pathway for release of hydrocarbon gas.
- Damage or loss of integrity to valve fittings, instrumentation and small bore tubing fitted to wells may compromise the integrity of the secondary barrier envelope and could lead to a situation of relying on a single barrier envelope to control the well reservoir.
- Maintaining well integrity with a two barrier philosophy is considered good industry practice.
- Gas lift line shutdown valves (SDV) should be fitted as close as practicable to the wellhead and the SDV should be activated with the same signal as the surface safety valve to effect isolation of the gas lift line and any small bore take-offs.
- Keeping abreast of relevant industry literature: the risks of significant gas lift gas release had been identified previously. Refer to publications referenced below.

The legislation

Schedule 3 of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* places specific duties on the operator of a facility to take all reasonably practicable steps to ensure that any plant, equipment, materials and substances at the facility are safe and without risk to health.

Facility operators, employers, and persons in charge of work activities should review their wellhead configurations, with regard to the above information.

References

The following publications provide further information on the issue of gas lift well integrity:

2016, Oil & Gas UK, Well Life Cycle Integrity Guidelines *'Configuration should be such that a sidearm valve can be closed to effect isolation should the instrumentation or gauge assembly be knocked off the wellhead', 'If wells are gas lifted, the surface wellhead should be designed to reduce the risk of loss of 'A'-annulus containment to ALARP.'* Ref. Oil & Gas UK, Well Life Cycle Integrity Guidelines, Issue 3 March 2016, ISBN 1 903 004 71 6

2014, Zakum Development Company identified for gas lift production and injection wells '… the risk of venting significant lift gas volumes to atmosphere in a manned area through dropped objects or other failures.' Ref. 2014, Newton. D, Odom. W, Burchell, G, Kofoed. C, Surface Safety Systems Enhances Gas Lift Safety and Optimizes Surface Line Architecture on Island Wells, SPE 171748

2013, NORSOK standard D-010 Well integrity in drilling and well operations section 7.7.2 Gas lift wells "The large volume of pressurised hydrocarbon gas in both surface lines and in the A-annuli represents a substantial risk to a platform. The volume of release hydrocarbon gas due to accidental damage to the tree, wellhead or surface lines shall be minimized. 2013, NORSOK standard D-010 Rev 4. June 2013

2011, Offshore Magazine published an article *'…many major operating companies are looking to eliminate the well integrity compromises that have previously existed in their gas lift well designs, with particular regard to: the risk of high pressure gas venting from the annulus in the event that the HP lift gas flowline or wellhead fixture to the annulus is damaged.'* Ref. 2011, Brodie. A, Petroleum Technology Co. Gas-lift valve design addresses long-term well integrity needs, Offshore Magazine

2007, BP Clair Platform design review identified *'…integrity of the tree/wellhead assemblies and to include both annular safety valves and integral wellhead gas lift check valves. …gas in the annulus is isolated to the maximum possible extent should a failure of the gas lift line and / or connection at the wellhead occur.'* Ref. Tam. T, Coleman. S, 2007, The BP Clair Platform: A Case Study of Application of Layout in the Control of Explosion Hazards, IChemE Symposium Series No. 153.

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