

Investigation report

| Report | |
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| Report title Investigation of a work accident at the Mongstad refinery – personal injury after falling during work in the cracker on 29 November 2014 | Activity number 001902001 |

| Security grading | | |
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| <input checked="" type="checkbox"/> Public | <input type="checkbox"/> Restricted | <input type="checkbox"/> Strictly confidential |
| <input type="checkbox"/> Not publicly available | <input type="checkbox"/> Confidential | |

| Summary |
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| A work accident occurred on 29 November 2014 at Statoil Mongstad in connection with preparations for maintenance of a compressor. An employee fell about three metres from a ladder and was seriously injured. He suffered serious head injuries in addition to broken bones. |

| Involved | |
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| Main group T-L | Approved by/date Kjell Arild Anfinsen |
| Members of the investigation team Sissel Bukkholm Øyvind Lauridsen | Investigation leader Arne Johan Thorsen |

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1 Summary

A work accident occurred on 29 November 2014 at Statoil's Mongstad facility in connection with preparations for maintenance of a compressor. An employee fell about three metres from a ladder and was seriously injured. He suffered serious head injuries in addition to broken bones, and was hospitalised.

During preparations for maintenance of a compressor in the cracker, a valve was to be operated above ground level. This is a 10-inch gate valve positioned at a height of 4.2 metres. A chain pulley installed on the valve's hand wheel allowed it to be operated from the ground.

The work team discovered that the sleeve which protected the spindle was bent. They decided that it was safe to inspect the valve, and fetched a ladder to climb up. The ladder was placed against an H-beam at a height of 3.7 metres, and secured by an operator holding onto it. Another operator ascended to take a look. He could not see what was wrong. The assistant operations supervisor was called to help in assessing the valve. He ascended the ladder to look

at the valve with sleeve. The others who were present then heard a bang and saw the assistant operations supervisor falling from the ladder, a height of about three metres.

The following nonconformity has been identified

- no risk assessment when changing to geared valve.

The following improvement points have been identified

- inadequate training in the functioning of the valve
- unfortunate practice when using a ladder
- inadequate risk assessment before ascending a ladder.

Information received during the investigation indicates that the emergency response accorded with established plans.

2 Introduction

A work accident occurred on 29 November 2014 at Statoil's Mongstad facility in connection with preparations for maintenance of a compressor. A valve above ground level was to be investigated and, in that connection, an employee fell about three metres from a ladder and was seriously injured. The Petroleum Safety Authority Norway (PSA) decided on 1 December 2014 to conduct its own investigation of the incident.

Composition of the investigation team:

Arne J Thorsen, process and mechanical equipment, investigation leader

Øyvind Lauridsen, working environment

Sissel Bukkholm, working environment

Procedure

The investigation team travelled to Mongstad on 1 December 2014.

On the next day, a brief review of the incident presented by Statoil was followed by an inspection of the accident site. The investigation team conducted a number of interviews at the plant, inspected the valve and gear which had been taken to the workshop, and reviewed documentation related to the incident.

The valve gear was also investigated at Statoil's materials department in Trondheim.

The investigation team returned home on 3 December 2014.

Mandate

1. *Clarify the incident's scope and the course of events*
 - a. *identify and assess safety and emergency preparedness aspects*
 - b. *clarify assessments made in advance of the incident*
2. *Describe the actual and potential consequences*
3. *Assess direct and underlying causes, with an emphasis on human, technical and operational (HTO) aspects and organisational conditions*
 - a. *observed nonconformities from requirements, approaches and procedures*
 - b. *improvement points*
4. *Discuss and describe possible uncertainties/unclear aspects*

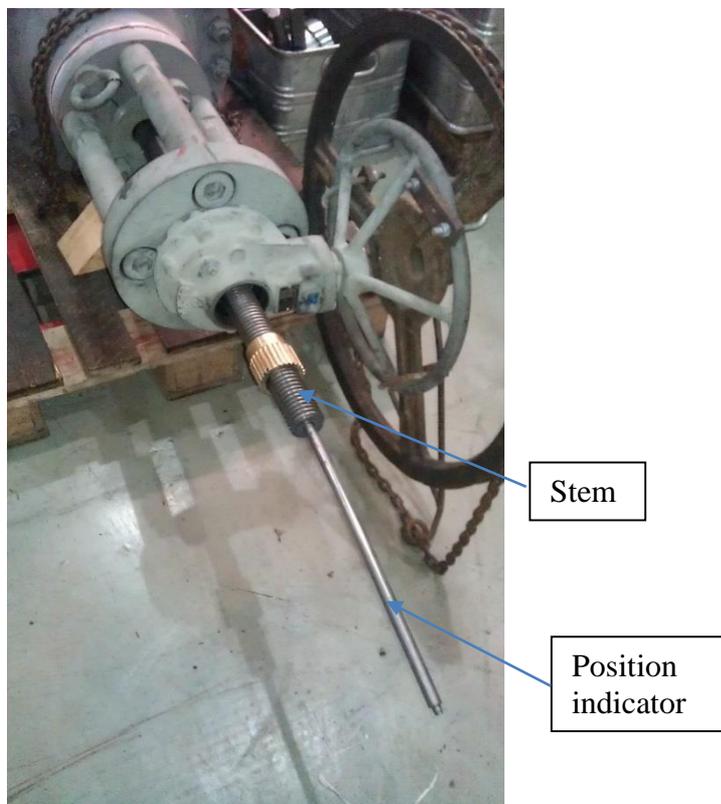
5. *Identify possible breaches of the regulations, recommend further follow-up and propose use of reactions*
6. *Assess the player's own investigation after the incident*
7. *Prepare a report and a covering letter in accordance with the template*

The police are conducting their own investigation of the incident.

3 Course of events

During preparations for maintenance of a compressor in the cracker, a valve was to be operated above ground level. This is a 10-inch gate valve positioned at a height of 4.2 metres. The valve was replaced during the maintenance turnaround at the plant in September 2014. A chain pulley installed on the valve's hand wheel allowed it to be operated from the ground. The night shift initiated the job on 28 November 2014 and the intention, according to work order 23233054, was to install a double block and bleed. Problems were encountered in closing the valve, and blinding was recommend.

The work team on the day shift comprised two people. They decided to open and close the valve again with the aid of the chain pulley. Earlier experience indicated that this could be sufficient to close this type of valve completely, but they did not succeed. Blinding would require assistance from a mechanic and the erection of scaffolding.





Metal sleeve

A position indicator is installed on the valve stem. The latter is protected by a metal sleeve. The indicator shows the position of the valve. The work team discovered that the sleeve was bent by about 45°, and discussed what could have caused this. They decided that it was safe to inspect the valve, and fetched a ladder to climb up. The ladder was placed against an H-beam at a height of 3.7 metres, and secured by an operator holding onto it. Another operator ascended to take a look. He banged on the sleeve with a pipe wrench, but could not see what was wrong. After descending the ladder, he called the assistant operations supervisor to help in assessing the valve. The latter ascended the ladder to look at the valve with sleeve. The others who were present then heard a bang and saw the operator falling from the ladder, a height of about three metres. He landed on a pallet jack and suffered serious head injuries and broken bones. The metal sleeve was found on the ground beside him

The work team immediately notified the alarm centre at Mongstad, which mobilised internal and external resources. The victim was transported to Haukeland hospital by air ambulance.

Since the facility had been shut down for compressor maintenance, no further safeguarding of the process or equipment was necessary.

4 Direct and underlying causes

Direct causes

The direct cause of the accident was that the victim lost his balance and fell from the ladder. This loss of balance could have several possible causes. See the chapter on uncertainties.

Underlying causes

A gearless valve was replaced by a geared valve without any risk assessment of the change (see nonconformity 6.1.1).

Inadequate training in the way the valve worked meant that so much force was applied in pulling on the chain that the gear became overloaded (see improvement point 6.2.1).

The HSE handbook for Mongstad does not specify which activities can be conducted from a ladder (see improvement point 6.2.2).

Risk assessment before checking the valve was inadequate (see improvement point 6.2.3).

5 Actual and potential consequences of the incident

Actual consequences

One person suffered serious head injuries and broken bones, and was hospitalised.

The valve gear was damaged and the valve had to be replaced. No further material damage was caused and, since the facility had been shut down because of the compressor failure, no production was lost. The incident caused no harm to the environment.

Potential consequences

The incident had the potential to cause even more extensive injuries to the operator, who could have been killed by the fall.

The area was not cordoned off, and three people were present who could be hit by the falling operator.

It is unlikely that the incident could have caused further damage to material assets or the natural environment, or any loss of production.

6 Observations

The PSA's observations fall generally into three categories:

- nonconformities: observations where the PSA believes that regulations have been breached
- improvement points: observations where deficiencies are found, but insufficient information is available to establish a breach of the regulations
- other observations.

6.1 Nonconformity

6.1.1 No risk assessment when changing to geared valve

A gearless valve was replaced by a geared valve without any risk assessment of the change.

Grounds

The valve was replaced during the maintenance turnaround in September 2014. The new valve was equipped with a gear, which is not normal practice for 10-inch valves in the Statoil system. The chain pulley used with the old valve was reinstalled on the new one. This pulley has a bigger diameter than the valve's factory-installed hand wheel. The gear and the increased pulley diameter mean that components in the gear and valve can be exposed to bigger forces than they are designed for. None of those interviewed could point to any risk assessment or discussion related to this change.

Requirements

Section 11 of the management regulations on the basis for making decisions and decision criteria, which states in part: "Before decisions are made, the responsible party shall ensure that issues relating to health, safety and the environment have been comprehensively and adequately considered"

Section 7 of the technical and operational regulations on installations, systems and equipment, which states in part: "c) they are suitable for use and able to withstand the loads they can be exposed to during operation"

6.2 Improvement points

6.2.1 Inadequate training in the functioning of the valve

The personnel involved lacked sufficient knowledge about the way the valve functioned, and therefore applied so much force to the chain that the gear was overloaded during efforts to close the valve to that it stayed tight.

Grounds

Technical material investigations of the damaged valve gear from Mongstad, MAT-2015125, show that the drive sleeve was subjected to so much force that it broke.

It was explained in interviews that normal practice in the event of leaking valves was to open them a little and then close them quickly and hard. Statoil has calculated that the force required to tighten the valve is about 40 kg. The load in this case was considerably greater. The personnel involved lacked sufficient knowledge about the way the valve functioned.

Requirement

Section 51 of the technical and operational regulations on training in safety and working environment, which states in part: "Training as mentioned in the third subsection shall be provided upon employment, transfer or change of work tasks, introduction of new work equipment or changes to the equipment and upon introduction of new technology that applies to the individual's workplace or work tasks"

6.2.2 Incorrect work practice when using a ladder

A ladder was used to check the valve. The operators also stood with their backs to the ladder, which meant they lacked a secure grip.

Grounds

Checking the valve was not assessed as work at a height. Version 6 of the GL4100 personal handbook for Mongstad states that a ladder should be used exceptionally and only for brief periods. The handbook does not state that a ladder should only be used for access and only exceptionally as a work platform if other and safer equipment is not appropriate, as specified in the recognised norm for work at a height. In this case, a personnel lift located in the immediate vicinity could have been used.

The norm also specifies that ladders should be used in such a way that the worker has a safe grip and a steady footing at all times. It emerged from interviews that both operators who mounted the ladder stood with their backs to the rungs while checking the valve.

Requirements

Section 46 of the technical and operational regulations on organisation of work, see the guidelines which specify that chapter 17 in regulations on conduct of work should be used for work at a height. Section 17-30 on the use of ladders specifies in part that "Ladders must be positioned so that they are stable during work. Ladders must be used so that workers have a secure grip and a steady footing at all times. Workers who must carry something while standing on the ladder must have a secure grip ..."

6.2.3 Inadequate risk assessment before ascending a ladder

The risk assessment before checking the valve was inadequate.

Grounds

Physical changes in the sleeve protecting the valve stem were observed before the accident. Although their cause was uncertain, the work team opted to ascend a ladder to check the valve. The work team underestimated the risk that something unforeseen could occur with valve or gear. The area under the valve was not cleared and cordoned off before the operators ascended the ladder. A pallet jack stood under the ladder, and the operator hit this before landing on the ground.

Requirement

Section 46 of the technical and operational regulations on organisation of work, see the guidelines which specify that chapter 17 in regulations on conduct of work should be used for work at a height. Among other provisions, section 17.1 on planning of work at a height specifies that: "Work which requires the use of scaffolding, ladders, roof bridges, etc, must be planned in such a way that set-up of and work on the facility are conducted in accordance with this chapter"

6.3 Barriers which functioned

Emergency response to the incident involved local personnel at the Mongstad facility as well as calling an air ambulance and ambulance. The air ambulance was used to transport the injured operator to Haukeland hospital.

Information received during the investigation indicates that the emergency response accorded with established plans.

7 Discussion of uncertainties

The three people who were in the area when the accident happened did not see why the victim fell. It has so far not been possible to speak to the victim. Several possible explanations exist for the fall.

The victim could have lost his balance because he was startled by the bang when the stem released and shot out to its full length. He may also have been holding the protective sleeve on the stem and thereby been draw out of balance when this broke off. He could also have slipped on the rung of the ladder or lost his balance for another reason while holding the sleeve and thereby contributed to its coming free at just the time he was up there. The investigation team believes that this uncertainty has little significance for the conclusions in its report.

8 Appendices

B: The following documents have been used in the investigation:

- Technical material investigation of the damaged valve gear from Mongstad, MAT-2015125

- Operation log report from 21.46 on 27 November to 21.46 on 29 November
- Valve/blind list C-1531 LUFT, work order 23233054
- Mongstad personal HSE handbook for Statoil's land-based plants, GL 4100

C: Overview of personnel interviewed.