PETROLEUMSTILSYNET

Investigation report

Report	
Report title Investigation of an incident involving a dropped object on the Heidrun TLP, 22 September 2015	Activity number 001124022

Security grading		
☑ Public	☐ Restricted	☐ Strictly confidential
☐ Not publicly available	☐ Confidential	

Summary

A grating plate fell eight metres on the Heidrun TLP on 22 September 2015. In falling, it grazed a person who suffered pain and swelling in one shoulder. The grating weighed 31 kilograms and represented a kinetic energy just before impact of 2 430 joules.

The incident occurred when rigging down after a coiled tubing operation. An Odim heave compensator attached to a length of riser was being lifted when it thumped against an open deck hatch with attached gratings and knocked off one of the grating plates.

In slightly different circumstances, the incident had the potential to cause a fatal or serious personal injury and substantial material damage. The grating could have fallen further to the underlying decks, where personnel and hydrocarbon systems were present.

Involved	
Main group T-1	Approved by/date
Members of the investigation team Sissel Bukkholm, Roar Sognnes and Jan Ketil Moberg	Investigation leader Jan Ketil Moberg

Contents

1 Summary

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A number of barrier breaches have been identified by the investigation. The investigation team's impression is that several barriers failed simultaneously. Several of these are fundamental in nature, such as risk assessment, planning and expertise. While design weaknesses have been identified with the deck hatch, most of the barrier breaches relate to organisational and operational elements.

The PSA has identified the following conditions of significance for the incident

- lack of technical integrity – BIT deck hatch
- inadequate follow-up
- inadequate identification of risk
- unclear roles and responsibilities
- deficiencies in governing documentation

2 Definitions and abbreviations

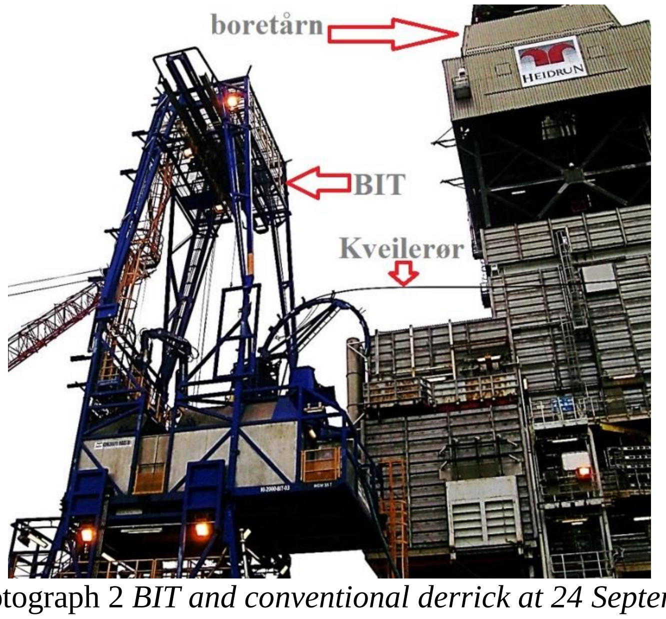
BIT	Well intervention derrick (initials of the Norwegian name)
BOP	Blowout preventer
CT	Coiled tubing
Drops	Dropped objects prevention scheme
DSHA	Defined situations of hazard and accident
ISF	Integrated skidding frame
HTO	Human, technological, organisational
NCS	Norwegian continental shelf
NDT	Non-destructive testing
NPD	Norwegian Petroleum Directorate
PSA	Petroleum Safety Authority Norway
TBT	Toolbox talk
TLP	Tension-leg platform
WP	Work permit

3 Introduction

The Heidrun field lies in about 350 metres of water on the Halten Bank in the Norwegian Sea. It has been developed with a floating concrete-hulled tension-leg platform (TLP) installed over a subsea template with 56 slots. The Heidrun TLP came on stream in 1995 and produces both oil and gas. Both field and facility are operated by Statoil.

Photograph 1 *Heidrun TLP facility.*

The Heidrun TLP has a skiddable conventional derrick which can handle ordinary drilling and well completion. Odfjell Drilling is the drilling contractor and responsible for the area. A separate well intervention derrick (BIT) installed alongside the main derrick is equipped for wireline and coiled tubing (CT) operations.



Photograph 2 *BIT and conventional derrick at 24 September 2015.*

The BIT was originally built and installed in 2007, but was taken ashore and modified in 2012 before being re-installed on the Heidrun TLP in 2013.

Service companies Baker Hughes and Altus Intervention conduct CT and wireline operations respectively for Statoil’s Heidrun well intervention section. Odfjell Drilling has been contracted by Statoil to maintain the BIT and the integrated skidding frame (ISF).

While rigging down on 22 September 2015 after a well intervention operating involving CT, an incident occurred when a grating plate was knocked off a hatch on the BIT. This object fell eight metres, weighed 31 kilograms and represented a kinetic energy just before impact of 2430 joules.

Photograph 3 *BIT and conventional derrick at 24 September 2015.*

The Petroleum Safety Authority Norway (PSA) decided on 23 September 2015 to investigate the incident. The PSA also supported the police inquiry into the incident.

<u>Composition of the investigation team</u>

- Sissel Bukkholm, occupational health and safety
- Roar Sognnes, drilling and well
- Jan Ketil Moberg, logistics and emergency preparedness – investigation leader

<u>Conduct of the investigation</u>

The investigation team arrived on Heidrun around 11.00 on 24 September 2015. Kick-off and concluding meetings were held jointly with the police. Statoil's own investigation team arrived later the same day.

The PSA and the police conducted a joint inspection of the incident site. The PSA participated in 12 interviews together with the police. In addition, it conducted one interview of its own offshore without the police being present.

Subsequently, the PSA interviewed people associated with the incident in the Statoil, Odfjell and Altus Intervention well intervention organisations for Heidrun in Stjørdal and Stavanger, as well as technical staff in Kongshavn Industri AS, the BIT manufacturer, at Godvik outside Bergen.

Documentation acquired and received in connection with the investigation is listed in appendix B.

As a basis for this investigation report, a human, technological, organisational (HTO) diagram has been created to map the underlying and direct causes. The HTO diagram uses the concepts of operational, organisational and technical factors. See appendix A.

<u>Mandate</u>

The mandate for the investigation accords with the PSA's investigation procedure.

a. *Clarify the incident's scope and course of events with an emphasis on safety, working environment and emergency preparedness aspects.*
b. *Assess the actual and potential consequences*
    1. *Harm caused to people, material assets and the environment.*
    2. *The potential of the incident to harm people, material assets and the environment.*
c. *Assess direct and underlying causes, with an emphasis on human, technological, organisational (HTO) and operational aspects, from a barrier perspective.*
d. *Discuss and describe possible uncertainties/unclear aspects.*
e. *Identify nonconformities and improvement points related to the regulations (and internal requirements).*
f. *Discuss barriers which have functioned (in other words, those which have helped to prevent a hazard from developing into an accident, or which have reduced the consequences of an accident).*
g. *Assess the player's own investigation report (the PSA's assessment is communicated in a meeting or by letter).*
h. *Prepare a report and a covering letter (possibly with proposals for the use of reactions) in accordance with the template.*
i. *Recommend – and contribute to – further follow-up.*

4 Course of events

4.1 Course of events before and during the incident

Simultaneous drilling and well activities are regularly conducted on Heidrun. Drilling operations are conducted with the ordinary drilling facilities and derrick at the same time as activities involving other wells using CT or wirelining through the BIT.

While rigging down equipment after a CT operation on well A-54, plans called for a heave compensator attached to a length of riser to be lifted out of a CT adapter on a hatch on the hatch deck located beneath the BIT. During this operation, four large aluminium spacer rings were to be removed manually followed by installing a master bushing and then landing the riser in a suitable set of slips. The steps to be taken in order to rig down the CT equipment from the relevant well were planned and described in *Step list/guidelines on rig down from A-54 and R/U on A-45 A. Rev 1.0*, where each stage was listed and numbered.

The work team prepared for the job by going through the Step list covering the conduct of the operation. Led by Statoil's well supervisor, this review took place initially in a meeting room.

Only one member of the work team had participated earlier in rigging down this equipment, while the other participants were unfamiliar with the operation. As a result, a toolbox talk (TBT) was conducted ahead of the actual lifting operation.

The work team comprised personnel from Altus Intervention and Baker Hughes. Altus Intervention conducts wireline operations on Heidrun and operates the lifting winches on the BIT. Baker Hughes conducts well intervention programmes which involve operations with the CT equipment on the Heidrun TLP.

Members of the work team were deployed at three different levels (see figure 1). The deck hatches on the BIT BOP deck were raised to the vertical position. The heave compensator was raised so that its top section was level with the lower edge of the deck hatch on the BIT BOP deck, where two people were standing and observing. One of these supported the lift until it had reached the agreed vertical position. TLP motion then caused the compensator to oscillate and to thump against a grating plate (section) in the hatch cover, so that the grating broke free from its fasteners and fell to the hatch deck eight metres below. There, it struck a person wearing a safety harness, whose job was to remove the spacer rings in the hatch opening, before it coming to rest atop the actual hatch in the hatch deck. Weather conditions were relatively calm when the incident occurred, with little wind or waves.

The two people on the BIT BOP deck descended to the injured person and escorted him out of the drop zone. His safety harness was removed.

The nurse was notified, and subsequently the control room. The injured person was accompanied to the sick bay for examination.

Following the incident, the area was secured.

On 19 September 2015, three days before the incident with the dropped grating, another incident had occurred in connection with cutting CT on the BIT BOP deck. The deck hatch covers were then in their horizontal position, and an air-powered saw was used to cut the CT into suitable lengths. These were then intended to drop directly into a container placed beneath the hatch opening. While a new suitable length of CT was being fed in for cutting, the opening in the hatch structure on the BIT BOP deck was subject to heavy pressure generated by the CT running tool and somewhat damaged/deformed.

4.2 Status of the plant before, during and after the incident

The BIT and ISF were manufactured by Kongshavn Industri AS, designed in accordance with machinery regulations[1] and CE marked. The machinery regulations (FOR 2009-05-20-544) describe principles for integrating safety. These require machines to be designed for operation, adjustment and maintenance without exposing people to risk when work is done – not only under conditions foreseen by the manufacturer but also in the event of erroneous use which could reasonably have been foreseen.

According to Kongshavn Industri, Hazop and Hazid analyses were conducted before manufacturing the BIT and ISF as the basis for risk assessments.

The deck hatch was modified in 2012. This involved upgrading such aspects as winches and control systems for lifting above pressurised equipment. Moreover, the lifting height over the work deck was increased and the BIT structure and deck hatch were strengthened. The deck hatch was shortened by 400mm towards the north in order to provide better space for landing CT on the BOP. A risk analysis was conducted in accordance with ISO 12100: 2010 before the BIT modifications in 2012, but did not cover the relevant hatch with deck gratings.

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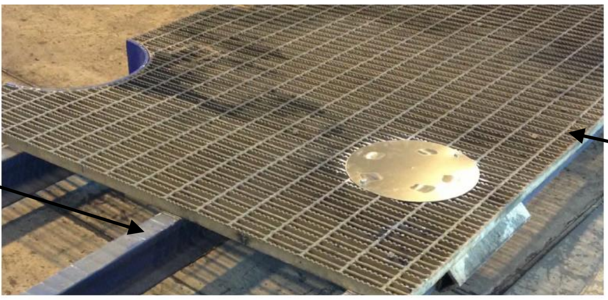
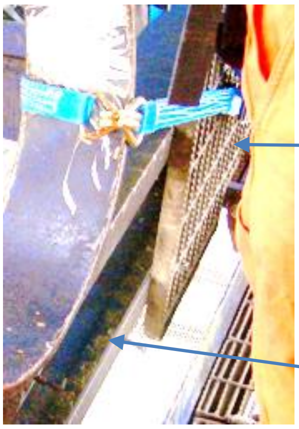
[1] *The machinery regulations adopted in Norway on the basis of the EU machinery directive specify that the manufacturer or its representative must see that a risk assessment is carried out to determine which requirements for protecting against hazards to life or health relate to the relevant machine. When the BIT and ISF were designed, such standards were available as* ISO 12100:2003, Basic concepts, general principles for design - Part 1: Basic terminology, methodology *and* Part 2: Technical principles.

Owing to its design[2], the hatch is subject to physical forces if loads oscillate or come into contact with it during loading operations. The photograph below shows deck gratings installed on the hatch structure.



Photograph 4 *Deck grating on hatch structure (source: user manual).*

The photograph below shows how the remaining deck grating on the hatch structure is installed. The grating sticks down.



Photograph 5 *Deck grating on the hatch structure in vertical position.*

The hatch mechanism/hinges were designed in such a way that the grating panel could fall through the gap when it was vertical. Photograph 6 below shows the width of the gap.

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[2] *According to the manufacturer, the deck hatch with gratings was designed in accordance with Norsok N-003,* Action and action effects*, table 5, NS3472,* Design of steel structures – calculation and construction rules *(now replaced by EN1993) and supplier information on gratings from Norsk Stål. According to the manufacture, the type is offshore grating, Norgesrist Type S, 35mm.*

Gap between deck and hatch

Photograph 6 *Gap between deck and hatch*.

The deck grating section had several types of fasteners, which were unsuitable for absorbing loads vertically. Although the fasteners have various designs, their common denominator is that the fasteners are not designed for vertical loads. They only clamp over a rod in the grating. To their rear, they are threaded for screwing into place with a bolt. One of the fasteners on the hatch where the grating fell off lacked a spring washer.

Deck grating fastener

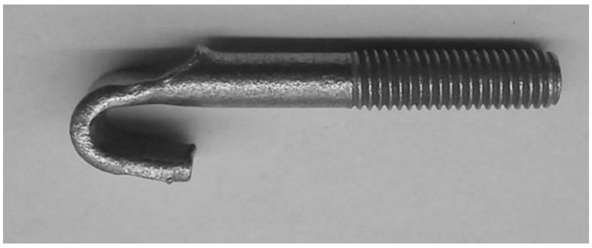
Photograph 7 *Deck grating fastener*.

Photograph 8 *Deck grating fastener*.

Photograph 9 *Deformed deck grating fastener where the grating came loose.*

With reference to photographs 10 and 11, the J hook is claimed by the manufacturer to have sufficient capacity. The hook has a shear strength of 870 kg and a tensile strength of 400 kg. The actual lip has a capacity of 215 kg.

Photograph 10 *Deformed J hook for the deck grating, with bolt and spring washer disassembled from the hatch where the deck grating came loose.*

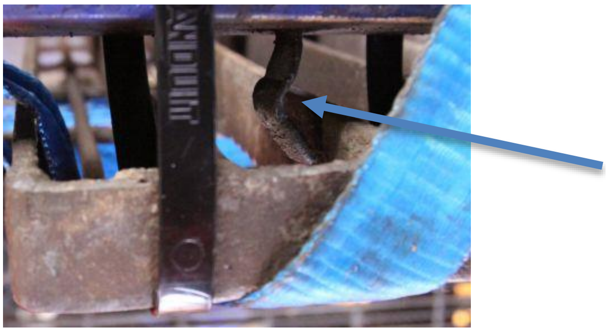


Photograph 11 *A new fastener of the J hook type for a deck grating, as it originally looked when the BIT was manufactured for the Heidrun TLP. (Source: Kongshavn Industri)*

Before the incident, the deck grating structure was probably damaged by an earlier event on 19 September 2015. The photographs below show the damaged structure and the deformed J hook fastener.

Damaged/deformed deck hatch structure

Photograph 12 *Damaged deck hatch structure.*



Deformed and loosened J hook fastener for remaining gratings on the hatch arm where the structural deformation was greatest

Photograph 13 *Deformed fastener hook under the remaining grating on the deformed deck grating structure, close to the spot where part of the deck grating came loose.*

The BIT and ISF were modified by Odfjell Drilling in 2012. Stricter restrictions on use were introduced because of the modified structure and changes to the design values. These changes reflected measurements of Heidrun TLP motions. For certain nodes in the structure, the modification resulted in a utilisation factor close to one (full utilisation)

The winch system used for lifting operations in the BIT was upgraded in 2012 in order to permit synchronous lifting. According to the winch operator, synchronous lifting was not used when the incident occurred. Section 2.2.4 of the user manual for the Heidrun BIT and ISF specifies that synchronous lifting should be used when lifting above pressurised equipment. Although work was being conducted under a suspended load, the lifting system – winches with equipment – was not placed in its most secure configuration, which involves synchronous lifting. According to Odfjell Drilling, synchronous lifting with the winches provides double security.

The BIT was sent to land in 2013 for non-destructive testing (NDT) of nodes as a result of identified fatigue cracking. Stricter use restrictions meant it was no longer permitted to place the heave compensator on the BIT BOP deck. It now had to be placed on the hatch deck. See figure 1, *Agreed and actual positioning for lifting the Odim heave compensator.*

Following the incident of 22 September 2015, the heave compensator and hatches with gratings were secured. Somewhat later, the heave compensator was lowered and removed from the BIT.

4.3 Chronological sequence of events

Statoil invited tenders for the BIT and ISF on 30 May 2005. A design review involving the users took place on 1 September 2005. Kongshavn Industri began design and production of the BIT and ISF in 2006. A Hazid and Hazop were conducted. The BIT and ISF were delivered to Statoil in 2007. Kongshavn Industri issued a conformity declaration for the BIT and ISF on 29 March 2007 pursuant to the 1994 machinery regulations (order number 522). A certificate was issued by DNV GL in 2007.

A dropped object (Drops) inspection was conducted at Kongshavn Industri on 24-25 January 2007. This formed part of Statoil’s follow-up to reduce the number of dropped objects in its development and operation Norway (DPN) business area.

Modification work to be carried out by Odfjell Drilling/engineering was identified in 2012. Its scope was eventually widened. The BIT’s height was increased and stricter environmental loads were applied to the design. More stringent use restrictions were imposed. A new conformity declaration was issued for the area which had been modified.

Fatigue cracking was identified offshore in 2012. The BIT and ISF were sent ashore for NDT of all important nodes before being returned offshore and reinstalled.

A PSA audit on the Heidrun TLP in 2012 (2012/522) identified work under suspended loads (audit report item 5.1.4). Statoil responded that personnel should not be under suspended loads pursuant to its governing documentation, and that the work should have been stopped.

Preparation of a Step list for work related to rigging down CT equipment used in/on well A-54 began in 2015. Statoil led the work of revising this. Owing to the use restrictions introduced after the conversion of the BIT, handling of the heave compensator was moved down to the hatch deck. The Step list included work under a suspended load.

A lifting test was conducted in June 2015 with the heave compensator, with three lifting operations conducted on the hatch deck in the BIT in connection with wells A-40 and A-54.

Odfjell Drilling issued a conformity declaration on 8 July 2015 pursuant to EU machinery directive 2006/42/EF, annex IIA. This declaration did not include the modified deck hatch.

DNV GL issued a new certificate (BGN115-7999) on 16 July 2015.

Cutting of CT took place on 19 September 2015. In connection with this work, the CT caused buckling of the edge of the opening in the hatch structure where the grating which fell was installed and bent the structure. CT-cutting finished on 20 September 2015.

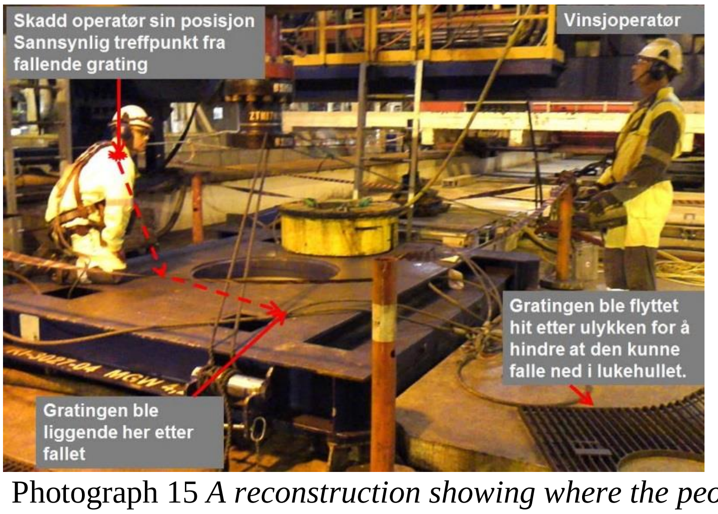
The grating was checked on 21 September 2015 by Baker Hughes and Statoil personnel and observed to be displaced in the gravitational direction. No corrective action was taken.

Planning to lift the heave compensator with part of a riser began on 22 September 2015. The deck hatches were opened. The night shift came on duty and met the Statoil well supervisor to conduct a TBT. Eight people took part – one from Statoil, four from Baker Hughes and three from Altus Intervention. Because of the lack of experience, it was decided to complete the TBT on site.

The operation to lift the heave compensator began, and was halted once the designated height had been reached. One person who was supporting the heave compensator up on the BIT BOP deck released his hold.

Photograph 14 *Taken after the incident, this shows the position of the heave compensator in relation to the relevant hatch arm on the BIT BOP deck where the grating came loose. (Source: Statoil)*

The injured person, wearing safety harness, crawled in past the barriers and crouched under the heavy compensator in order to remove some aluminium spacer rings. The heave compensator oscillated and hit the grating, which was knocked free from its vertical position on the hatch arm. It fell about eight metres through the gap between the deck hatch and the deck to the hatch deck. It grazed the shoulder of the injured person before landing on the deck and coming to rest.



Photograph 15 *A reconstruction showing where the people on the hatch deck were placed when the grating landed. (Source: Statoil)*

The injured person raised himself to a kneeling position. Two people descended from the BIT BOP deck in the derrick and the injured person was helped to remove his safety harness. The medic and control room were notified.

The emergency response organisation was subsequently notified. The medic and a stretcher team arrived at the injured person. He was able to get to his feet and was escorted to the sick bay, where he was then checked by the medic and assigned to alternative work on board.

The heave compensator and gratings were secured. The heave compensator was lowered. Drops inspections were conducted in the wake of the incident.

4.4 Description of conditions at the site

Figure 1 shows the agreed and actual locations of the Odim Heave Compensator, and the positions of the people involved when the incident occurred.

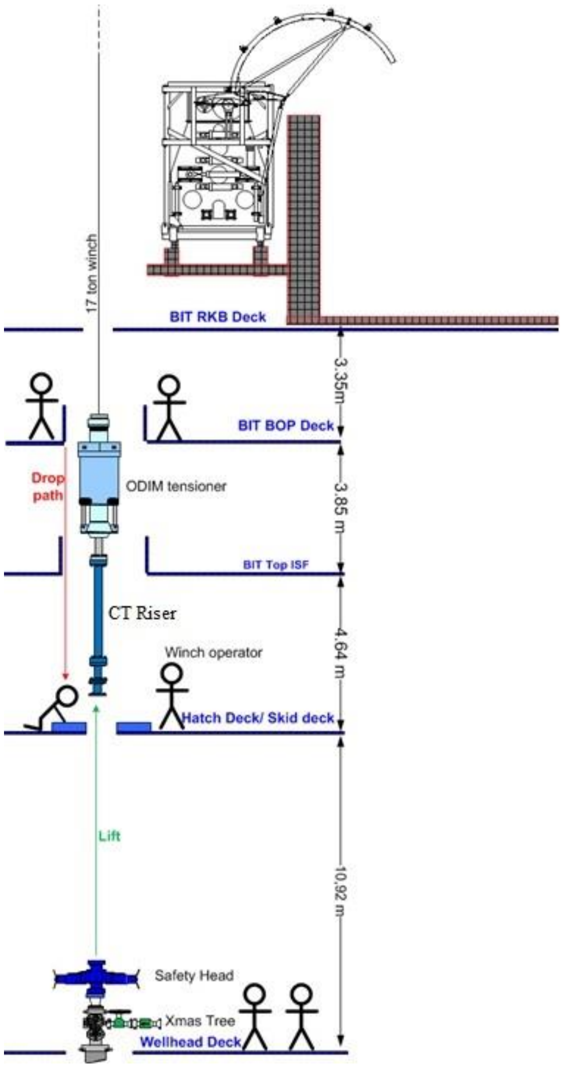


Figure 1 *Agreed and actual location for lifting the Odim heave compensator with riser section suspended beneath – indicated in the figure as "CT Riser". (Source: Statoil)*

5 Potential of the incident

5.1 Actual consequences

The incident caused a personal injury. The grating weighed 31kg and fell eight metres. The injured person was under the suspended load in order to remove spacer rings so that a master bushing could be installed in the opening in the hatch deck. The grating appears to have grazed the injured person's shoulder blade.

The injured person suffered pain and swelling in his shoulder. He was checked medically and given alternative light work. The job was temporarily suspended. The grating was deformed by the impact with the deck. Photograph 16 shows the grating section which fell.

Photograph 16 *Damaged deck grating plate.*

The photograph below shows how the grating was mounted on the hatch. The round circles indicate the position of the grating fasteners.

Photograph 17 *Position of the grating which fell.*

5.2 Potential consequences

Under slightly different circumstances, the fall of the grating could have caused serious personal injury or death. In addition, a person was three metres from the spot where the grating landed. The grating could have dropped to the wellhead deck below, which contains hydrocarbon systems and equipment. That could have caused hydrocarbon leaks with possibilities for ignition and emissions.

6 Observations

6.1 Nonconformities

6.1.1 Lack of technical integrity – deck hatch in the BIT

Nonconformity
The deck hatch had deficiencies related to its design, outstanding maintenance and earlier damage, which was not identified and corrected.

Grounds
The deck hatch was designed in such a way that raising it to a vertical position opened a gap between deck and hatch, allowing a grating to fall through. Hazards related to this gap were not identified when designing the hatch. Gratings installed on the hatch structure were not adequately secured to withstand blows from oscillating loads.

Drops inspections had failed to identify hazards from using the hatch.

The manufacturer of the BIT and ISF and the company which modified the BIT failed to conduct adequate risk analyses which could have identified the hatch design hazards.

As the drilling contractor, Odfjell Drilling is responsible for maintaining the BIT and ISF. That includes both preventive and corrective maintenance. The user manual from Kongshavn Industri specifies monthly Drops inspections. The drilling contractor has established a maintenance programme which covers the threat of dropped objects. The Drops inspection due in August 2015 was not carried out.

Requirements
Section 5s, letter c, of the facilities regulations on design of facilities
Section 45 of the activities regulations on maintenance

6.1.2 Inadequate follow-up

Nonconformity
Failure to identify and correct damage to the deck hatch after the incident of 19 September 2015.

Grounds
Two days before the grating section fell, another incident occurred while cutting CT in the same area. During this activity, parts of the relevant hatch structure on the BIT BOP deck came under heavy pressure and were deformed/damaged.

The damage was not reported to Odfjell Drilling, which had maintenance responsibility for the BIT and ISF. No repair notification was entered in the maintenance system.

Requirements
Section 45 of the activities regulations on maintenance
Section 77 of the activities regulations on handling hazard and accident situations

6.1.3 Inadequate identification of risk

Nonconformity
Inadequate identification of risk in planning and executing the lifting operation.

Grounds
The method chosen for rigging down the heave compensator required work under a suspended load. In this lifting operation, the injured person was under a suspended load.

Ahead and during the planning, important conditions such as work under a suspended load, a damaged deck hatch and a constricted lifting area were not adequately assessed.

The Step list which formed the basis for planning the lifting activity does not describe the risk associated with work under a suspended load. It emerged that no separate risk assessment had been carried out for the work operations. The lifting operation was conducted during the incident without using the synchronous lifting system, which means the use of two winches. The user manual specifies that synchronous lifting must be used over pressurised systems and critical equipment.

The lifting operation was conducted in a constricted area. Norsok R-003N and the internal work process/requirement *DW911 Lifting and pipehandling operations in drilling and well areas* applied by Statoil specifies that lifting through hatches is to be regarded as a blind lift. This calls for extra care in planning. Lifting over several levels was not described by a local procedure or a safe job analysis (SJA). The standard also specifies that special attention should be paid to the threat of the load or load bearer snagging on hatch coamings.

Requirements
Section 30 of the activities regulations on safety-clearance of activities
Section 92 of the activities regulations on lifting operations, see the guidelines which refer to Norsok R-003N

6.1.4 Unclear roles and responsibilities

Nonconformity
Roles, responsibilities and reporting lines were not unambiguously defined and understood before and after the lifting operation.

Grounds
The CT supervisor led the TBT immediately before the actual lifting operation, but interview statements indicated that responsibility for the lifting operation was unclear.

It emerged from interviews that the person with operational responsibility for the lifting operation, the logistics supervisor in Heidrun operations, was not directly involved in the planning or the TBT. Although a local appendix for Heidrun, OM10.01.01.01, notes that operational responsibility has been delegated to the wireline team leader, it emerged from interviews that a perception existed among logistics supervisors that they have the overall operational responsibility for lifting.

It was also unclear who was responsible for preparing and updating the Step list.

Requirements
Section 6, paragraph 2, of the management regulations on management of health, safety and the environment
Section 92 of the activities regulations on lifting operations, see the guidelines which refer to Norsok R-003N

6.1.5 Deficiencies in governing documentation

Nonconformity
The work operations described in the Step list were not entrenched in governing documentation.

Grounds
A Step list had been prepared as the basis for the lifting operation. This carries both Baker Hughes and Statoil logos. The list is entrenched in the activity plan for the well.

The Step list describes work operations to be performed by both Statoil and the well contractors. Interviewees said Statoil had led the work of revising the list. According to Statoil, both Altus International and Baker Hughes were involved in its preparation. Interviewees say the list is not entrenched in Statoil's governing documentation, but Statoil has updated it with revision numbers. It emerged from several interviews that the Step list was perceived as a Statoil document. It was not entrenched in Statoil governing documentation.

Requirements
Section 20, paragraph two, of the activities regulations on start-up and operation of facilities with guidelines
Section 24 of the activities regulations on procedures

6.2 Improvement points

6.2.1 Staffing and expertise

Improvement point
Unclear conditions on staffing and expertise.

Grounds
On the basis of interviews with contractors and Statoil, it is unclear whether Statoil and contractors hired for well maintenance have sufficient staffing and expertise to ensure that lifting operations in the well area can be conducted in a safe manner.

Requirements
Section 12 of the framework regulations on organisation and competence
Section 21 of the activities regulations on competence
Section 92 of the activities regulations on lifting operations, see the guidelines which refer to Norsok R-003N

6.2.2 Notification of the incident

Improvement point
Deficiencies in notification of the incident.

Grounds
Statoil's governing document on emergency preparedness on the Norwegian continental shelf (NCS) – Heidrun, DSHA 06 on personal injury or illness specifies that the medic, first-aider, on-scene commander and emergency response commander must be notified. The emergency response commander, the platform manager, was not immediately notified of the incident.

The incident was not logged.

Requirement
Section 77 of the activities regulations on handling hazard and accident situations.

7 Barriers

7.1 Barrier elements which failed and functioned

The table below shows which barriers failed to function and which functioned. These are identified using the HTO methodology. See the HTO diagram in appendix A.

The barriers are also shown in relation to the technical, organisational and operational barrier elements.

Date	Barriers which failed to function	Barriers which functioned	Technical elements	Organisa-tional elements	Operational elements
2006	Design of hatch with deck gratings		Hatch had design weaknesses with regard to vertical loads and fasteners Lack of risk assessment and follow-up		
2012	Modification of hatch with deck gratings		Modification of hatch with deck gratings was not risk-assessed		
26-29 Aug 15	Nonconformity identified by the PSA concerning work under suspended load			PSA finding of work under a suspended load was not corrected	
2015	Inadequate Step list/guidelines			Described work under suspended load	
19 Sep 15	Inadequate planning of the work			Inadequate planning of CT cutting	

Date	Barriers which failed to function	Barriers which functioned	Technical elements	Organisa-tional elements	Operational elements
				No risk assessment of the work operations Step list/ guidelines not entrenched in governing documentation	
21 Sep 15	No measures taken after damage to hatch structure identified		Hatch structure suffered damage		No follow-up of damage to hatch structure on 19 September 2015
	Drilling contractor responsible for the BIT was not informed			Corrective measures not implemented	Inadequate information to the BIT maintenance manager
22 Sep 15	Inadequate expertise among lifting personnel			Inadequate - risk analysis - planning - use of governing documentation Synchronous lifting not used SJA not used	Only one person had experience from similar operations
		People involved in the lifting operation were positioned at different deck levels			
		Areas at the various levels were cordoned off			
	Inadequate training				Little knowledge of planning and risk assessment for lifting operations
22 Sep 15	Unclear roles and responsibilities in the lifting operation				Inadequate information and involvement
	Person with operational responsibility did not participate in planning (critical lifting operation)				Inadequate information and involvement

Date	Barriers which failed to function	Barriers which functioned	Technical elements	Organisa-tional elements	Operational elements
	Work under suspended load				Work under suspended load Inadequate risk assessment
	Not secured against possibility of grating falling to the underlying wellhead deck, with people and hydrogen systems present				Adequate security not put in place
		Heave compensator was secured after the incident			
	Control room not notified immediately after the incident				Medic was notified first Control room was notified later via the Statoil well supervisor Initial information gave wrong location
	Personal injury not notified to the cabins (DSHA 06)				PA announcement did not reach the emergency response commander, platform manager
		Injured person looked after by colleagues, medic and stretcher team			
	Inadequate maintenance (Drops)				Drops inspections failed to identify possibility of a dropped grating Inadequate maintenance

Table 1 *Identified barriers related to technical, organisational and operational factors.*

7.2 Discussion of uncertainties

The following uncertainties emerged from the investigation.

7.2.1 Follow-up and learning

The investigation shows that there was inadequate reporting after the damage caused to the hatch structure before the incident, and that the person responsible for lifting operations in the well area had not been involved in planning the lifting operation. Adequate lessons do not appear to have been learnt from the nonconformity related to work under a suspended load identified in the PSA's audit of CT operations on the Heidrun facility in 2013.

8 Appendices

A: HTO incident and causality analyses
B: Documents used by the investigation
C: Overview of personnel interviewed