

# Investigation report

## Report

Report title Investigation report – Goliat FPSO – serious personal injury 250616	Activity number 014229058
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## Security grading

<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

A deck operator on the Goliat facility was seriously injured at about 10.55 on 25 June 2016. He was hit on the head by wire rope being reeled in using a work winch in the D-10 area.

The accident occurred while the area was being cleared after offloading crude oil the day before.

The PSA's investigation concludes that the socket termination on the wire rope got caught in the guide roller in front of the winch, which caused it to come under considerable strain. Findings at the site and witness statements indicate that the cast socket came free and that the rope struck the deck operator on the head.

Several regulatory breaches have been identified, including a lack of or inadequate barriers which could otherwise have prevented the serious incident. A number of underlying technical, organisational and operational causes have thereby contributed to allowing this accident to happen.

The investigation has found deficiencies in governing documents, inadequate management of risk and competence, and a lack of clarity in roles and responsibilities.

Examples include design faults and deficiencies in the winch and guide roller, a lack of risk assessment for the work operation, insufficient competence and inadequate training in using the equipment. In addition, user manuals were missing and no conformity measurements had been made of the equipment being used.

## Involved

Main group T-2	Approved by/date Erik Hørnlund/5 January 2017
Members of the investigation team Arnt-Heikki Steinbakk, Sigmund Andreassen and Eva Hølmebakk	Investigation leader Arnt-Heikki Steinbakk

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**Photograph 1:** The Goliat facility. (Source: Eni)

## 1 Summary

A deck operator was seriously injured at about 10.55 on 25 June 2016 when he was hit on the head by an object. This incident in the D-10 area of the Goliat facility occurred when a length of wire rope was being reeled in.

The area was being cleared after offloading crude oil to a shuttle tanker the day before. The clearing-up involved reeling in the wire rope which still lay on the deck. This rope was used to pull the offloading hose into the right position while it was being wound up.

While the wire rope was being reeled in, its socket termination became snagged in the guide roller located about eight metres from the winch – hereafter designated the work winch. This placed the rope under considerable strain. Findings at the site and witness statements indicate that the cast socket termination on the rope came free, and that the rope struck the deck operator on the head.

The investigation identified several regulatory breaches, including the lack of or inadequate barriers and measures which could otherwise have prevented the serious incident. A number of underlying technical, organisational and operational causes have thereby contributed to allowing this accident to happen.

The investigation has found deficiencies in governing documents, inadequate management of risk and competence, and a lack of clarity in roles and responsibilities.

Examples include design faults and deficiencies in the work winch and guide roller, a lack of risk assessment for the work operation, insufficient competence and inadequate training in using the equipment, a lack of user manuals and a failure to make conformity measurements of the equipment being used.

These observations and findings must be viewed in connection with the PSA's earlier follow-up of Eni Norge AS (Eni) and with the order received by Eni on 17 February 2016. That applies particularly to conditions associated with material handling, clarification of roles, competence and communication of information.

Nonconformities have been identified in the following areas:

- follow-up of technical conditions
- identification of operational risk
- governing documents
- work processes
- worker participation
- commissioning work before start-up and operation
- material handling plan
- roles and responsibilities
- competence.

In addition, the investigation has identified improvement points related to

- marking and signage
- evacuation routes.

## 2 Definitions and abbreviations

<b>Definitions</b>	
<b>Barriers</b>	Technical, operational and organisational elements which are intended individually or collectively to reduce the possibility of a specific error, hazard or accident occurring, or which limit its harm/disadvantages.
<b>CE marking</b>	Where users and government agencies exercising control of products are concerned, such marking means that the product meets the safety requirements which apply in the EU/EEA area, and that this can be documented. Machines with CE marking which are accompanied by a conformity certificate are to be regarded as complying with the regulatory requirements. See section 11 of the machinery regulations on compliance with health and safety requirements for CE marking.
<b>Abbreviations</b>	
<b>APL</b>	Advanced Production and Loading (NOV company)
<b>Eni</b>	Eni Norge AS
<b>FPSO</b>	Floating production, storage and offloading facility. See the guidelines to section 25 of the framework regulations
<b>Machinery regulations</b>	Regulations on machinery FOR-2009-05-20-544
<b>Norsok R-002</b>	Lifting equipment (standard)
<b>Norsok R-003N</b>	Safe use of lifting equipment (standard)
<b>NOV</b>	National Oilwell Varco
<b>PSA</b>	Petroleum Safety Authority Norway
<b>SJA</b>	Safe job analysis
<b>SWL</b>	Safe working load (for wire rope, for example)
<b>WP</b>	Work permit

## 3 Introduction

The Goliat field lies in production licence 229, awarded in the Barents Sea round in 1997. Licensees for PLs 229/229B are Eni (operator) with 65 per cent and Statoil Petroleum AS with 35 per cent. The field came on stream on 18 April 2016.

The Goliat facility is an FPSO installed on the Goliat field in the Barents Sea north-west of Hammerfest. This Sevan 1000 type has been developed by Sevan Marine on the basis of the latter's proprietary technology. According to Eni, the FPSO is specially configured for environment-friendly operation and energy recovery, including power from shore, segregated ballast tanks and a system to prevent polluted ballast water being discharged to the sea.

The specially designed winterisation solution is claimed to provide good working conditions for crew also during the winter season.

### 3.1 Local conditions

Goliat lies some 88km from Hammerfest and takes about 20 minutes to reach by helicopter. Flying time from the field to Tromsø is roughly 50 minutes. The search and rescue (SAR) helicopter in Hammerfest has a 15-minute response time while passenger flights are under way, but up to an hour for the rest of the day. The Sea King helicopter in Banak takes 45-73 minutes to reach the field, depending on weather conditions.

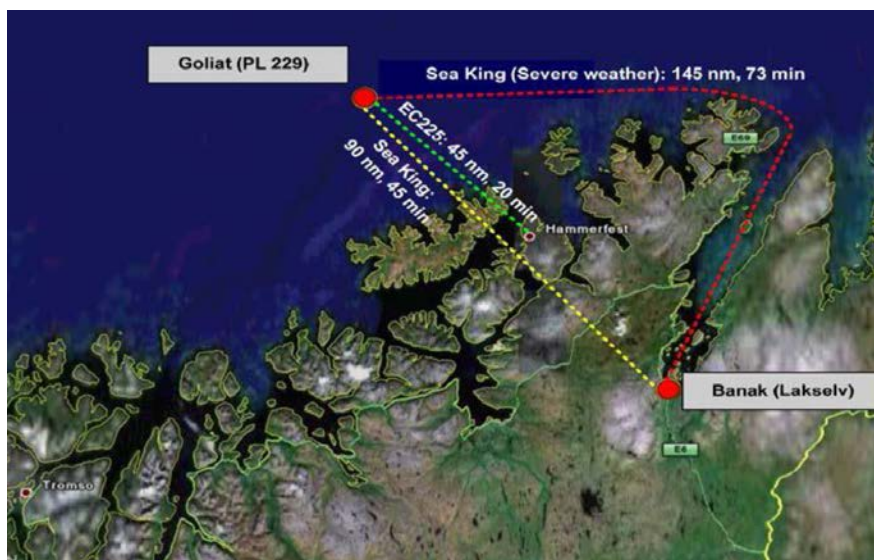


Figure 1: Distances and flying times to Hammerfest and Banak. (Source: Eni)

## 4 The investigation

The PSA was notified by Eni on the morning of Saturday 25 June of a serious accident on the Goliat facility. An object had reportedly struck a deck operator on the head during reeling of a wire rope in the D-10 area, and he had now been flown by helicopter to the University Hospital of Northern Norway (UNN) in Tromsø. His condition was unclear, but described as serious.

The work which led to the accident was being done by personnel from Apply Sørco. The winch operator and injured deck operator had been hired in connection with commissioning the facility.

On the basis of the information received from Eni, the PSA resolved to investigate the incident.

### 4.1 Investigation team mandate

The mandate for the PSA investigation was as follows.

- a. Clarify the incident's scope and course of events including planning, risk assessments and execution of the work (normally with the aid of a human, technology and organisation (HTO) diagram), with the emphasis on safety, working environment and emergency preparedness aspects.
- b. Assess training, competence and familiarisation with the operation for those involved.
- c. Assess emergency medical preparedness and evacuation.
- d. 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.
- e. Assess direct and underlying causes, with an emphasis on human, technology and organisation (HTO) aspects from a barrier perspective.
- f. Discuss and describe possible uncertainties/unclear aspects.
- g. Identify nonconformities and improvement points related to the regulations (and internal requirements).

- h. Assess the player's own investigation report.*
- i. Prepare a report and a covering letter (possibly with proposals for the use of reactions) in accordance with the template.*
- j. 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).*
- k. Recommend – and normally contribute to – further follow-up.*

## 4.2 The investigation team

Name	Position	Discipline
Eva Hølmebakk	Principal engineer	Working environment
Sigmund Andreassen	Principal engineer	Logistics and emergency preparedness
Arnt-Heikki Steinbakk	Principal engineer/ investigation leader	Logistics and emergency preparedness

The investigation team arrived on the Goliat facility around 11.00 on Monday 27 June in the same helicopter as Eni's investigation team. The police arrived around 18.00 on the same day.

## 4.3 Methodology

The investigation took the form of interviews with personnel in the land and offshore organisations and verifications on the facility, including inspection of the incident site and assessment of governing **documents** and findings in Eni's own investigation report.

In charge of investigating the incident, the Troms police district received assistance from two tactical investigators from the Rogaland police district as well as its own technical specialist.

The PSA team was asked to support the police and joined them in inspecting the incident site on Monday evening. It was also present during seven police interviews. In addition, the team conducted its own interviews on the facility without the police being present.

Interviews were also carried out on land together with the police. The injured person was interviewed in Bergen on 27 September. A group of senior Apply Sørco personnel responsible for the contract with Eni, and for follow-up of workers contracted out to the Goliat facility, was interviewed on Tuesday 4 October.

Documents requested and received by the team in connection with the investigation are listed in chapter 13.

The underlying causes of the incident were identified by reviewing technical, operational and organisational elements.

A chronological overview has been produced to visualise the course of events and to identify and describe the underlying and direct causes. A schematic overview of the most important barriers which failed has also been prepared.

## 5 Equipment and activities in the D10 area

The module where offloading of oil to shuttle tankers takes place is known as the D10 area.



**Photograph 2:** Top left: offloading hose before enclosure. Top right: D10 area in front of the flare boom after enclosure. Above left: offloading hose seen from the sea. Above right: the reel with the loading hose viewed inside the D10 area. (Source: Eni)

### 5.1 Offloading system

The whole offloading system is placed in an enclosed module (D10) to avoid icing. This system has been designed for Arctic conditions.

The offloading system involves a hose reel, hose and hose support system. The suspension system comprises a platform hung on the exterior of the facility to ensure a safe distance between hose and hull. The system is designed to prevent overloading of the hose reel.

Two large sliding doors provide the main access to D10, but other doors also open into the area.

The hose reel with support structure is 12.5m in diameter and 15m wide. The offloading solution otherwise comprises two utility systems with two winches. One is used to handle the mooring hawser, the other for hose handling and replacing hose components. The last of these is designated the work winch in this report.

The Goliat facility is an FPSO, which allows shuttle tankers to take position on it in line with the prevailing weather. With a length of about 400m, the hose is longer than those normally used for such operations.

The offloading system has been designed and delivered by APL in Arendal, a subsidiary of NOV Completion & Production Solutions. It was installed during construction of the facility at Hyundai Heavy Industries in South Korea.



### 5.1.1 Equipment in the D10 area

- Winch for replacing hose components (work winch).
- Winch for offloading hose.
- Winch for mooring hawser.
- Hoists and overhead travelling cranes for various support operations.

### 5.1.2 Equipment in use during the incident

- Work winch (tag 33MK003).
- Operation panel (tag 33JC004).
- Guide roller for wire rope (tag 33MZ008).

### 5.1.3 Work winch with equipment

- The winch is a double unit, with capacities of 40 tonnes in one section and 10 tonnes in the other. The wire rope is 18mm with a cast socket termination for the smaller section and three-eighth mm for the larger. Remote control is installed.
- The 10-tonne section of the winch was upgraded to 13 tonnes.
- The winch is designed in accordance with machinery group M1, with a design life of 30 years and Atex category 2 zone 1.
- According to Eni, the winch was delivered with *material certificates 3.1 – material* for its load-bearing components, which will accord with *Norsok R-002* and the relevant section of *EN 13852-1*.



**Photograph 3:** Incident site viewed through the door from the quarters module. (Source: PSA)

## 5.2 Material handling and the operator's responsibility

Eni's material handling philosophy is expressed in section 11 of the *229A-HHI-R-FD-0002* document. This says that equipment for material handling must be delivered in accordance with *Norsok R-002 rev April 2010* as well as the applicable *machinery regulations*.

Equipment used during the incident must comply with the stated specifications on acceptance, before it begins to be utilised. Specifications for material handling equipment are provided in section 13 of the *229A-HHI-R-FD-0003* document.

The material handling plan contains a general description of the D10 area. Use of winches for handling hoses and mooring hawsers is not included.

According to section 9 of Eni's 229-*HHI-R-FD-0003* governing document, lifting facilities must be certified by a recognised certification authority and possess the following documents:

- conformity declaration
- certificate of compliance
- loading certificate and list of certificates
- functional acceptance test
- certificate for application
- operating instructions

#### Certification of lifting equipment

According to section 9 of Eni's 229-*HHI-R-FD-0003* governing document, a "competent person" must certify all lifting equipment.

Eni bases the use of lifting equipment on *Norsok R-003*. See Eni governing document 229A-*HHI-R-FD-0003 Material Handling Analysis Report for General and LQ*.

Other significant considerations for material handling equipment include the manufacturer's and main supplier's responsibility for complying with the requirements specified in the *machinery regulations*, and the operator's duty to see to it that relevant requirements in these regulations are complied with.

### **5.3 Shuttle tankers**

Knudsen NYK Offshore Tankers won Eni's contract for transporting oil to market. Shuttle tankers load 850 000 barrels per week. Statoil lifts its share of production with its own shuttle tanker (*Eagle Barents*).

## **6 D10 area and course of events**

The incident occurred in the D10 area – the module for oil offloading. Regular offloading began on 29 March 2016.

### **6.1 Roles and responsibilities**

#### **6.1.1 Maritime and logistic supervisor (M&L)**

Eni's *maritime and logistic supervisor* is responsible for loading and offloading operations on the facility, including in the D10 area. According to the job description, this position bears the *operational responsibility* role. See *Norsok R-003N*.

#### **6.1.2 Operations and maintenance supervisor (O&M)**

Eni's *operations and maintenance supervisor* is responsible for operation and maintenance. This includes machinery and equipment used for offloading oil in the D10 area. According to the job description, this position bears the *technical responsibility* role. See *Norsok R-003N*. This includes responsibility for ensuring that all personnel have the right competence for using lifting equipment, that all necessary equipment documents are available, and that those involved have the right expertise.

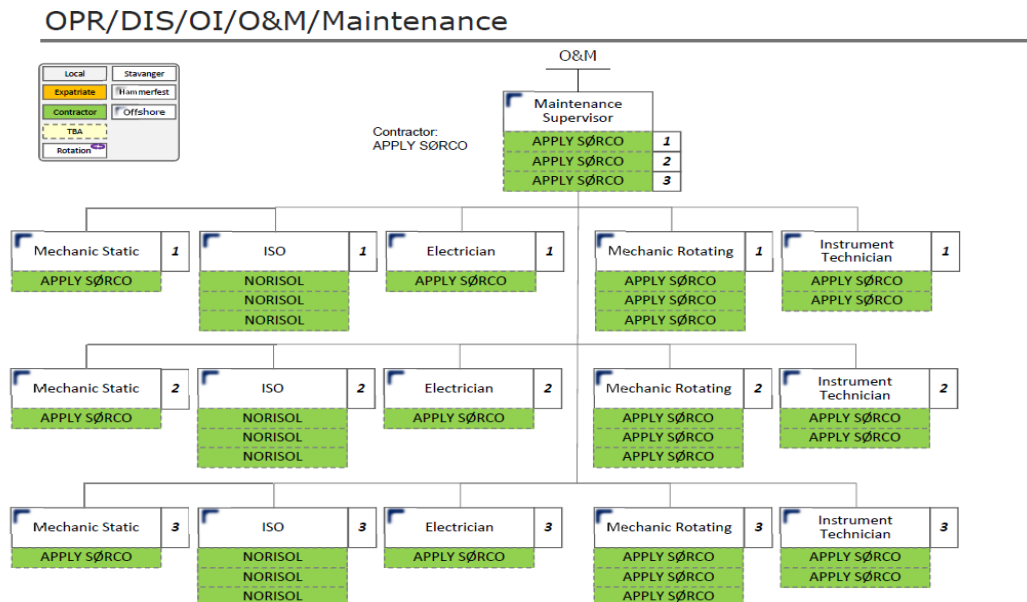
### 6.1.3 Mechanic

According to Eni's job description for the *mechanic*, one responsibility is to ensure – in cooperation with the *maritime and logistic supervisor* – that offloading proceeds in a safe manner and in compliance with procedures. The *mechanic* reports to Eni's *operations and maintenance manager*.

It appears from the job description for the *mechanic* that this position was originally intended to be filled by Eni personnel, but people from Apply Sørco are entered in the organogram and report to that company's *maintenance supervisor* on the facility.

### 6.1.4 Maintenance supervisor

According to the job description and the contract with Eni, Apply Sørco's *maintenance supervisor* reports to Eni's *operations and maintenance supervisor*.



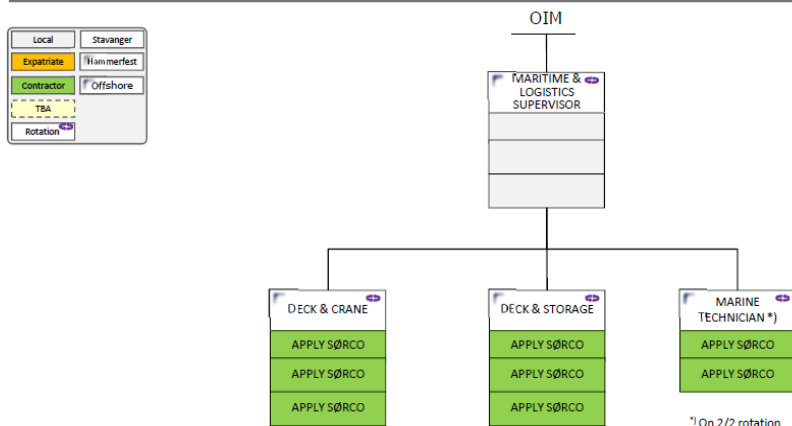
**Figure 2:** Organogram showing reporting lines between the operations and maintenance supervisor (Eni), the maintenance supervisor (Apply Sørco) and Apply Sørco personnel on board, including the mechanic. (Source: Eni's presentation)

### 6.1.5 Crane and deck personnel

All crane and lifting operations on the facility are performed by Apply Sørco personnel. That also applies to work carried out in the D10 area when connecting/disconnecting during offloading. Pursuant to their job descriptions, these personnel report to Apply Sørco's maintenance supervisor on board.

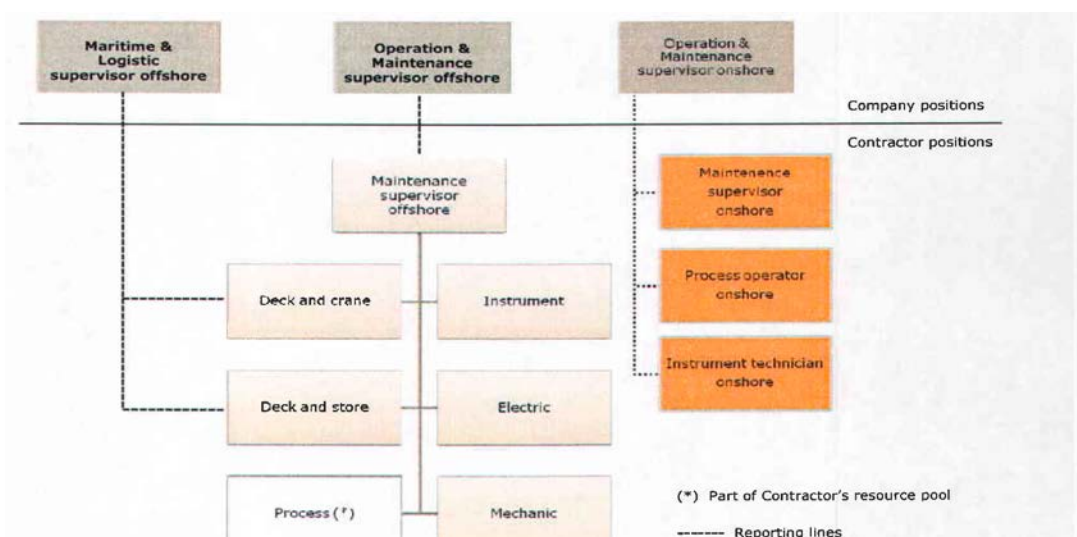
However, Eni's organogram shows crane and deck personnel directly subordinate to the operator's *maritime and logistic supervisor*.

## OPR/DIS/OI/M&L



**Figure 3:** Organogram showing reporting lines between the maritime and logistic supervisor (Eni) and crane and deck personnel (Apply Sørco). (Source: Eni's presentation)

The organogram in section 4.1 of appendix A to the contract between Eni and Apply Sørco on *scope of work* shows that the reporting lines run to *both* Eni's maritime and logistic supervisor and Apply Sørco's maintenance supervisor. Section 4.1.2.1 states that crane and deck personnel will report to their own maintenance supervisor, but will coordinate all activity with Eni's maritime and logistic supervisor.



**Figure 4:** Organogram showing reporting lines between the maritime and logistic supervisor (Eni) and crane and deck personnel (Apply Sørco). (Source: contract between Eni and Apply Sørco)

### 6.1.6 Extra campaign and maintenance personnel

In a supplement to the contract with Apply Sørco, Eni has ordered additional personnel for the start-up phase. The injured deck operator worked as a *banksman* on fixed rotation and belongs to this category of personnel. According to their job description, *banksmen* assist crane and deck personnel and report to Apply Sørco's maintenance supervisor on board.

## 6.2 Take-over of equipment from project by operations

### 6.2.1 Eni's regulatory basis and use of standards

Eni has based machinery acquisitions on the *machinery regulations*. The latter apply to permanently installed facilities in the petroleum industry in areas specified in section 2 of the *framework regulations* on scope of application.

The work winch is a machine subject to the *machinery regulations*.

The *machinery regulations* require a conformity assessment of the complete machine, a risk assessment, a design which safeguards life and health, and the preparation of a conformity declaration for the finished machine. See appendix II to the regulations. A user manual is also required. See section 1.7.4.2 of appendix I to the regulations.

A conformity assessment of machines must be based on harmonised and recognised standards. In this case, for example, those responsible could have applied *EN-ISO 12100:2010 Safety of machinery*, or possibly *EN 14492-1:2006+AI:2009/AC2010 Cranes, power driven winches and hoists, Part 1 Power driven winches*.

Manufacturer NOV Molde applied *EN 14492-1:2006+AI:2009/AC2010* when assembling the work winch.

### 6.2.2 Equipment in use

A document review showed that Eni describes the work winch both as a “hose handling winch w/wire rope” and a “hose replacement winch” in the documentation relating to equipment in the D10 area.

This review also showed that the work winch is not included in Eni's analysis report for material handling on board. See document *229A-HHI-R-FD-0003 material handling analysis report for general and LQ*.

Documents *229A-APL-O-KA-0001 Hose replacement procedure* and *229A-APL-K-MB-0004 Inspection, maintenance & repair program* state that the work winch is to be used for lifting operations and is accordingly subject to section 69 of the *facilities regulations* on lifting appliances and lifting gear in addition to the *machinery regulations*.

Technical requirements for the work winch in document *229A-APL-ER812-R-DS-0001 Winch data sheet and technical description* are that the material certificate and the material in load-bearing components must accord with *Norsok R-003* and relevant sections of *EN13852-1 Cranes, offshore cranes, part 1*. See section 3.3 in the document. The same document states that the safety factor is set at 3.15:1 for a normal traction of 10 tonnes.

### 6.2.3 Equipment documentation

The documentation shows that NOV conducted a factory acceptance test (FAT) of the work winch (tag 33MK003) in November 2011. This test attested that DNV was to verify requirements set by NOV. See document *229A-APL-ER812-R-CA-0002 Hose Replacement Winch – Report final acceptance test*.

An assembly declaration for the work winch was prepared by supplier NOV's Molde works on 6 March 2012. See document 229A-APL-ER812-C-VB-000. This confirmed that the work winch complied with the *machinery regulations* and satisfied *EN 14492-1 Power driven winches*. It also confirmed that the winch satisfied *EN 13852-1 Cranes, offshore cranes*.

On page 101 of document 229A-HHI-A-KA-6003 rev C08, the 10-tonne capacity was crossed out and replaced with 13 tonnes on 16 August 2015. See also section 6.1.2.8 in this report.

Commissioning and inspection were carried out at the yard. See document 229A-APL-R-KA-0006 *Yard commissioning procedure, SDS Goliat*. But this procedure does not indicate whether the equipment used during the incident was subject to an overall assessment. This suggests that verifications were only conducted on an individual basis, without making an *overall* assessment of these in relation to directives and regulations.

That also emerges from document 229A-APL-ER812-R-MA-0001 *Functional Description Installation and Maintenance*, which states in item 1 that the operating system for the winches was not part of the NOV order for the delivery. It also states that APL will deliver the remote control for the work winch. See section 8 on control systems in document 229A-APL-ER812-R-DS-0001 *Winch data sheet and technical description*.

Section 8 in the *machinery regulations* on sale and delivery of machinery indicates that, when assembling a number of components, an overall risk assessment and review of documentation for each component incorporated in the assembled machine must be carried out. Furthermore, a conformity declaration and a user manual must be prepared for the finished machine

#### **6.2.4 Components included in equipment and machinery**

The following components form part of the completed machine in this case:

- work winch (tag 33MK003) with wire rope and cast socket termination
- guide roller for wire rope (tag 33MZ008), installed some distance from the winch
- control panel (tag 33JC004), also installed some distance from the winch
- power supply for operating these components.

#### **6.2.5 Responsibility when taking over equipment and machinery**

Where possible, the manufacturer must design the machine so that hazards which might arise from use or misuse are eliminated or minimised. If the design fails to provide satisfactory protection against loss of life or health, protective systems must be installed.

The user manual must give users a clear picture of residual hazards. At take-over and before using the machine, the responsible party (Eni) must see to it that the *machinery regulations* have been complied with, and that the necessary documentation and documents – such as a conformity declaration and user manuals – are in place.

It has not been possible to establish, on the basis of the documentation and documents made available, whether Eni satisfied itself about this on take-over.

### 6.2.6 User manual and internal procedures

Eni could not produce user manuals for the equipment in use.

No user manual for the work winch also means that no genuine basis is available to determine training requirements for personnel who are to use the equipment.

Nor have internal procedures for use of the work winch have been established. The only document presented to the team was unfinished.

Although the documents made available to the team contain information which could be included in a user manual for the work winch, they are far from adequate. The *machinery regulations* specify the content of a user manual for an assembled machine. See sections 1.7.4 of appendix 1 on the user manual, 1.7.4.2 on the content of the manual and 4.4.2 on lifting machines.

229A-APL-S-RA-0002 *Human factor analysis report* contains an assessment which states that a detailed procedure must be prepared for operation of the work winch because it has a long response time and continues to move after being put in neutral. This is described as “crucial”. See Note 10, page 11 in the report. Furthermore, Note 2 specifies that an assessment must be made of whether user manuals for the equipment are required in two languages and refers to *EN-12100*. The team cannot see that such an assessment has been made.

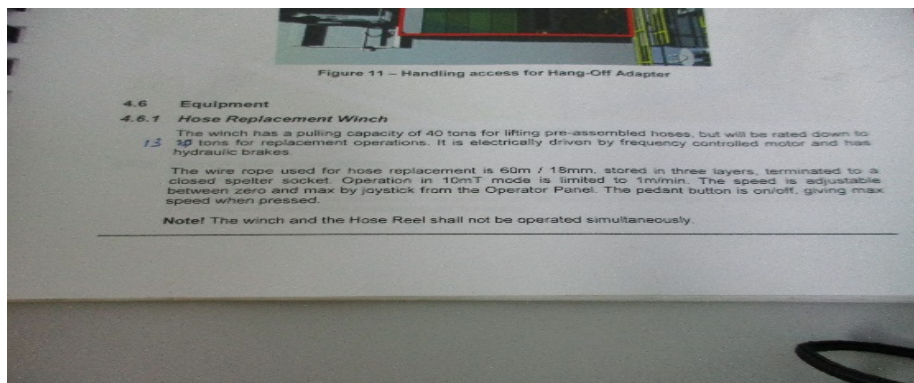
### 6.2.7 Material handling procedures

The work winch with equipment is described in an unclear way in Eni’s document 229A-HHI-R-FD-0002 *Material handling philosophy and management plan report, section 11 Offloading and external material handling* for the facility. Eni had not defined this as material handling equipment, but as part of the “offloading system”. The same document uses the term “offloading and external material handling”, without it being possible to find a description of the equipment in 229A-HHI-R-FD-0003 *Material handling analysis report for general and LQ*.

### 6.2.8 Upgrading of work winch traction

It emerged from conversations with personnel on board that the work winch was upgraded from 10 to 13 tonnes. It was unclear why this had been done, or by whom. Eni could not document the upgrading process. The capacity change is only shown by somebody having deleted “10 tonnes” and entered “13 tonnes”. This has been done solely on page 101 in document 229A-HHI-A-KA-6003 *Commissioning procedure for system 33*. The change was made on 16 August 2015. The other place where anything can be found on the upgrading is section 4.6.1 on the hose replacement winch in Eni document 229A-APL-O-KA-001 *Hose Replacement Procedure*, where “10 tonnes” has been deleted by a ballpoint pen and replaced with “13 tonnes”.

This procedure, where the change is depicted in photograph 4, was found in the main operation room for the main winch. Documents made available to the team so far show that the original documents have not been updated in any way.



**Photograph 4:** Document 229A-APL-O-KA-001. (Source: PSA)

Upgrading capacity from 10 to 13 tonnes reduces the safety factor for the wire rope from 3.15:1 to 2.42:1. Eni cannot document a risk assessment of the upgrade.

The breaking strength of the wire rope used is 31.5 tonnes. See *conformity declaration no 413149-2* from Carl Stahl AS. That gives a safety factor of 2.42:1. The safety factor for wire rope in a lifting system should normally be 5:1. See section 4.1.2.5, paragraph a, of the *machinery regulations* on safety factors for lifting gear and lifting components. Other components affected by the upgrade have not been assessed by the team, but must be assessed when issuing a conformity declaration.

Specifications for the work winch in section 4.2 of 229A-APL-ER812-R-DS-0001 *Winch data sheet and technical description* show that brake capacity is 12 tonnes for a 10-tonne work winch. It says nothing about assessing brake capacity after the upgrade to 13 tonnes.

### 6.2.9 Assembly testing

Nothing about obligatory assembly testing has been found when reviewing available documentation. See section 4.1.2.3 of appendix I to the *machinery regulations* on mechanical strength.

Eni cannot document that the work winch has been assessed against recognised standards for such equipment, such as *EN-ISO 12100:2010 Safety of machinery – general principles for design – risk assessment and risk reduction* and *EN 14492-1:2006+A1:2009/AC2010 Cranes - Power driven winches and hoists - Part 1: Power driven winches*. Had Eni applied this standard – see section 5.2.1 *Control devices* – the operator would have been able to stop the winch by placing the control lever in neutral.

In fact, the work winch continued to move *after* the lever was put in neutral. The wire rope moved about 27-30cm with no load on the winch. This was measured during inspection.

Had the work winch stopped when the lever was turned to off, the load on the wire rope is unlikely to have been as high as it was during the incident. The failure of the winch to stop immediately when the lever was put into neutral should have appeared in the user manual.

### 6.2.10 Changed area of application for the work winch

It emerged during interviews and the document review that the work winch was used for operations other than those it had originally been designed for. In the new mode, it was



utilised to untwist the offloading hose, which is reeled by the main winch. This operation can expose operating personnel to the threat of being hit by the wire rope or other objects being pulled or lifted.

Eni reported that wire rope slings used to begin with and during the initial operations failed to cope with the load and broke when untwisting the offloading hose. The company therefore converted to using chain slings.

### **6.2.11 Other winches in use**

A separate winch was used for the mooring hawser when deploying the offloading hose. This winch is also subject to the *machinery regulations*. It is controlled from the same panel as the work winch.

Eni cannot document that an overall conformity assessment has been carried out. Nor has a user manual been prepared for this equipment.

All operations involving material handling must be described as shown in sections B.5 and B.7 of *Norsok R-002* on material handling.

Equipment used during winch operations in the D10 area do not appear to have been assessed as assembled machines pursuant to the *machinery regulations*. It also appears that the various components have been treated independently in tests and commissioning processes during take-over.

## **6.3 The incident**

The Goliat facility is equipped to offload crude directly to shuttle tankers. The offloading equipment, with associated winches and hoses, is located in the D10 area where the incident occurred.

### **6.3.1 Offloading operations**

Before the actual offloading begins, a leader rope/mooring hawser is passed to the shuttle tanker with the aid of the standby ship. The rope is attached to the offloading hose, which is winched onto the tanker and connected to the pumping station in its bows. When offloading has been completed, the hose is winched back to the facility. The leader rope is similarly winched back onto a separate reel at the lowest D10 level.

Direct communication is established between the D10 area and the shuttle tanker when transferring the leader rope and connecting the offloading hose. During actual offloading, only the central control room (SCR) is in contact with the ship.

### **6.3.2 Reeling the offloading hose – twisting**

The offloading hose often gets twisted during reeling. Eni accordingly uses a separate work winch to pull/twist the hose into the right position before it is fully winched in. Information provided on board was that twisting was not foreseen in the original design of this equipment.

The offloading hose is twisted into the right position by passing a chain sling around it from the lower D10 deck. This is then connected to the wire rope from the work winch, before the

hose is tugged and twisted into the right position – when positioning stripes on the hose align. According to Eni, the hose is dimensioned to withstand up to 70 degrees of twisting.

When the offloading hose is to be twisted into the right position, an 18mm wire rope is lowered from the work winch via the guide roller to about 60-80cm above the deck and over to the chain sling. Once these have been connected, the work winch begins to pull.

Four-five people are involved throughout the operation. Their duties include lowering the leader rope/mooring hawser and offloading hose, reeling these in after use, operating winches and connecting chain slings. In addition come such jobs as cordoning-off areas before offloading operations and clearing up afterwards.

### **6.3.3 Status on the evening before the incident**

The offloading operation was completed on the morning of Friday 24 June. According to the log of M/T *Torill Knutsen*, the hose and hawser were released at 07.10, and the hose was reeled in.

The wire rope used to untwist the offloading hose during the final stage of reeling was *not* reeled in, but remained lying on the deck. It is unclear why the rope was not reeled up. All loose equipment is normally cleared away immediately after the operation has been completed.

When the wire rope is in use, it crosses gangways and evacuation routes in the D10 area. Leaving it on the deck can hinder free movement in gangways and evacuation routes.

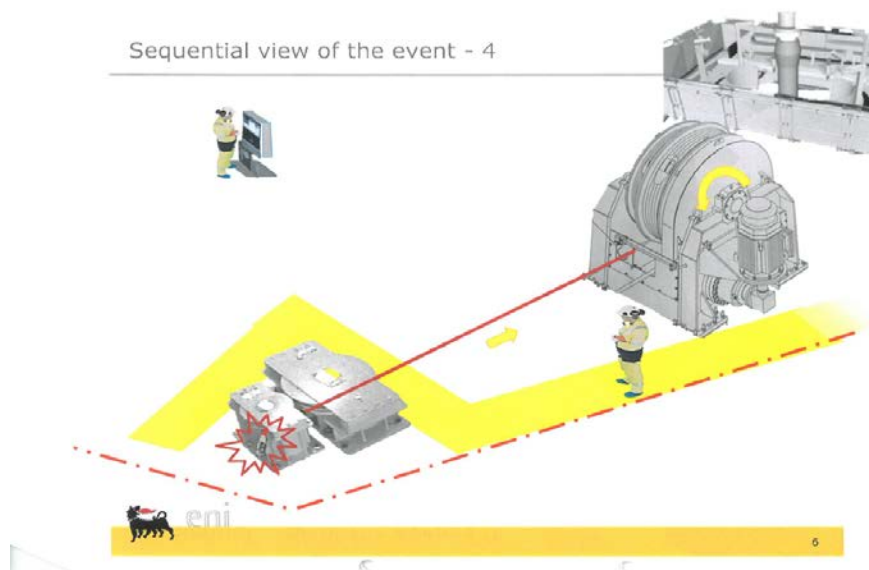
The wire rope remained on the deck until the following day, with the area cordoned off.

### **6.3.4 The day of the incident**

The crane operator (who operates the winch) and the deck operator (the victim) were in the D10 area at about 10.50 on Saturday 25 June. They then decided to clear away the wire rope spread across the deck.

The crane operator took his place at the winch control panel, while the deck operator stood roughly in the centre of the deck. The crane operator began to reel, and the deck operator kept an eye on the rope being pulled towards the guide roller. When the rope end approached the block, the operator positioned himself with his back towards the outer bulkhead roughly midway between winch and guide roller and facing the crane operator.

Reeling continued until the crane operator realised that something was wrong. The wire rope was taut, and the operator immediately put the control lever into neutral. The deck operator moved forward – probably to check why the rope had become snagged, according to a witness. The rope then came free from the guide and flew towards the deck operator. The crane operator believes that the socket termination or the rope hit the left-hand side of his hard hat and ear protector and threw him backwards towards the bulkhead. He remained lying there, clearly confused and partly unable to explain himself.



**Figure 5:** Overview of the D10 area on deck 50000 around 11.00 on 25 June 2016. Source: Eni presentation)

The crane operator understood immediately that the deck operator could be seriously injured and called for help over the internal VHF network via the crane frequency. This was noted by the control room operator and others on the same channel as the crane operator, who immediately notified the platform management, the nurse and the first-aid team. At the same time, he attempted to administer first aid to the deck operator.

It was decided not to sound a general alarm, but to send emergency response personnel directly to the injury site in order to save time and avoid having too many people in the area.

Within a few minutes, the victim was dealt with by the nurse and stretchered to the sick bay by the first-aid/stretcher team. At the same time, the incident commander requisitioned a SAR helicopter with doctor from Hammerfest. On arrival, the doctor immediately decided to send the victim to the University Hospital of Northern Norway (UNN) in Tromsø.

According to the facility log, less than an hour passed from notification of the incident until the SAR helicopter arrived. The UNN quickly determined that the victim had suffered a serious head injury.



**Photographs 5 and 6:** Overview of the D10 area on deck 50000 around 11.00 on 25 June 2016. Left: view from the stairs up to the main winch. Right: view from the mezzanine deck at the rear of the main winch. (Source: PSA)



**Photograph 7:** Control panel of the work winch (tag 33MK003). (Source: PSA)



**Photograph 8:** The guide roller (tag 33MZ008). (Source: PSA)

### 6.3.5 The incident in chronological order

Year	Period date/time	What	Comments
2011	Jan-Dec	Risk assessments of D10 area by APL	
	Aug	Hazop for replacement of offloading hoses, APL	
	Aug	229A-APL-S-RA-0002 Human factor analysis report	Version C02
	21 Oct	Verification of winch design, structure, DNV	
	17 Nov	Approval of 229A-APL-ER812-R-CA-0002 Hose Replacement Winch – Report final acceptance test	
	14 Dec	Approval of 229A-APL-ER812-R-DS-0001 Winch data sheet and technical description for winch with tag 33KM003	
2012	5 Feb	FAT verification of winch, DNV	
	6 Mar	Assembly declaration of winch with tag 33KM003 (T8556 performed in Molde by NOV) 229A-APL-ER812-C-VB-000	
	14 Sep	Conformity assessment of guide rollers (Møllerodden)	
2013	20 Jun	Approval 229A-APL-ER812-R-MA-0001 Functional Description Installation and Maintenance for winch with tag 33KM003	
	8 Nov	Approval of 229A-APL-R-KA-0006 Yard commissioning procedure, SDS Goliat	
	4 Dec	Approval of 229A-HHI-R-FD-0003 material handling analysis report	
2014	Over year at yard	Verification of equipment in D10 area	
	29 Apr	Approval of procedure for operation 229A-APL-O-	Absence noted by

		<i>MB-0001</i>	PSA as early as 2014
	29 Apr	Approval of system and operation manual for offloading system <i>229A-APL-O-MB-0001</i>	
	26 Sep	Approval of control panel	
2015	18 May	Approval of document <i>229A-APL-Y-SA-0001 Technical and functional description – offloading system</i>	
	24 Jun	Approval of <i>229A-HHI-R-FD-0003 material handling analysis report for general and LQ</i>	
	8 Jul	Approval of guide rollers	
	16 Aug	Approval of system 33, including winch tag 33KM003	
	16 Aug	Upgrading of winch from 10 to 13 tonnes appears only as a handwritten deletion and change by pen in <i>229A-HHI-A-KA-6003 rev C08, page 101</i>	
	24 Nov	<i>229A-APL-O-KA-0001 Hose replacement procedure</i>	
2016	9 Feb	Approval of <i>229A-APL-K-MB-0004 Inspection, maintenance &amp; repair program</i>	
	18 Feb	Approval of <i>229A-HHI-R-FD-0002 Material handling maintenance philosophy and management plan report.</i>	
	2016	Changes to duties and operating personnel for some of the jobs during offloading	No documented training
	2016	Training in offloading	
	30 Mar	First offloading of crude from the Goliat facility to a shuttle tanker	
	2016	Change in work method for hose handling – change to area of application for the winch	
2016	24 May	Procedure <i>229A-APL-R-KA-0019</i> for rotation of offloading hose	
	<b>Incident day</b>		
	24 Jun – afternoon/evening	Offloading terminated – deck not cleared up	
	25 Jun 10.50	Work in D10 area before lunch	
	25 Jun 10.55	<b>Incident occurs – person injured in D10 area</b>	
	25 Jun 10.56	Crane operator notifies need for medical assistance by radio	
	25 Jun 10.57	First-aiders reach victim	
	25 Jun 11.00	Nurse reaches victim	
	25 Jun 11.00	Management arrives at the <i>emergency response centre (ERC)</i>	
		PA announcement	
	25 Jun 11.00	Second line informed	
	25 Jun 11.05	More first-aiders reach the injury site	
	25 Jun 11.08	First meeting of the ERC	
	25 Jun 11.09	SAR helicopter requisitioned	
	25 Jun 11.10	Injury site centre established in D10 area	
	25 Jun 11.11	Helideck readied for helicopter	
	25 Jun 11.14	Victim subject to health check on board	
	25 Jun 11.22	Emergency medical communications centre (AMK) notified	
	25 Jun 11.53	SAR helicopter arrives at Goliat	
	25 Jun 11.56	Heliguard conducts doctor and nurse to health centre on board	
	25 Jun 12.32	SAR helicopter leaves Goliat with the victim and flies directly to the UNN in Tromsø	

## 7 Potential of the incident

### 7.1 Actual consequences

The deck operator was hit by the wire rope in the hard-hat/head region while the rope was being reeled in with the work winch in the D10 area. He suffered serious head injuries from being struck by the rope and/or when he was knocked to the deck/against the bulkhead by the blow. He was flown to the UNN in Tromsø on the same day and to Haukeland University Hospital in Bergen in the following week.

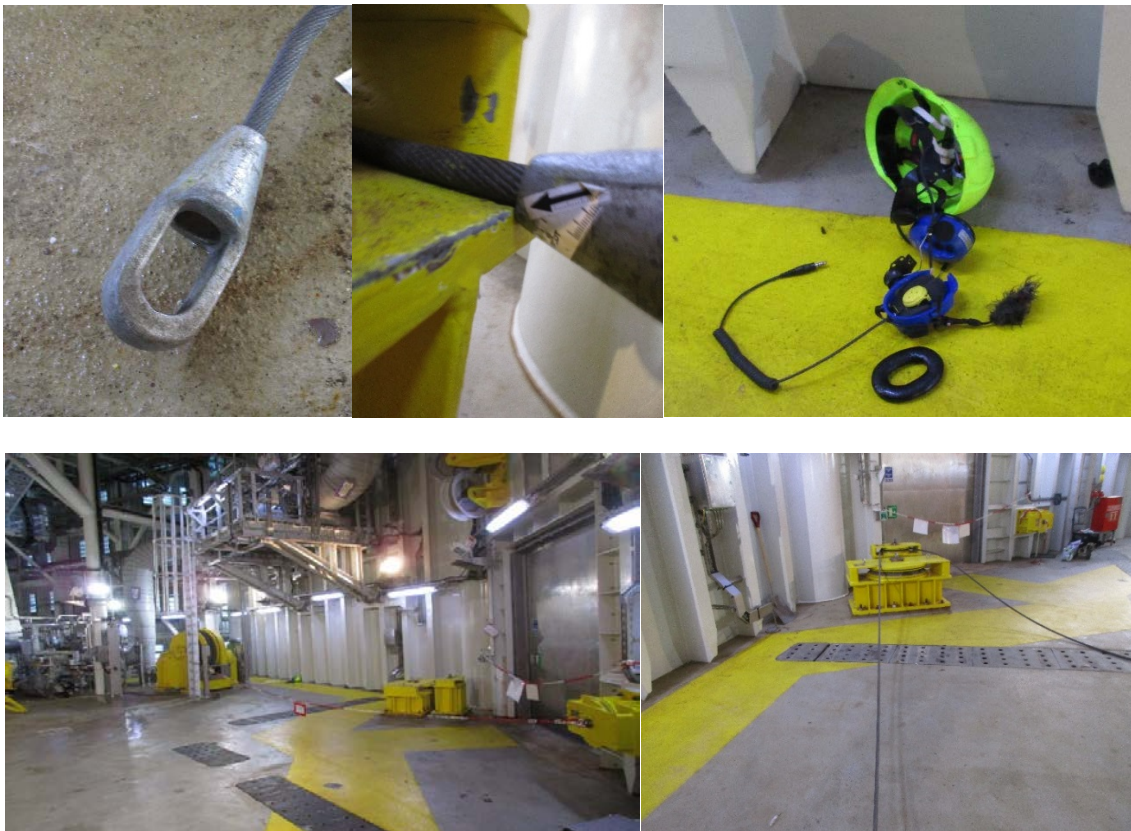
### 7.2 Potential consequences

Under different circumstances, the deck operator could have suffered several serious injuries or died.

## 8 Direct and underlying causes

### 8.1 Direct causes

The cast socket termination of the wire rope became caught in the guide roller, putting the rope under strain before it was suddenly released and hit the deck operator in the head area. It is unclear whether he was hit by the rope and/or the socket. The impact lifted him off his feet and threw him backwards against the bulkhead/deck. His hard hat landed some distance away, and the left-hand side of the ear protector was smashed for an unknown reason. The deck operator suffered head injuries and seemed confused when the crane operator ran to him.



*Photograph 9: The site of the incident. (Source: PSA)*

## 8.2 Underlying causes

Underlying causes can be divided into technical (what), operational (who) and organisational (how) elements. The most important of the elements and performance-affecting factors uncovered by the investigation are listed below.

### 8.2.1 Technical

- The equipment fails to comply with key requirements in the *machinery regulations*
- Harmonised standards are not fully complied with during production of the winches and associated equipment in the D10 area. See *EN 14492-1 Cranes, power driven winches and hoists, Part 1 Power driven winches*
- The threat of snagging was not identified. The decision basis for risk-reducing measures in the design phase was thereby inadequate
- The assembled machine was not risk-assessed
- Upgrading the machine from 10 to 13 tonnes of traction was not risk-assessed and documented
- Delay in shutting down the work winch. The machine does not stop immediately when the control lever is put in neutral. It continues to rotate/reel the wire rope for several seconds
- No conformity assessment of the assembled machine
- No risk assessments of weaknesses in the loading hose design which caused it to twist when being reeled up, nor of compensatory measures introduced.

### 8.2.2 Operational

- The division of roles and responsibilities between departments and companies on board and between sea and land for technical equipment and work operations in the D10 area was fragmented, difficult to understand and to some extent contradictory
- Ownership of the equipment being used was not allocated to the department with leading-edge expertise on this type of gear
- The technical manager in Eni was not aware that this equipment fell within his job's area of responsibility
- Changes to which personnel should be used for what work and when were not managed systematically, communicated or documented
- Personnel were assigned to jobs other than the ones planned and assumed in the contract and job descriptions

### 8.2.3 Organisational

- Inadequate management of competence and training of personnel for operational duties, and changes to these
- Inadequate training of deck operators
- Inadequate expertise among Eni personnel who take over and approve the system for commissioning
- Lack of a user manual for the assembled machine
- Inadequate overview for following up test certificates and other documentation when taking over the system
- Deficiencies in operational procedures

## 9 Observations

Observations by the PSA fall generally into two categories.

- Nonconformities: observations where it believes that regulations have been breached.
- Improvement points: observations where deficiencies are seen, but insufficient information is available to establish a breach of the regulations.

### 9.1 Nonconformities

#### 9.1.1 Follow-up of technical conditions

##### Nonconformity

Eni has not seen to it that equipment being used meets an acceptable standard.

##### Grounds

The machine in use does not accord with applicable demands in the *machinery regulations*. The hazards which the machine could pose and the hazardous conditions which could arise in connection with it had not been clarified.

Findings show that:

- the threat of snagging was not identified, and the decision basis for implementing risk-reducing measures was therefore not good enough
- the guide roller was designed in such a way that the threat of snagging was not adequately reduced or eliminated
- the guide roller design contributed to the wire rope snagging while being reeled in
- the winch was not designed so that it stops as soon as the operating lever is released, but pulls in a further 30cm of wire rope before coming to a complete halt – which means that the wire rope is put under strain if it snags
- the winch lacked a load indicator, so that the operator received no indication that the wire rope had snagged.

##### Requirements

*Section 7 of the framework regulations on responsibilities pursuant to these regulations. See appendix I, section 1.1.2 of the machinery regulations on requirements for protection against damage to life and health in the design and manufacture of machinery, section 6 of the management regulations on management of health, safety and the environment, and section 5 of the management regulations on barriers*

#### 9.1.2 Identification of operational risk

##### Nonconformity

Inadequate identification of conditions which can lead to faults and situations of hazards and accidents when preparing offloading operations and clearing up afterwards.

##### Grounds

- Risk when clearing up after offloading has not been adequately assessed. The decision basis for possible technical or organisational measures is inadequate, and no measures were instituted.
- Upgrading of work winch capacity from 10 to 13 tonnes had not been risk-assessed. No conformity declaration or test documentation is available which verifies that safety has been taken care of in the upgrade. What has been found is that 10 tonnes is crossed



out and changed to 13 tonnes on page 101 of document 229A-HHI-A-KA-6003 rev C08. This was done on 16 August 2015. See also section 6.1.2.8 in this report.

- Weaknesses in the design of the loading hose had not been adequately risk-assessed before compensatory measures were introduced.
- Deficiencies exist in the barrier strategy for the facility, including a failure to identify conditions which could lead to faults and situations of hazards and accidents.

### **Requirements**

*Section 16 of the management regulations on general requirements for analyses*

*Section 17 of the management regulations on risk analyses and emergency preparedness assessments. See section 5 of the management regulations on barriers*

## **9.1.3 Governing documents**

### **Nonconformity**

Governing documents required for the activities in the offloading area were deficient or not completed.

### **Grounds**

- Some governing documents exist as a draft without final approval (marked *Preliminary*, such as the procedure for operating the work winch for offloading-hose rotation, for example).
- Eni's governing documents for offloading operations failed to distinguish between the various duties to be performed by different groups. Examples are the *System and Operational Manual 229A-APL-O-MB-0001* and *Offloading hose rotational procedure 229A-APL-R-KA-0019*, which do not distinguish between work to be done by process personnel (Eni) and by crane and deck personnel (Apply Sørco).
- The *Offloading hose rotational procedure 229A-APL-R-KA-0019* is to be used for work operations during offloading, but contains no description of risk associated with use of the work winch.
- Some procedures had not been tried out systematically before use in order to establish whether they were unambiguous and user-friendly.
- This incident and earlier ones reveal inadequate knowledge of and compliance with procedures. That applies particularly to operations-related work processes, instructions and procedures.
- A number of the procedures are only available in English, and make it difficult for Eni and the various groups of personnel to ensure that they are doing the work as planned and assumed.
- No user manual exists for the equipment pursuant to section 1.7.4.2 of appendix 1 to the *machinery regulations*.

### **Requirements**

*Section 14 of the framework regulations on use of the Norwegian language*

*Section 6 of the management regulations on management of health, safety and the environment*

*Section 20, paragraphs 2a and b of the activities regulations on start-up and operation of facilities*

*Section 24, paragraph 2 of the activities regulations on procedures. See appendix I, section 1.7.4.2 of the machinery regulations on the content of the user manual*

### 9.1.4 Work processes

#### Nonconformity

Lack of consistency between governing documents and work processes

#### Grounds

- It is difficult to determine the relationship between governing documents at the overall level and procedures for certain work operations on Goliat.
- Difficult for personnel on Goliat to identify the correct governing documents when searching in Eni's internal electronic document system.
- Differing content in the same governing document presented offshore and obtained from the land organisation (job description for supervisory position).
- Eni's governing documents for offloading operations fail to distinguish between the various duties to be performed by different groups. Examples are the *System and Operational Manual 229A-APL-O-MB-0001* and *Offloading hose rotational procedure 229A-APL-R-KA-0019*, which do not distinguish between work to be done by process personnel (Eni) and by crane and deck personnel (Apply Sørco).
- Instructions for work in the offloading area were not available to Apply Sørco's personnel doing the work, but were included in the work instructions for Eni's operations personnel.
- Changes to which personnel are to be used for what jobs and when were not systematically documented. Personnel have been allocated to other jobs than those planned and assumed in the contract and job descriptions – without a clear entrenchment and without the involvement of personnel with responsibility for personnel, work operations or equipment. See section 6.1.1 on roles and responsibilities.

#### Requirements

*Section 8 of the framework regulations on the employer's duties toward employees other than its own*

*Section 13 of the management regulations on work processes*

*Section 20 of the activities regulations on start-up and operation of facilities*

*Section 24 of the activities regulations on procedures*

### 9.1.5 Worker participation

#### Nonconformity

Personnel in operations had not participated in assessing and formulating work instructions and procedures when these were updated.

#### Grounds

- Operations personnel had not contributed to formulating the procedures or in assessing whether their formulation and content covered the intended functions in a satisfactory way.
- The procedures have not been systematically checked out before use in order to see whether they are unambiguous and user-friendly.

#### Requirements

*Section 4-2 of the Working Environment Act on requirements regarding arrangement, participation and development*

*Section 13 of the framework regulations on facilitating employee participation*  
*Section 17 of the framework regulations on the duty to establish, follow up and further develop a management system*

### **9.1.6 Commissioning before start-up and operation**

#### **Nonconformity**

Eni had not ensured that the equipment involved in the incident was in an acceptable technical condition and was provided with the necessary documentation prior to use.

#### **Grounds**

It has not been assured that administrative requirements for the equipment, such as CE marking and a conformity declaration, complied with applicable regulations. Nor had it been assured that a user manual for the assembled equipment, covering training, use and maintenance, had been prepared.

#### **Requirements**

*Section 23 of the framework regulations on general requirements for material and information*

*Section 6 of the management regulations on s on management of health, safety and the environment*

*Section 20 of the activities regulations on start-up and operation of facilities*

*Section 22 of the activities regulations on safety and working environment training pursuant to the Working Environment Act. See section 8 of the machinery regulations on sale and delivery of machinery, paragraph 1f (CE marking), section 10 of the machinery regulations on procedure for conformity assessment of machinery, and appendix I, section 1.7.4.2 of the machinery regulations on the content of the user manual*

### **9.1.7 Material handling plan**

#### **Nonconformity**

Winch operations in the D10 area are not covered by Eni's material handling plan for the facility.

#### **Grounds**

Winches in the D10 area are used for material handling, but this does not emerge from Eni's material handling plan. See the *229A-HHI-R-FD-0002 material handling maintenance philosophy and management plan report*, which specifies that *all* operations involving material handling must be described as specified in sections B.5 and B.7 on material handling in *Norsok R-002* (April 2010 version).

#### **Requirements**

*Section 23 of the framework regulations on general requirements for material and information*

*Section 13 of the facilities regulations on materials handling*

*Section 12 of the management regulations on planning*

### 9.1.8 Roles and responsibilities

#### Nonconformity

Eni's description of roles, responsibilities and reporting lines when preparing for and conducting offloading operations and subsequent clearing up is fragmentary and unclear. Nor are staffing changes which could have consequences for health, safety and the environment adequately studied.

#### Grounds

- The plan was that Eni's own *process operators* would handle offloading of oil. Before the first offloading on 30 March 2016, however, the decision was taken to transfer some jobs to Apply Sørco's crane and deck personnel. This concerned preparing the hose system for offloading and reeling in the hose when the operation had been completed. See section 6.1.1 on roles and responsibilities. The fact that responsibility and reporting are divided between different people and departments, and that staffing changes were also implemented for various duties, makes it difficult to obtain an overview of the allocation of responsibility in practice. As far the team can see, the person responsible for safety clearance of the work operations which led to the accident seems to have been unclear to the personnel.
- Lines of responsibility and reporting in practice, in the organogram, in job descriptions and in the contract between Eni and Apply Sørco appear to have been established at different times and are not consistent with each other.
  - According to some documents, Apply Sørco's crane and deck operators should report to Apply Sørco's *maintenance supervisor* on board. In other places, these personnel are stated to report to Eni's *maritime and logistic supervisor*. However, it seems to the team that communication on operational conditions in the D10 area does *not* run via these supervisors, but to Eni's *operations and maintenance supervisor* on board. This contributes to further lack of clarity about who takes decisions concerning the conduct of work, risk assessments, changes to jobs and possible updating of procedures.
  - The role of *contract representative* (CR) is assigned to Eni's personnel in the *technical support group* (TSG) in Hammerfest, who are thereby responsible for following up the contract with Apply Sørco. But Eni has been unable to document the change in allocated duties between personnel from Eni and Apply Sørco when preparing for and clearing up after offloading. It is therefore unclear to the team whether Eni has secured the necessary coordination and communication with Apply Sørco to ensure that the contractor has acquired the necessary knowledge about conditions of significance for health, safety and the environment. This also indicates that Eni has not ensured the contractor's involvement in planning and risk assessment.
  - It emerged during the investigation that the *operations and maintenance supervisors* offshore had received a new and expanded job description in March 2016, without this being communicated to them. The description sets requirements for expertise which these supervisors do not possess, and which they do not know whether they needed to acquire through courses.
  - The injured deck operator from Apply Sørco worked as a *banksman/signaller*, and was brought in as additional personnel in the start-up phase. This extra personnel was also used for other duties normally performed by deck personnel. According to *Norsok R-003N*, *banksmen/signallers* who assist offshore crane operators should be designated as *deck operators*. This involves requirements for training and expertise above and beyond that required for

*banksmen/signallers*. It emerged from interviews that the man had not received *deck operator* training pursuant to *Norsok R-003N*. He also lacked machine-specific training and knowledge of the safety aspects of using the work winch.

- Deck personnel on board called for training of additional personnel in an e-mail sent on 16 May 2016 to the *maritime and logistic supervisor* (Eni), who forwarded this to the *senior crane and lifting engineer* (Eni) on land. The *maritime and logistic supervisor* sent a reminder on 19 June 2016. The status of the training had still not been clarified when the team was on board.
- Inadequate competence among *crane and lifting personnel* was also part of the order received by Eni on 17 February 2016 after the PSA audit of 5-7 January 2016.

## **Requirements**

*Section 12 of the framework regulations on organisation and competence*

*Section 18 of the framework regulations on qualification and follow-up of other participants*

*Section 6, paragraph 2 of the management regulations on management of health, safety and the environment*

*Section 12 of the management regulations on planning*

*Section 14 of the management regulations on manning and competence*

*Section 21 of the activities regulations on competence*

*Section 92 of the activities regulations on lifting operations*

### **9.1.9 Competence**

#### **Nonconformity**

Eni has not ensured systematic management of competence for crane and deck personnel with regard to the winch system and associated work operations.

#### **Grounds**

- Apply Sørco is contracted to make personnel with the appropriate competence available to Eni. The latter owns the lifting equipment and is responsible for familiarising personnel who are to operate and conduct operations with it through machine-specific training. The offshore installation manager (OIM), Eni's most senior representative on board, is responsible for ensuring compliance with *Norsok R-003N* in the conduct of lifting operations.
- The operations personnel involved had insufficient information about technical solutions and training in the use of new equipment and systems in use. The deck operator lacked proper training pursuant to *Norsok R-003N*. Eni could not document systematic training of personnel involved in offloading operations.
- Eni cannot document training of crane operators and deck personnel on the machines they are assigned to use. They simply sign off the equipment on a general checklist, which could give the impression that they have received training in the use of all lifting equipment on board. The training log for cranes, deck and storage show that the injured deck operator is supposed to have received user training, including with the user manual for the equipment. However, the checklist does not reveal what machinery and equipment the training applies to. When reviewing the training documents, a proper user manual for the work winch used during the incident does not appear to exist. In the view of the team, this means that the training does not cover the winch system signed off for in the checklist.

- A lack of risk assessment of the work during the incident also contributes to a failure to provide the decision basis for assessing competence requirements for reeling and rotating the offloading hose and subsequent clearing up.
- Competence needs for crane and deck personnel in other areas on board have been conveyed to Eni's management offshore and on land before, by both employees and the safety service on board, on the basis of requirements for deck personnel set by Eni in governing documents. In its review, the team did not find that this information on lack of competence was documented in the nonconformity system or other systems. Nor had employees and the safety service received any response on how this was dealt with. The matter is covered in the report from the PSA's audit of Eni's crane and lifting operations in January 2016.
- The changes to job descriptions for operations and maintenance supervisors offshore – see the second bullet point, third sub-bullet, under nonconformity 9.1.6 – shows a failure to follow up competence requirements.

### **Requirements**

*Section 12, paragraph 2, of the framework regulations on organisation and competence*

*Section 14 of the management regulations on manning and competence*

*Section 21 of the activities regulations on competence*

*Section 22, paragraphs 4 and 5 of the activities regulations on safety and working environment training pursuant to the Working Environment Act*

## **9.2 Improvement points**

### **9.2.1 Deficient marking and signage**

#### **Grounds**

During interviews and inspection of the incident site, it emerged that

- entrances/doors to the D10 area were signposted as closed even when operations were not under way
- signs about cordoning off were hung on the inside of entrances/doors, rather than facing towards surrounding areas on the outside.

#### **Requirements**

*Section 77 of the activities regulations on handling hazard and accident situations. See section 28 of the facilities regulations on safety signs and section 44 of the facilities regulations on means of evacuation*

### **9.2.2 Obstruction of evacuation routes**

#### **Grounds:**

During interviews and inspection of the incident site, it emerged that

- wire rope from the work winch lay across the deck after the offloading operation had been completed the day before the incident. This partly obstructed free movement in the evacuation routes passing through the area.

## **Requirements**

*Section 77 of the activities regulations on handling hazard and accident situations, see also section 44 of the facilities regulations on means of evacuation, and section 13 of the facilities regulations on materials handling*

### **9.3 Other comments**

After the incident, the HSE coordinator on board drew up a list of improvements for the sick bay. This list should be entered in the facility's incident log and implementation of the proposed measures should be assessed.

## **10 Barriers**

### **10.1 Barriers which failed**

#### **10.1.1 Snagging and straining of the wire rope**

- The design of the guide roller helped the wire rope to become snagged during reeling.
- The work winch does not stop immediately when the control level is put into neutral, but continues to reel the wire rope for several seconds. If the rope gets snagged, this puts it under strain.
- Since no load indicator is provided on the work winch, the operator receives no sign that the wire rope has become snagged.
- The threat of snagging was not identified, with the result that the decision basis for implementing risk-reducing measures was not good enough.

#### **10.1.2 Safe distance from dropped/moving objects**

- Insufficient training had been provided in understanding the boundaries for a safe distance from the work area at the incident site.
- No user manuals for the work winch and instructions for conducting the work operation with one or more people involved had been prepared.

### **10.2 Barriers which functioned**

#### **10.2.1 Limiting personnel injury**

- The emergency response organisation was notified and reacted immediately by mobilising the first-aid/stretchers team and notifying the SAR helicopter with doctor.
- The victim was dealt with by first-aid personnel and taken to the sick bay on board to prepare for further transport to the hospital on land.
- The SAR helicopter with doctor on board arrived from Hammerfest less than an hour after the accident occurred.
- The SAR helicopter transported the patient to the UNN and landed about 2.5 hours after the accident occurred. Treatment of the patient began immediately.

## 11 Discussion of uncertainties

Three conditions have attracted particular attention.

1. During the reconstruction of the incident, some uncertainty prevailed about exactly *where* the socket on the wire rope had snagged in the guide roller because marks and scratched paint were evident at a number of places on the metal sheets comprising the roller framework.
2. Some uncertainty prevailed about the object which injured the deck operator – whether it was the actual wire rope or its socket termination. Given the incident’s actual and potential consequences, however, this is considered to be of minor significance.
3. It is difficult to obtain a clear reason why the injured deck operator was in the D10 area at the time of the incident – to assist during the planned work operation or on other grounds.

## 12 Other considerations

### 12.1 Similar incidents

According to Eni’s investigation report, it is unaware of similar incidents of this type and has therefore not registered such events in its own reporting system

For its part, the team is aware that this type of incident has occurred before both in the fishing industry and in the petroleum sector on supply and anchorhandling vessels.

### 12.2 Eni’s investigation report

Eni itself investigated the incident, and its investigation report was completed on 13 July 2016. The description of the course of events and the direct and underlying causes related to technical conditions largely coincide with the team’s observations and assessments.

However, little attention has been paid to operational and organisational conditions related to roles, responsibilities and reporting lines. That applies particularly to the changes made to staffing of the jobs to be done during offloading operations. See section 9.1.8 in this report. Nor are the systematics of management and documentation of competence at the interface between Apply Sørco and Eni and the various departments on board dealt with in Eni’s report. See section 9.1.3 and others in this report.

However, the letter accompanying the report (*ref LT-GOL-PSA-0070*) says that operations with the work winch in the D10 area have not been adequately risk-assessed, and that understanding of risk should be improved at several levels in the organisation. Furthermore, it states that roles and responsibilities will be clarified, that the organograms will be reviewed and that a number of Eni’s documents will be translated into Norwegian. Competence management and worker participation are mentioned in the letter, but without more specific details being provided.

## 13 Documents

The investigation has drawn on the following documents.

*EN 14492-1 Cranes, power driven winches and hoists, Part 1 Power driven winches.*



*EN –ISO 12100 Safety of machinery – General principles for design – Risk assessment and risk reduction*  
*FOR-2009-05-20-544 Forskrift om maskiner (machinery regulations)*  
*2-OC-OPR-410536 Functional description of district operations Hammerfest district*  
*22A-APL-ER812-C-VB-0001 Declaration of Incorporation*  
*229A-APL-A-LD-0001 Supplier master information register – SMIR*  
*229A-APL-B-LA-0003 Hose Reel Technical File for CE Marking*  
*229A-APL-C-VB-0001 Offloading system declaration of conformity*  
*229A-APL-ER812-C-RA-0001 Third party verification*  
*229A-APL-ER812-R-CA-0002 Hose Replacement Winch report final acceptance test*  
*229A-APL-ER812-R-DS-001 Winch datasheet and technical description*  
*229A-APL-ER812-R-MA-0001 Function Description Installation and Maintenance*  
*229A-APL-O-KA-0001 Hose Replacement Procedure*  
*229A-APL-O-MB-0001 System and operation manual*  
*229A-APL-O-MB-0002 Operator panels manual*  
*229A-APL-R-KA-0006 Yard Commissioning Procedure SDS Goliat*  
*229A-APL-R-KA-0019 Offloading hose rotational procedure*  
*229A-APL-T-VA-0014 Guide roller system*  
*229A-HHI-A-KA-6033 Commission Procedure for system 33 pages 47-130*  
*33MK003 T-8556 18mm steelrope DoC 413149-2 from NOV - Carl Stahl*  
*33MK003 T-8556 18mm steelrope test certificate 03861 from ArcelorMittal*  
*33MK003 T-8556 38mm steelrope DoC 413149-1 from NOV - Carl Stahl*  
*229A-APL-O-MB-0002 - User Manual Panels D10*  
*229A-APL-R-FD-0001\_C01 - Design Criteria - Brief - Hose Reel*  
*229A-APL-Y-SA-0001\_C02 - Technical and Functional Description Offloading Loading*  
*229A-HHI-R-FD-0002\_Z01 - Material Handling Maintenance Philosophy and Management Plan*  
*229A-HHI-R-FD-0003\_C06 - Material Handling Analysis Report for General and LQ*  
*1635-APL-R-KA-0017 - Preliminary offloading hose rotational procedure - Goliat*  
*33MK003 T-8556 18mm steelrope DoC 413149-2 from NOV - Carl Stahl*  
*33MK003 T-8556 18mm steelrope test certificate 03861 from ArcelorMittal*  
*33MK003 T-8556 38mm steelrope DoC 413149-1 from NOV - Carl Stahl*  
*229A-APL-O-MB-0002 - User Manual Panels D10*  
*229A-APL-R-FD-0001\_C01 - Design Criteria - Brief - Hose Reel*  
*229A-APL-Y-SA-0001\_C02 - Technical and Functional Description Offloading Loading*  
*229A-HHI-R-FD-0002\_Z01 - Material Handling Maintenance Philosophy and Management Plan*  
*229A-HHI-R-FD-0003\_C06 - Material Handling Analysis Report for General and LQ*  
*1635-APL-R-KA-0017 - Preliminary offloading hose rotational procedure - Goliat*  
*229A-APL-K-MA-0008\_C02 – Material Equipment Handling, Storage and Preservation*  
*229A-APL-K-MB-0004\_C02 - Inspection, maintenance and repair program*  
*229A-APL-O-KA-0001\_Z01 - Hose replacement procedure*  
*229A-APL-S-RA-0002\_C02 - Human factor analysis report*  
*229A-ENI-V-SP-0001\_rev03 - Offloading System Outline Description and Requirements*  
*229A-ENI-V-SP-0007\_rev03 - Technical specification for offloading system*