



Investigation report

Report

Report title Investigation Saipem – ballast incident <i>Scarabeo 8</i> , 4 September 2012	Activity number 401003006
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Summary

The semi-submersible drilling unit *Scarabeo 8* developed an unintended list of about seven degrees while drilling exploration well 7220/10-1 Salina on 4 September 2012.

This incident had no serious consequences in terms of injuries to people or damage to the environment or material assets, but the investigation has exposed deficiencies in aspects of key significance for acceptable operation. These include processes for ensuring compliance with requirements for expertise on safety-critical functions, utilising information of significance for safety, and risk management.

Involved

Main group T-Mobile	Date
Members of the investigation team Gunnar Dybvig Jorunn Tharaldsen Leif J Dalsgaard	Investigation leader Gunnar Dybvig

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1 Summary

The semi-submersible drilling unit *Scarabeo 8* developed an unintended list while drilling exploration well 7220/10-1 Salina on 4 September 2012. This list reached seven degrees during the duration of the incident.¹ The incident is regarded as serious, but had no serious consequences in terms of injuries to people or damage to the environment or material assets.

The Petroleum Safety Authority Norway (PSA) has carried out an investigation of the incident confined to Saipem's management and assurance of staffing and expertise, and to relevant functions and systems in Saipem's land-based organisation.

Although the incident did not have serious consequences, the investigation has exposed deficiencies in aspects of key significance for acceptable operation. These include processes for ensuring compliance with requirements for expertise on safety-critical functions, utilising information of significance for safety, and risk management.

The investigation team has identified four nonconformities, which concern management follow-up, compliance with internal requirements for ensuring expertise, and dealing with nonconformities, including risk assessment. The report also identifies an improvement area related to the human-machine interface (HMI).

2 Introduction

The semi-submersible drilling unit *Scarabeo 8* secured an acknowledgement of compliance (AoC) from the PSA in May 2012, and was operating at the time of the incident for ENI Norge on exploration well 7220/10-1 Salina in the Barents Sea. On 4 September 2012, the unit developed an unintended list while drilling on this location. The incident began at 14.40. Erroneous operation of the ballast system at 14.49 caused the unit to develop a seven-degree list. The error was discovered 20 minutes later, and all valves to the ballast system were shut at 15.12. The position subsequently normalised. ENI Norge notified the PSA that afternoon.

The PSA resolved to conduct its own investigation of the incident.

The investigation team comprised the following members:
 Gunnar Dybvig (investigation leader), HSE management discipline
 Leif J Dalsgaard, structural integrity discipline
 Jorunn Tharaldsen, working environment discipline.

The investigation was conducted through meetings, interviews and document reviews in accordance with the following plan:

- 1 Oct 2012 Kick-off meeting at Saipem Norway
- 1-4 Oct and 17 Oct 2012 Interviews with selected members of Saipem Norway's land and offshore organisations, Cerno and ENI
- 24 Oct 2012 Summing-up meeting at Saipem Norway
- 19 Sep–30 Nov 2012 Document review, analyses and completion of report

¹ Times are not exact because the clocks on *Scarabeo 8* were not synchronised.

Mandate

The PSA's investigation team received the following mandate:

1. Concentrate on the underlying causes of the incident, paying particular attention to Saipem's management and assurance of staffing and the expertise of relevant personnel, both in the company generally and on *Scarabeo 8* in particular. The investigation team will not confine itself to management of staffing and expertise offshore, but also look at relevant functions and systems in Saipem's land-based organisation.
2. Identify and describe possible deficiencies/weaknesses/uncertainties and unclear aspects of the investigation conducted by Saipem and ENI Norge.
3. Identify possible breaches of the regulations, recommend further action and propose the use of instruments.
4. Prepare a report and accompanying letter in accordance with the templates for these.

The investigation will basically be conducted without visiting the unit, and on the basis of the investigation report prepared jointly by Saipem/ENI Norge after the incident.

The PSA's restrictions were based on information from meetings with Saipem and ENI immediately after the incident, and preliminary results and observations from the joint Saipem/ENI investigation team. Since this information created a clear picture of the direct cause of the incident, the PSA chose to conduct a restricted investigation as specified in the mandate above.

3 Sequence of events

Scarabeo 8 developed an unintended list on 4 September 2012 while drilling exploration well 7220/10-1 Salina (PL 533) in the Barents Sea. Weather conditions before and during the incident were a wind strength of 17-21 knots and a wave height of 1.25-2.5 metres. The unit was moored by eight lines.

One control room operator (COOP) is on duty in the central control room on the bridge when the incident began. Because of the drilling operation, the COOP is devoting particular attention to keeping the unit as far as possible on an even keel.

At 14.40, the COOP observes listing at the stern to starboard. Based on information from the company, the list at that time was about one degree.

The COOP contacts the crane driver by UHF to check whether crane operations are under way which could relate to the listing. He is told by the driver that no activities which could have caused listing are under way.

The COOP begins to operate the ballast system. The aim is to pump water from ballast tank 22S in order to bring the unit back on an even keel. He sees no positive effect from managing ballast. Instead, the list worsens. It subsequently transpires that the aft starboard sea chest was unintentionally opened at 14.49.

Listing increases to two-three degrees. The COOP finds the position stressful and cannot understand why conditions are worsening. He calls the stability section leader (SSL) and the platform manager (PLM).

The PLM and SSL arrive quickly to help clarify the position. Based on information from Saipem, this is estimated to have been around 14.55-15.00. The PLM also contacts the crane driver, who again reports that there are no crane operations which could explain the listing.

None of those present in the control room succeed immediately in identifying the cause of the listing on the basis of information available from the control room systems, despite being personnel with long experience of and expertise in ballast management.

The SSL and the COOP now work together on the ballast panel – one operating the unit's starboard side while the other operates the port side to bring the unit back on an even keel.

Eni Norge's drilling supervisor (EDS) also arrives in the control room at this time, and recommends a concentration on the ballast system. At the same time, the PLM initiates a general alarm on the unit at 15.08.

Immediately afterwards, the SSL observes that the valve to the aft starboard sea chest is open. This sea chest has a large-diameter valve (ND 300) which opens directly to the sea. Water is accordingly flowing at a high rate into 22S as a result of gravitational filling.

At 15.12, the PLM orders the closure of all valves in the ballast control system. The unit has a list of about seven degrees at this point. The position stabilises when the valves are closed, and the unit is brought back on an even keel.

A new update is provided to the crew by the PLM at 15.23 via the PA system, stating that the position is now under control and the unit has been returned to its normal position.

A full overview of personnel on board (POB) is established at 15.29. This takes longer than expected because a number of people on board have gone to the wrong muster station. Fourteen people go directly to the forward lifeboats instead of the prescribed muster station.

Once a full POB overview is in place, the PLM goes to the muster area to provide information on the position.

The human resources department on land contacts with relatives of those on board during the afternoon and evening to inform them about the position and that it is under control.

4 Results

Our investigation has identified that the company has tools, systems and processes for recruiting, qualifying and training its own personnel. However, key requirements for ensuring that the system functions as intended have not been complied with.

The company has pursued follow-up activities to identify technical, operational and organisational errors and deficiencies. However, it emerged from the investigation that management personnel at various levels have received information from a number of sources about challenges related to staffing and expertise, without taking these signals seriously or following up with specific measures. Examples of such challenges include:

- availability of sufficient qualified personnel
- weaknesses related to training of the company's own employees and other personnel in general, and training with safety-critical systems in particular
- challenges related to a number of conditions involving the HMI on *Scarabeo 8*.

The investigation has also identified a lack of involvement by key personnel in the company's own organisation and a failure to comply with internal requirements in the process of selecting personnel for a safety-critical post and staffing of a safety-critical function.

Some of those interviewed during the investigation stated that the shortage of personnel and expertise in the market has influenced decisions which have led up to this incident. However, a high level of activity combined with a shortage of competent personnel represents a challenge for all companies in the Norwegian petroleum industry. This requires that stronger attention is paid to planning, risk assessments and acceptable handling of nonconformities to ensure robust solutions which accord with requirements in the regulations.

Our investigation draws no conclusions about the extent to which deficient decision-making processes in connection with this incident represent a single case of inadequate compliance, or whether it indicates wider organisational weaknesses. However, we have identified deficient processes and failures of management prioritisation in a number of areas, at different levels and in various phases. This could indicate that the company has challenges with its overall culture for compliance, and with assessing the consequences of various management decisions for risk on board.

We have identified four nonconformities and one improvement point.

5 Observations

The PSA's observations fall into two general categories:

- nonconformities: this category embraces observations which the PSA regards as a breach of the regulations
- improvement points: these relate to observations where the PSA sees deficiencies, but lacks sufficient information to be able to establish a breach of the regulations.

5.1 Nonconformities

5.1.1 Assuring expertise in safety-critical posts

Nonconformity: Failure to comply with the requirements to assure staffing and expertise in safety-critical functions.

Grounds:

- The COOP on duty when the incident occurred had six weeks of experience on this unit and no experience from other drilling facilities. Saipem's job description for a COOP requires three years of experience from mobile units and internal training (familiarisation).
- The breach of internal requirements was not registered or followed up the company as a nonconformity from internal or regulatory requirements.

The decision to place the COOP concerned in a senior safety-critical post without meeting key expertise requirements in the job description was taken jointly by the unit's management on land and offshore. The management decision was taken even though it was known to breach internal requirements on expertise and training for the post (see Saipem job description for a COOP).

Requirements:

Section 14 of the management regulations on manning and competence

Section 21 of the activities regulations on competence

Section 24 of the activities regulations on procedures

5.1.2 Training of contract personnel

Nonconformity: Inadequate training of contract personnel in a safety-critical post.

Grounds:

- The COOP on duty when the incident occurred had insufficient on-the-job training (OJT) and familiarisation on board. Familiarisation and OJT are internal requirements for a COOP. The checklist and training manual for OJT specifies the level of detail for such training and familiarisation.
- The reason the COOP had not received sufficient training was that contract personnel are not included in Saipem's OJT programme.

Requirements:

Section 14 of the management regulations on manning and competence

Section 21 of the activities regulations on competence

Section 22 of the activities regulations on safety and working environment training pursuant to the Working Environment Act

5.1.3 Use of available information with significance for safety

Nonconformity: Deficiencies in the use made by management of available information with significance for safety.

Grounds:

Saipem had information available about deficiencies in the *Scarabeo 8* organisation related to assuring sufficient capacity and expertise. These deficiencies were revealed through various types of follow-up, such as external audits, verifications and analyses of the HMI in the control room, without that resulting in specific action being taken.

Examples of challenges include meeting requirements for training personnel in the company's own organisation and at contractors, deficient evaluation of the effect of the education and training provided, and availability of personnel.

- Findings from an external HMI verification of *Scarabeo 8* (final report 24 August 2012) noted that training in the safety system provided for COOPs by the supplier had been very brief, and that key COOPs were insufficiently familiar with how to navigate effectively through the control room system.
- ENI Norge's audit report on the *Scarabeo 8* management system of 19 July 2012 noted a backlog in training the company's own personnel and the fact that contract personnel and contractors are not included in Saipem's OJT system.
- The ISM audit report of 30 March 2012 – ISM-6 resources and personnel – identified deficiencies in the company's assessment of the effect of education and training.
- The organisation and staffing study of 13 July 2009 is not available in a final version, and contains a number of proposals for adjustments. It is thereby unclear how or whether these proposals have been followed up.
- The offshore organisation had requested two COOPs on the bridge, even when the unit was moored with conventional anchors. This requirement related to the running-in of a new unit, the large size of the control room, and the lack of time to become familiar with new systems. These needs were not met by the management of the land organisation. As far as the investigating team can see, the grounds for this refusal were not subjected to a formal assessment process.

Requirements:

Section 12 of the management regulations on planning

Section 19 of the management regulations on collection, processing and use of data

Section 29 of the activities regulations on planning

5.1.4 Management of change

Nonconformity: Inadequate compliance with requirements for managing changes in risk.

Grounds:

Internal process requirements for management of change and dealing with nonconformities were not complied with in connection with staffing a safety-critical post (the COOP).

- Saipem has an HSE management of changes procedure for identifying and managing such aspects as changes in staffing and expertise during operation. This procedure was not used to assess the employment of contract personnel without adequate expertise in a safety-critical post on the unit
- According to the company's own rules, a nonconformity report must be prepared in the event of a failure to conform with requirements. This was not done.
- The nonconformity was not risk-assessed or followed up with compensatory measures.
- Relevant personnel responsible for expertise management and for handling nonconformities in the land-based organisation were not informed of or involved in the decision to staff the control room in violation of internal requirements.

Requirements:

Section 11 of the management regulations on the basis for making decisions and decision criteria

Section 22 of the management regulations on handling of nonconformities

5.2 Improvement point

5.2.1 HMI

Improvement point: Design of solutions related to the HMI in the control room.

Grounds:

The company had received several indications that *Scarabeo 8* lacked an optimum HMI. This emerges from the Saipem *Scarabeo 8* HMI verification of 24 August 2012, ENI/Saipem's investigation report and interviews conducted for the PSA investigation.

A number of weak points were identified by the external HMI verification, such as choice of background colours, weak contrasts on the panel displays (readability), shadowing, the failure to orient ballast images of the pontoons in accordance with their actual direction, the fact that two images had to be up simultaneously in order to run ballasting, and so forth. The summing-up stated "Several HMI shortcomings have been identified, especially with regards to legibility and to the way information of low operational value is emphasised on the safety system's HMIs".

The course of events supports the view that the HMI was not optimum: the COOP does not understand why he fails to achieve the desired effect from ballast management, and calls the PLM and SSL. They arrive quickly to clarify the position, but neither of them is immediately able to identify the direct cause even though they have long experience of and expertise with ballast management.

Requirement:

Section 21 of the facilities regulations on human-machine interface and information presentation

6 Assessment of the ENI Norge/Saipem investigation report

The decision to conduct a joint ENI Norge/Saipem investigation of the incident, led by ENI Norge's representative, was taken on the day the incident occurred. The work was carried out with a short deadline and completed just under two weeks later. The PSA has been told that the short deadline was set because it was considered important to report quickly.

One consequence of the short deadline was that underlying causes were not addressed to any extent. The ENI Norge/Saipem investigation team opted to concentrate on conditions related to the incident on the unit. As a result, the role played in advance by decisions and processes in the land-based organisation was not investigated in more detail.

6.1 Assessment of the incident's potential

6.1.1 ENI Norge/Saipem's assessment of the incident's potential

ENI Norge/Saipem's investigation report concludes that the incident caused no injury to personnel or damage to the environment, material assets or the unit. The major accident potential of the incident is discussed primarily in terms of whether the incident could have caused the unit to capsize. It notes that, even if the aft ballast tank of 1 189 cu.m had filled completely, the unit would not have been in danger of capsizing. On that basis, the report concludes that the incident did not have the potential to become a major accident.

The report furthermore discusses the threat of personal injuries and material damage had the list become greater. Filling the aft ballast tank would have caused a list of 12.2 degrees, which would have increased the chance of various objects coming loose and causing possible injuries and damage. Since all personnel were mustered, and none were close to large containers or other heavy items which might have injured them, it was concluded that no threat of fatalities could be observed.

6.1.2 The PSA's assessment of the incident's potential

The Kongsberg system log shows that a command was issued at 14.49.43 to open the aft starboard sea chest valve and the valve to ballast tank 22S. Opening the valve to the sea chest poses no problem as long as all subsequent valves are closed or not leaking, and that other leaks do not exist. The unit is designed to cope with unintentional damage (puncturing) of two neighbouring tanks without listing more than 17 degrees. In this case, the valve to one tank was open, which would have caused a maximum list of 12.2 degrees.

When *Ocean Developer* sank in 1995, the causes were linked to inadequate understanding of the ballast system and erroneous actions². The description of the incident notes that the ballast system was complicated to operate, that the crew were inexperienced, and that "someone may have pushed the wrong button" (NPD 2003, *Ageing rigs*, p 22). When *Ocean Traveler* (1966) experienced an eight-degree list following a collision in the North Sea, many people jumped into the sea, while a number boarded liferafts. It must be noted here that a list can develop

² The PSA's report after the *Deepwater Horizon* accident at www.ptil.no, and *Ageing rigs. Review of major accidents. Causes and barriers*, November 2003, Norwegian Petroleum Directorate.

more quickly after a collision than in connection with ballasting. When *Aban Pearl* sank in 2010, most of the crew took to the lifeboats and got away when the unit had a 10-degree list.

In the PSA's assessment, the possibility cannot be excluded that personnel would have abandoned *Scarabeo 8* with available rescue equipment if the list had developed towards 12.2 degrees. Experience shows that such evacuations can cause accidents in themselves.

The PSA finds no indications that the valves did not function as intended. When the "close all valves" command was issued during the incident, the position normalised. However, we know from the RNNP report on trends in risk level in the petroleum activity for 2011 (main report, chapter 7, figure 104) that faults were found in about 0.4 per cent of all ballast valve tests on new units. Some possibility accordingly exists that other tanks could also have experienced water intrusion, even if their valves were showing closed.

The investigation report after the *Alexander L Kielland* accident contains a separate section (chapter 3.3.6.3, pp 136-137) on loose objects. This noted that blocking of cabin doors by loose objects represented the biggest problem. It is nevertheless difficult to envisage that a listing as slow as that which occurred on *Scarabeo 8* would lead to similar problems.

6.2 Direct and underlying causes

6.2.1 Direct causes of the incident

The ENI Norge/Saipem investigation report identifies the opening of the valves to the aft starboard sea chest and to ballast tank 22S and leaving both open for a relatively long time as the direct cause of the incident. Page 7 of the report states "It seems as if the valves were opened in order to compensate for a condition (movement of the rig) which changed due to other causes such as crane operations, and new actions were taken without closing the first action".

The COOP's written statement from the incident is attached to the investigation report, but fails to give a clear picture of what actually happened. In an interview with the PSA, the COOP states that he does not remember opening both valves, and that it was the SSL who made him aware, later in the course of events, that the sea chest was open and who then closed this. However, the system log shows that both valves were opened in roughly the same period,³ which explains why the listing was not corrected but got worse.

As the direct cause of the incident, emphasis is given to erroneous handling of equipment by one person (the COOP). However, the PSA would also questions why personnel with key posts in relation to ballast management, such as the SSL and the PLM, did not immediately discover that both valves were open and why neither of them initiated the "close all valves" function at once.

6.2.2 Underlying causes

In its discussion of the underlying causes, the ENI Norge/Saipem report points, like the PSA's report, to a number of aspects related to lack of clarity concerning the decision process to

³ The Kongsberg system log shows that a command was issued at 14.49.43 to open the aft starboard sea chest valve, and that the forward starboard sea chest valve was opened at 14.51.05.

place the COOP in a safety-critical post, weaknesses in Saipem's system for selecting personnel for safety-critical posts, lack of compensatory measures with regard to the solution chosen, considerations related to the availability of personnel, the lack of OJT for contract personnel, and the sub-optimum HMI for ballast control on the unit.

The ENI Norge/Saipem investigation report highlights the sub-optimum HMI in the control room. Its proposals include the following short- or long-term measures to improve these conditions – issuing a standing order to close all valves after ballast operations (issued 4 September 2012), simulator training for ballast management, the introduction of automatic closure for all inlet valves at specified thresholds, and a review of functions/alarms on critical valves.

The PSA investigation has not included verification of the HMI offshore. It is thereby difficult to form a view of the role which challenges related to the HMI has played in the course of events. The PSA's investigation team has not taken a more detailed look at the causal picture related to the HMI.

Our assessments of the underlying conditions related to management of staffing and expertise in the company are reflected in chapter 4, results, and in the nonconformities and improvement point identified in chapter 5.

7 Appendices

A. The following documents have been used in the investigation

- Organogram for Saipem's land-based and offshore organisations at 9 April 2012
- ENI/Saipem's *Event investigation report, ballast incident Scarabeo*, rev 01, 17 September 2012
- Saipem's system for organising and resourcing the projects, competence assurance
- *HSE management of changes*, WI-SPA-HSE-005-E, Rev 01, 31 January 2011
- *Organisation and manning study for Scarabeo 8*, Rev A1, 13 July 2009
- *Scarabeo 8* HMI verification, 24 August 2012
- Saipem presentation at kick-off meeting, *Scarabeo 8* ballast incident, 1 October 2012
- Job descriptions for the following personnel:
 - hydraulic engineer
 - electrical technician
 - technical manager
 - stability section leader
 - control room operator
 - safety supervisor
 - platform manager
 - rig manager
 - branch manager
 - assistant rig manager
 - human resources organisation and ICT manager
 - QHSE manager
- On-the-job training for the following personnel:
 - platform manager
 - control room operator
 - stability section leader
- *Scarabeo 8* training matrix for marine personnel, 24 May 2012
- *Scarabeo 8* on-board document system, Rev 02, 7 April 2012
- SNB audit schedule, Saipem SpA Norway Branch
- Overview of contractors and companies under contract on *Scarabeo 8*
- Saipem SPA form audit report, Rev 02, 2 February 2012
- Saipem SPA form audit report, Rev 02, 9 January 2012
- Audit report – *Scarabeo 8* management system, ENI, Rev 02, 19 July 2012
- NOV MRU pitch roll
- Extract from *Scarabeo 8* event list

B. Overview of people interviewed

(removed from the internet version)