PETROLEUMSTILSYNET

Investigation report

Report	
Report title Lifeboat incidents on Veslefrikk B and Kristin	Activity number 001052005

Classification		
☑ Public	☐ Restricted	☐ Strictly confidential
☐ Not for publication	☐ Confidential	

Summary

Problems with releasing FF1000S-type freefall lifeboats were identified during testing on the Kristin and Veslefrikk B installations in December 2008 and January 2009. These incidents led to the FF1000S-type lifeboats on both installations being taken out of service on 7 January 2009, with a consequent workforce reduction on Veslefrikk B and a workforce reduction and production shutdown on Kristin. The faults identified during testing have caused no harm to people or the environment.

The potential consequences should it have been necessary to evacuate the installation(s) with the aid of lifeboats during the period between the last test of these craft and their removal from service are likely to have been serious injury or loss of life. That would naturally have depended on the circumstances which gave rise to the possible requirement for evacuation.

The investigation team's most important observations can be summarised as follows:

- Deficient or faulty design of the FFH13 release mechanism.
- Deficient management of activities related to replacing and improving the lifeboats on Kristin and Veslefrikk B. Control of these activities was inadequate.
- Deficient transfer of experience as a basis for improvement measures. Neither the operator nor the manufacturer has taken account of available knowledge about known weaknesses in the FFH13 release mechanism in a way which meets the requirement for systematic gathering, processing and application of experience data.
- Inadequate discharge of compliance responsibility. Inadequate follow-up of the supplier to ensure compliance with requirements in the health, safety and environmental regulations.
- Inadequate assessment and analysis. Changes have been made without any analysis of the risk associated with new lifeboats as a complete evacuation system.
- Inadequate follow-up of safety-critical faults.
- A deficient testing and maintenance programme.

Involvement	
Main group T-1	Approved by/date Mona Haugstøyl/27 March 2009
Members of the investigation team Sigurd Robert Jacobsen, Oddvar Øvestad, Arne Kvitrud and Vidar Kristensen	Team leader Sigurd Robert Jacobsen

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The faults identified during testing have caused no harm to people or the environment. The potential consequences should it have been necessary to evacuate the installation(s) with the aid of lifeboats during the period between the last test of these craft and their removal from service are likely to have been serious injury or loss of life. That would naturally have depended on the circumstances which gave rise to the possible requirement for evacuation

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1 Introduction

1.1 Background

Problems with releasing FF1000S-type freefall lifeboats were identified during testing on the Kristin and Veslefrikk B installations in December 2008 and January 2009. These incidents led to the FF1000S-type lifeboats on both installations being taken out of service on 7 January 2009, with a consequent workforce reduction on Veslefrikk B and a workforce reduction and production shutdown on Kristin. The Petroleum Safety Authority (PSA) resolved on 9 January 2009 to conduct its own investigation of the incident.

1.2 Those involved

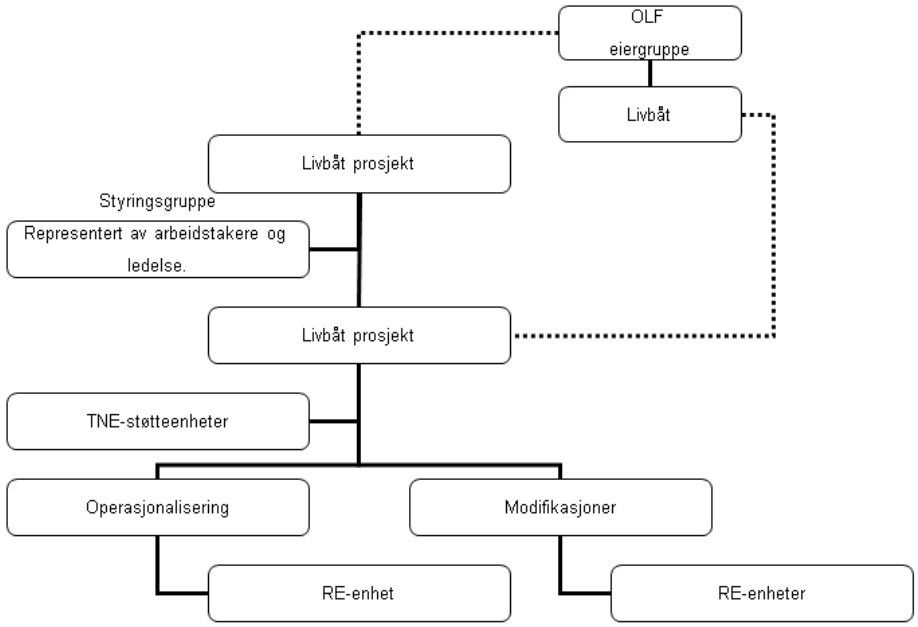
StatoilHydro's follow-up of replacing and improving the lifeboats has been assigned to a separate project and underlying sub-projects related to the various operations areas and installations. The plant integrity (AI) departments in the various operations entities have system responsibility for lifeboats on the relevant installations. The overarching StatoilHydro lifeboat project reports to the management of the Exploration & Production Norway (EPN) business area.

StatoilHydro lifeboat project (SH-LBP)
StatoilHydro established a project in 2007 to replace and improve existing freefall lifeboats on its own installations, including Kristin and Veslefrikk B. This project is referred to in this report as the StatoilHydro lifeboat project (SH-LBP).

The SH-LBP is organised as a joint overarching organisation which coordinates activities with the lifeboat suppliers and StatoilHydro's operations units. A distinction is drawn in this project between modifications to be made and operationalisation of the recommendations and requirements specified by the Norwegian Oil Industry Association lifeboat project (OLF-LBP). See figures 1 and 2 below.

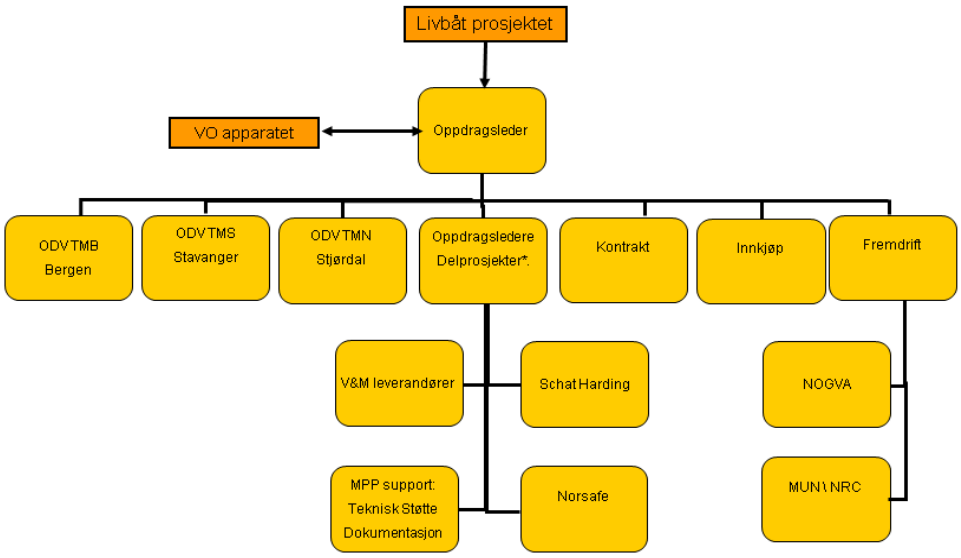
The scope of work for the SH-LBP has been to implement and deal with the recommendations given to the industry by the OLF-LBP. In addition to this role, SH-LBP (modifications) has been responsible for prioritising the sequence of and coordinating work on all modifications and replacements in StatoilHydro across the operational entities and installations involved. SH-LBP (modifications) has also maintained a close follow-up of and dialogue with the lifeboat supplier(s).

This investigation has revealed that the SH-LBP has not regarded an assessment of freefall lifeboats as a unified evacuation system as part of its scope of work. It has also emerged that SH-LBP has not considered an assessment of the release mechanism on freefall lifeboats as part of its scope. The SH-LBP takes the view that responsibility for conditions over and above the recommendations from the OLF-LBP rests with the AI department in each operational entity.



Key: OLF eiergruppe = OLF owner group. Livbåt = lifeboat. Livbåt prosjekt = Lifeboat project. Styringsgruppe = Steering group. Representert av arbeidstaker og ledelse = Represented by employees and management. TNE-støtteenheter = TNE support units. Operasjonalisering = Operationalisation. Modifikasjoner = Modifications. RE-enhet = Business units.

Figure 1 Organisation of StatoilHydro's lifeboat project (Source: SH, ref /8/)



Key: Livbåt prosjektet = Lifeboat project. VO apparatet = Safety delegate organisation. Oppdragsleder = Project manager. Oppdragsledere Delprosjekter = Sub-project managers. Kontrakt = Contracts. Innkjøp = Procurement. Fremdrift = Progress V&M leverandører = Maintenance and modification contractors. Teknisk Støtte = Technical support. Dokumentasjon = Documentation.

Figure 2 StatoilHydro's organisation for implementing lifeboat modifications (Source: SH, ref /8/)

Veslefrikk lifeboat project

Veslefrikk is part of the operations North Sea entity and supported by the land organisation in Bergen. StatoilHydro uses Aibel as its maintenance and modification contractor on Veslefrikk, and has also used Odfjell Technology to lift on and install the new and modified freefall lifeboats on Veslefrikk B.

The AI entity for Veslefrikk has system responsibility for lifeboats on the field, and has accordingly been the client and responsible entity for replacement and improvement of its own lifeboats – though in dialogue and coordinated with SH-LBP. AI is also the entity which has placed orders for new and modified lifeboats for the installation.

A separate project has been established by the Veslefrikk organisation for replacing and modifying its own lifeboats. This is referred to in the rest of this report as the Veslefrikk lifeboat project.

Kristin lifeboat project
Kristin is part of the operations north entity, and supported by the land organisation in Stjørdal. StatoilHydro uses Aker Reinertsen as the maintenance and modification contractor on this field.

The AI entity for Kristin has system responsibility for lifeboats on the field, and has accordingly been the client and responsible entity for replacement and improvement of its own lifeboats – though in dialogue and coordinated with SH-LBP. AI is also the entity which has ordered new lifeboats for the installation.

A separate project has been established by the Kristin organisation for replacing and modifying its own lifeboats. This is referred to in the rest of this report at the Kristin lifeboat project.

Umoe Schat-Harding (USH)
The freefall lifeboats on Veslefrikk B and Kristin are the FF1000S type, produced, delivered and supplied by lifeboat builder Umoe Schat-Harding (USH).

The freefall lifeboats delivered to Veslefrikk B and Kristin are designed, built and certified in accordance with maritime regulations, Solas and the lifesaving appliances (LSA) code. Lloyd's Register has certified both the new and the modified lifeboats.

This investigation has revealed that USH does not consider and has never considered it to be part of its job or scope of work to assess how far the freefall lifeboats delivered to Veslefrikk B and Kristin comply with the requirements in the HSE regulations for the petroleum industry in Norway.

OLF lifeboat project (OLF-LBP)
From the start, the scope of work of the OLF-LBP has covered various problems and challenges related to freefall lifeboats. The OLF-LBP has primarily worked on solving challenges related to the strength of the hull and superstructure, acceleration (G) forces acting on people in the lifeboat, the development of new seats and harness, and problems of securing sufficient speed for the lifeboat in the sea.

Work by the OLF-LBP has resulted in recommendations on improvements to existing freefall lifeboats and guidelines for new craft. Improvement recommendations from the project have been communicated to the industry along the way. A new DNV standard for freefall lifeboats being prepared on the basis of OLF guideline no 124 is expected to be completed in the spring of 2009.

This investigation has revealed that the OLF-LBP has not considered an assessment of freefall lifeboats as a unified evacuation system to form part of its scope of work. It has also emerged that the OLF-LBP has not considered an assessment of release mechanisms for freefall lifeboats to form part of its scope of work /117/.

No further assessment of the OLF-LBP has been made in this connection.

Comments
It should be noted that the SH-LBP has only been assessed in relation to roles and responsibilities for replacing and improving the lifeboats on Kristin and Veslefrikk B. Similarly, USH has only been assessed in relation to roles and responsibilities for replacing and improving the lifeboats on Kristin

and Veslefrikk B, with the exception of the FFH13 release mechanism, where the investigation team has also looked at faults and non-conformities reported by other owners and customers.

Where the operations entities and installations included in the SH-LBP are concerned, the investigation relates only to Veslefrikk B and Kristin. No effort has been made to establish if the findings made by the investigation are unique to the work of replacing lifeboats on Kristin and Veslefrikk B or if similar conditions prevail in other affected parts of the organisation.

1.3 Procedure

The investigation has been pursued in the following manner:

- Interviews were conducted with the SH-LBP and the operations organisation in Bergen on 13-14 January 2009, USH in Rosendal on 15 January 2009, the SH-LBP in Stavanger on 16 January 2009 and the StatoilHydro operations organisation in Stjørdal on 19 January 2009, plus two telephone interviews with offshore personnel on 21 January 2009 and 23 January 2009, a meeting and interview with StatoilHydro's corporate audit on 29 January 2009, an interview with StatoilHydro and USH in Bergen on 4 February 2009 and a telephone interview with USH on 20 February 2009.
- Verifications have been conducted through a review of documents received. See appendix B.
- A human, technology and organisation (HTO) analysis has been conducted as the means of acquiring an overview of the chain of events, weaknesses or failures in barriers, underlying and direct causes and identified non-conformities for Kristin, Veslefrikk, USH and the SH-LBP. Chapter 6 of this report provides a detailed description of the results from the HTO analysis.
- No use has been made of consultants or outside expertise other than PSA resources and the people who have been interviewed at the parties involved.

1.4 Composition of the investigation team:

- Vidar Kristensen, process integrity
- Arne Kvitrud, structural integrity
- Oddvar Øvestad, logistics and emergency preparedness
- Sigurd Robert Jacobsen, logistics and emergency preparedness, investigation leader

1.5 Mandate of the investigation team

1) Clarify the chain of events and its scope and potential, and assess direct and underlying causes as well as the operator's follow-up measures.
2) Assess emergency preparedness, operational, technical and management factors related to the incident.
3) Assess management, including risk management, factors related to specification, ordering and design for, and procedures for testing, qualification and maintenance of components and systems affected by the replacement of lifeboats on Kristin and Veslefrikk.
4) Assess follow-up of the Veslefrikk incident in 2006.
5) Contribute to assessing measures to be implemented before the lifeboats are returned to service.
6) Identify possible violations of the regulations, recommend further follow-up and identify possible requirements for the use of instruments.
7) The investigation is directed in the first instance at StatoilHydro and lifeboat supplier USH. It can be extended to cover other players and suppliers affected by the findings which result from the investigation team's work.
8) Report the status to the PSA.
9) Produce an investigation report.

The investigation team reached agreement with the person commissioning its work to confine its inquiries to the period until 7 January 2009, when a problem with releasing new freefall lifeboats on Veslefrikk B was identified.

Abbreviations

The following abbreviations are used in this report
AI = plant integrity
Af = activity regulations
EPN = Exploration & Production Norway
FFLB = freefall lifeboat
GUB = remaining exemption crew
HSE = health, safety and the environment
If = facilities regulations
IMO = International Maritime Organisation
KRI = Kristin
LB = lifeboat
LSA = lifesaving appliances
NCS = Norwegian continental shelf
NMD = Norwegian Maritime Directorate
OLF-LBP = Norwegian Oil Industry Association (OLF) lifeboat project
PSA = Petroleum Safety Authority Norway
Rf = framework HSE regulations
Sf = management regulations
SH = StatoilHydro
SH-LBP = StatoilHydro lifeboat project
Solas = International Convention for the Safety of Life at Sea, 1974
USH = Umoe Schat-Harding
VFA = Veslefrikk A
VFB = Veslefrikk B

2 Description of the FFH13 release mechanism

2.1 Principal functions of the release mechanism

A release mechanism must ensure in part:

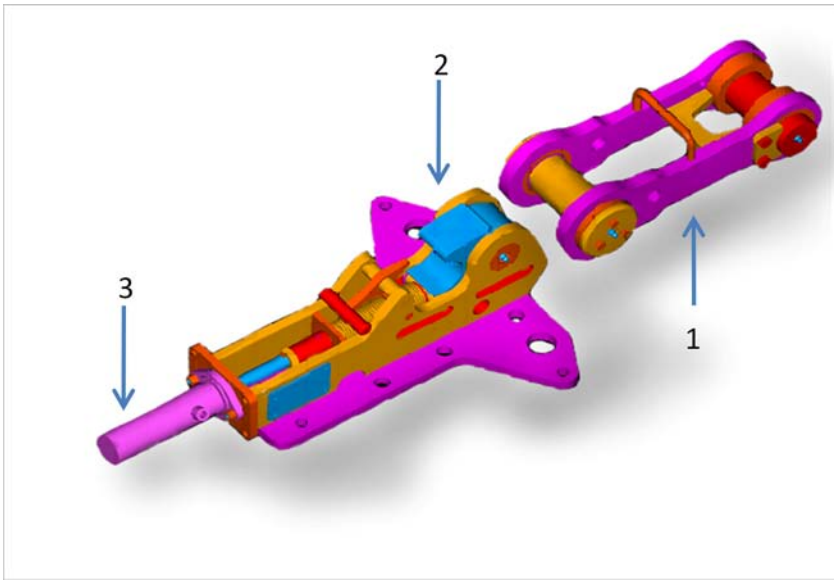
1. That the freefall lifeboat is released when required – in other words, when crew and passengers are aboard and properly secured, and execute the procedure to release (drop) the craft.

2. That the freefall lifeboat is not released unintentionally. In other words, in circumstances where the crew and passengers are not in place and properly secured. This applies both before a release (drop) procedure is initiated and if personnel (from one person to all crew and passengers) must leave their seats before the craft has been dropped into the sea.

2.2 Technical description of the FFH13

The FFH13 release mechanism was developed by a consultancy company in 1998-1999 for use on the FF1000S-type lifeboat from USF. This solution was incorporated in lifeboats installed on KRI and VFB in 2008 and in lifeboats installed on VFB in 2004 and KRI in 2005.

The FFH13 comprises three principal components: the link (attached to the installation and the release hook), the release hook (attached to lifeboat and link) and the hydraulic system (in the lifeboat, connected to the release hook). In operational condition, the lifeboat hangs by the release hook attached to the link and will be released from the link during an evacuation.

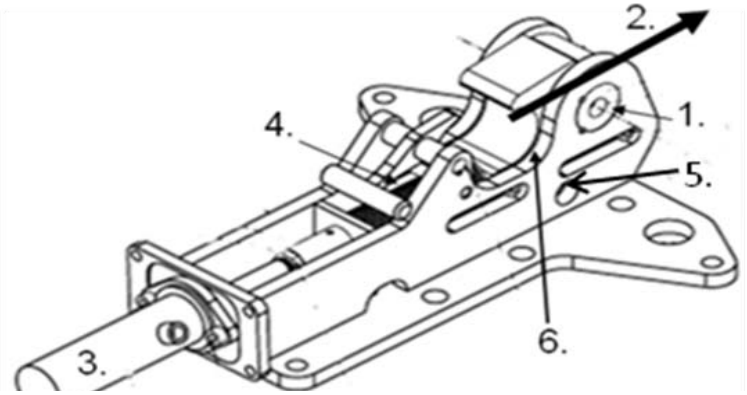


1 = link
2 = hook counterweight (release hook)
3 = hydraulic cylinder

See figure 6 for a more detailed description of the hydraulic system

Figure 3. Release system, release hook and link (Source: USH, ref /11/)

In operational condition, the weight of the lifeboat will help to keep the hook counterweight in its locked position. In addition, the release rod held in place by the spring system will lock the counterweight in a secure position. As an extra barrier, SH requires the safety bolt to be permanently mounted in operational condition.



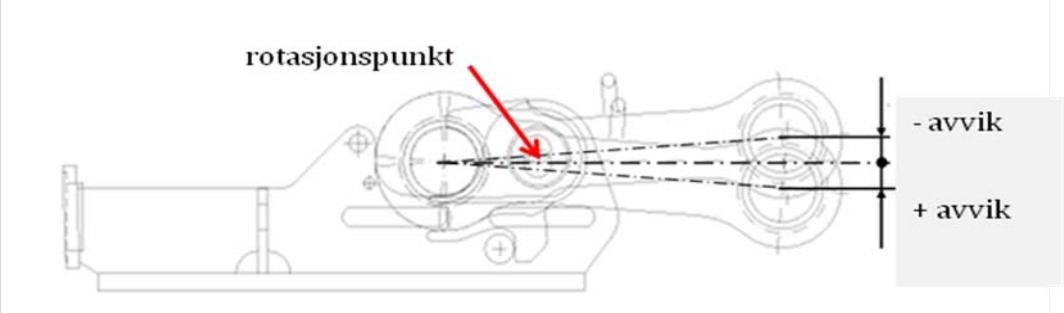
1 = main axle
2 = hook counterweight (release hook)
3 = release rod
4 = spring system
5 = hole for safety bolt
6 = flange

See appendix D for a more detailed description of the individual components.

Figure 4: Sketch of the FFH13 release mechanism (Source: SH, ref /2/)

During an evacuation, the hook is released with the aid of a hydraulic cylinder. The safety bolt must be removed before the hydraulics are activated. The cylinder is linked to the release hook by a release rod, and is activated with the aid of a hydraulic pump installed in the lifeboat. When the pressure is pumped up (normally to 160 bar in accordance with Statoil's in-depth study /1/, and a maximum of 220 bar), the cylinder will apply traction to the release rod and help to rotate the hook counterweight so that the lifeboat is released from the link.

In the optimum position, the axis of the link is about 3.5mm below the rotation point. See figure 4. The link then lies with a self-locking moment against the hook and in the area indicated as "+ deviation" in figure 5. If the gap between rotation point and link axis increases in the direction of + deviation, the amount of power to turn the hook – in other words, the self-locking moment – will also rise. Combined with the extra weight of the lifeboat, the need for hydraulic power will increase to provide the necessary turning moment for the release hook and free the lifeboat.



Key: Rotasjonspunkt = Rotation point. Avvik = Deviation.

Figure 5. Angle of deviation for the link between hook and installation (Source: SH, ref /28/)

The following table shows the measured deviation for the link position, confer figure 5, for all the lifeboats. When the link position passes 3.5mm, more power is needed to release the hook. The measurement result shows that it could potentially have been difficult to release several of the lifeboats on both installations. If LB3 on KRI or LB3 on VFB had been chosen for the 110 per cent load test, it is not certain that the faults would have been discovered.

Measurement of link position, deviation	Kristin	Veslefrikk B
Lifeboat 1	15 mm	16.5 mm
Lifeboat 2	11.0 mm	15.0 mm
Lifeboat 3	3.5 mm	6.5 mm

Table 1 Measuring the link position for lifeboats on KRI and VFB. (Source: SH, ref /28/)

Function-testing of the release hook is required as part of preventive maintenance for the release mechanism. This test involves using the hydraulic system to activate the hook. The hook counterweight then rotates until stopped by the safety bolt. When the hydraulic pressure is released, the release rod and hook counterweight are supposed to move towards the locked position with the aid of a spring. To assist resetting, the safety bolt must be rotated so that the release rod can engage with the hook counterweight and lock it. As the link axis reaches a position in the direction of "- deviation", the self-locking moment is overcome and the link will be able to open the hook if the safety bolt is not installed.

The FFH13 release mechanism comprises two "partly" independent and redundant systems for pumping up pressure into the automatic three-way valve. See figure 6. "Partly independent" means that parts of the hydraulic hose and tank are shared. The remainder of the release mechanism, from the automatic three-way valve, consists solely of individual components in series. A failure or fault in one of these components could mean that the release mechanism is unable to function as intended. No alternative methods exist for launching lifeboats with this type of mechanism.

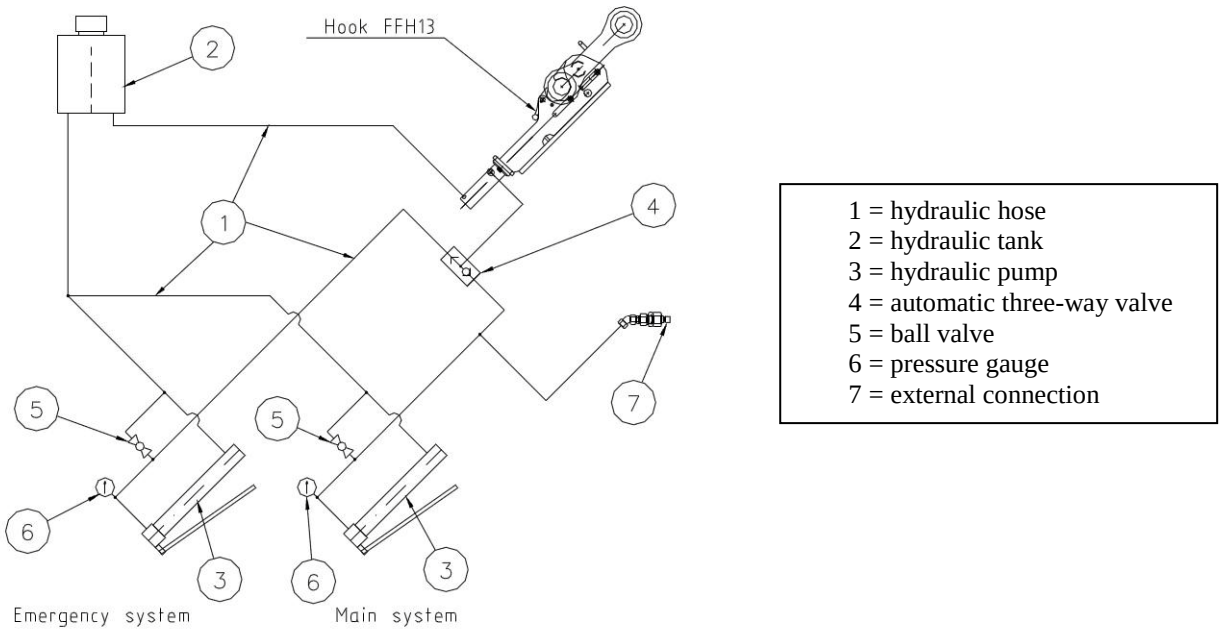


Figure 6. Diagram of the hydraulic part of the release mechanism. (Sourch: USH, ref /51/)

Regardless of where a fault arises in those parts of the release mechanism which consist only of individual components, it will be impossible in most cases to leave the lifeboat in a safe and acceptable manner once the safety bolt has been removed and pumping has begun. This is because it will not be possible to reverse the release operation by resetting the system, for instance, or replacing the safety bolt in a secure position. That means it would not be acceptable for people to release their seat harness in order to leave the boat, since it cannot be determined if and possibly when the boat might release. Small movements in the boat could be sufficient to release it. People inside the boat cannot check the position of the hook without opening doors or hatches on the lifeboat.

The investigation team accordingly concludes that individual faults with the FFH13 release mechanism could result in unacceptable consequences. These could arise because:

- the lifeboat fails to release when it should, which could leave it exposed to incidents on the installation
- people must move from a harnessed (secure) position after the release of the boat has failed.

2.3 Operating experience with the FFH13 on Kristin and Veslefrikk

The investigation has established that a number of incidents and problems have occurred on KRI and VFB with lifeboats incorporating this release mechanism during the period since they were installed on VFB in 2004. See appendix A for further details. These incidents are:

- 13 August 2006: safety bolt became stuck (old lifeboat on VFB)
- 16 January 2008: cylinder rusted solid (old lifeboat on KRI),
- 12 December 2008: could not release lifeboat, probably because of angular deviation (new lifeboat on KRI)
- 17 December 2008: could not release lifeboat, probably because of angular deviation (new lifeboat on KRI)
- 30 December 2008: could not release lifeboat, probably because of rust (new lifeboat on VFB)
- 31 December 2008: could not release lifeboat, probably because of angular deviation (new lifeboat on VFB)
- 7 January 2009: could not release lifeboat, probably because of angular deviation (new lifeboat on VFB).

In addition, a number of instances have been recorded where the release mechanism could not be reset in the prescribed manner.

3 Course of events

A selection of the activities pursued in the period up to the identification of the faults with the new lifeboats on VFB and KRI are presented here. This brief overview could be rather difficult to follow because of the large number of participants. Viewing the list in conjunction with section 1.2 concerning those involved is recommended.

- 1998/99: The FFH13 release mechanism is designed by consultants for USH
- 3 September 2002: USH receives the first reports of faults in and deficiencies with the release mechanism. A number of problems with the release mechanism are subsequently experienced. See appendix A
- 2002: FF1000S lifeboats are ordered for VFB
- 2004: Freefall lifeboats are installed on VFB
- 2005: FF1000S freefall lifeboats are installed on KRI while it is under construction
- 21 June 2005: Serious faults are identified during drop tests with a freefall lifeboat on VFB.
- 13 August 2006: Problems are experienced in removing the safety bolt from the FFH13 release mechanism for freefall lifeboats on VFB. A number of problems are subsequently recorded with the release mechanism on VFB. See appendix A. An in-depth study is conducted thereafter to identify the problems with the release mechanism.
- 18 October 2006: Completion of the in-depth study on factors related to the release mechanism for freefall lifeboats on VFB
- 10 November 2006: The PSA removes references to the maritime regulations for freefall lifeboats from the HSE regulations
- 16 January 2008: KRI experiences the first problems with the release mechanism for freefall lifeboats. A series of problems are subsequently experienced with the release mechanism on KRI. See appendix A
- 18 April 2008: Follow-up of the in-depth study from 2006 is completed without all the measures being satisfactorily implemented
- Sep/Oct 2008: Lifeboats on KRI are replaced with FF1000S freefall lifeboats
- Nov 2008: Replacement of lifeboats on VFB begins, and a new FF1000S freefall craft is taken on board
- 12 December 2008: SH experiences problems with one of the new FF1000S freefall lifeboats on KRI
- 30 December 2008: The PSA is notified that it is not possible to release an old freefall lifeboat on VFB. This problem has been discovered when the craft is to be removed to make space for a modified freefall lifeboat
- 2 January 2009: The safety delegate service on Veslefrikk requires that the freefall lifeboats be taken out of service and that staffing on VFB be reduced to the available capacity of conventional lifeboats on VFA. This demand was made pursuant to section 6.3 in the Working Environment Act on the right of the safety delegate to halt hazardous work.
- 3 January 2009: The last of the old freefall lifeboats is dropped from VFB, and new craft are taken on board
- 7 January 2009: It is established in the early morning that problems exist in releasing the hook on one of the new freefall lifeboats on VFB when it was fully laden
- 7 January 2009: SH reports that the workforce on KRI is to be reduced to the GUB because it has the same type of freefall lifeboats as on VFB and because uncertainty has arisen over the release mechanisms after tests on the latter.
- 7 January 2009: SH resolves to investigate the incidents
- 9 January 2009: The PSA resolves to investigate the incidents

4 Potential of the incident

4.1 Actual consequences

The faults were exposed during testing, and have caused no harm to people, the environment or material assets, other than the financial consequences of restricted activity and the production shutdown on KRI.

Veslefrikk
For an indefinite period up to 30 December 2008, it was not possible to launch LB3. This condition was not known to personnel on the platform until it proved impossible to launch the lifeboat on 30 December 2008. During the period from 31 December 2008, when a new lifeboat was taken aboard and installed in the LB3 position, and until 7 January 2009, when the test under 110 per cent load failed, it was also not known that this lifeboat could not be launched under these conditions. It has subsequently transpired that the safety delegate service was justified in requiring that the freefall lifeboats on VFB be taken out of service. Lifeboat capacity has probably been weakened for an indefinite period until the faults were discovered and corrected.

Activities were pursued to secure the wells on VFA in the period from 2 to 7 January 2009. Work took place over the period to reduce the workforce on VFA and VFB to 58 people.

Veslefrikk has a maximum of 169 personnel on board (POB).

Kristin
Lifeboat capacity on KRI has probably been weakened during the period from the installation of the new lifeboats until the fault was discovered on 7 January 2009 and the workforce reduced to fewer than 19 people (GUB).

KRI has a maximum of 104 personnel on board (POB).

4.2 Potential consequences

Lifeboats or lifeboat systems are not the primary means of evacuation for KRI and VFB. The first line of evacuation from VFB will be the bridge to VFA and helicopters. On KRI, it will be use of helicopters. Under certain circumstances, on the other hand, it would not be possible to use these means of evacuation. That could be because of weather, wind, smoke or lack of time. Conditions could arise where lifeboats are the primary means of evacuation. As a result, evacuation by lifeboat is safety-critical.

Means of evacuation such as escape chutes and liferafts are not to be regarded as equivalent to lifeboats, and can accordingly not be taken into account when calculating acceptable capacity.

It would not be possible to leave the FF1000S lifeboat type in an acceptable and safe manner after starting to pump the release mechanism. In the event of an unsuccessful launch, the condition of the release mechanism would be unknown and leaving the lifeboat to use an alternative means of evacuation would be insecure. See the description in section 2.2 for a more detailed explanation.

The potential consequences if it had been necessary to evacuate the installation(s) with the aid of lifeboats during the period between the last lifeboat test and the removal of the lifeboats from service are considered to have been serious injury to or loss of life among personnel in one or more of the relevant lifeboats, because their evacuation function on VFB and VFA must be regarded as lost.

5 Causes of the incident

The investigation team's assessments related to the direct and underlying causes are summarised in this chapter.

5.1 Direct causes

5.1.1 Deficient or faulty design of the release mechanism

The direct cause of the incident on VFB on 30 December 2008 was corrosion of the spring system. The direct cause of the incident on VFB in the early morning of 7 January 2009 was that the link and hook were outside their geometric tolerance, and the weight of the lifeboat was too great in relation to the available hydraulic pressure to release the lifeboat with the release mechanism.

It has also emerged that a failure in one of several components in the FFH13 release mechanism, or an individual mistake in connection with releasing the FF1000S lifeboat (with the FFH13 installed) could mean that the lifeboat fails to release as intended when required.

5.2 Underlying causes

5.2.1 Deficient management of activities for replacing and improving lifeboats on KRI and VFB

Management of activities related to replacing and improving lifeboats on KRI and VFB has been deficient.

5.2.2 Deficient transfer of experience as a basis for improvement measures

Inadequate use has been made of experience as a basis for improvement measures. Neither SH as owner nor USH as supplier has applied available knowledge about known weaknesses with the release mechanisms in a way which satisfies the requirement for systematic gathering, processing and application of experience data.

5.2.3 Inadequate discharge of compliance responsibility

SH has provided USH with a deficient specification for delivery in accordance with the HSE regulations. SH's follow-up of the supplier to ensure compliance with the requirements of the HSE regulations has been inadequate.

5.2.4 Inadequate assessment and analysis

The SH-LBP has been pursued without the risk associated with the lifeboats as a unified evacuation system being analysed and assessed in an acceptable and adequate manner. Furthermore, the FFH13 release mechanism has not been assessed and analysed in an acceptable and adequate manner in relation to both in-house requirements and the HSE regulations related to individual faults, barriers, functionality and the performance of safety-critical components and systems.

5.2.5 Inadequate follow-up of safety-critical faults

Inadequate follow-up of safety-critical faults with the FFH13 release mechanism has been identified.

5.2.6 Deficient testing and maintenance programme

A deficient testing and maintenance programme for the FFH13 release mechanism has been identified.

6 Observations related to the regulations

The PSA's observations generally fall into two categories

- Non-conformities: this category embraces observations where the PSA believes that the regulations have been violated.
- Improvement points: relate to observations which identify deficiencies, but without sufficient information to determine whether the regulations have been violated.

6.1 Deficient or faulty design of the release mechanism

Non-conformities:
The failure of one or more components in the FFH13 release mechanism or an individual mistake when releasing the FF1000S-type lifeboat (with the FFH13 installed) could mean that the lifeboat fails to release. Furthermore, a failure or fault in individual components could prevent resetting of the release mechanism during testing.

Reasons:
1. As discussed in chapter 4 on the potential of the incident, and as illustrated in figure 6, the FFH13 release mechanism consists only of individual components in series from the three-way valve right through to the hook counterweight. A functional failure or fault in any of these components, such as the three-valve, the flange, the spring system, the release rod or the hook counterweight, could mean that the boat fails to release as required or that the mechanism cannot be reset after testing.

2. If the safety bolt cannot be released (is stuck), the consequence will be that the lifeboat cannot be released. Should this be discovered before release of the lifeboat is initiated (in other words, before starting to pump), it could nevertheless be acceptable in some circumstances to leave the lifeboat (alternatively refrain from entering the lifeboat) in order to use an alternative means of evacuation or – in some circumstances – wait until the safety bolt has been released.

3. It is possible to initiate lifeboat release (pumping) when the safety bolt is in place. Once pumping has started, however, it is impossible in practice to check in a safe and acceptable way whether the safety bolt has been removed when seated in the lifeboat. Confer chapter 4. A single mistake (starting to release-pump the lifeboat before the safety bolt has been removed) could therefore mean that the boat does not release when required.

4. Routine replacements and improvements to individual components could improve the reliability and availability of the lifeboats. So long as the release mechanism consists of individual components in series, however, it will be impossible to exclude the possibility that an individual error or fault could prevent the lifeboats from launching when required. The LSA code /118/ requires two independent activation systems for initiating the release mechanism from inside the lifeboat. Such independence is provided only for the pump in the relevant mechanism, but not in the rest of it.

Sources
Reported in the interviews
/26/ USH non-conformities and claims related to FFH13
/118/ IMO: Lifesaving appliances, 2003 edition, chapter IV section 4.7.6.
Appendix A

Requirements:
If section 4 on design of facilities: "Facilities shall be based on robust and the simplest possible solutions and shall be designed so that ... failure of a component, a system or one single mistake does not lead to unacceptable consequences" (continuation of principles from earlier regulations)

Sf section 1 on risk reduction: "The requirement for independence as mentioned in the third paragraph implies that several important barriers shall not be impaired or cease to function

simultaneously, inter alia as a consequence of a single failure or a single incident." (from the guidelines)

Af section 68, paragraph d on handling of situations of hazard and accident: "the personnel on the facility can be quickly and efficiently evacuated at all times, cf. also the Facilities Regulations Section 43 on means of evacuation."

If section 43 on means of evacuation: "It shall be possible to carry out quick and effective evacuation of personnel on facilities to a safe area in all weather conditions."

6.2 Deficient management of activities for replacing and improving lifeboats on KRI and VFB

Non-conformity:
Management of activities for replacing and improving lifeboats on KRI and VFB was inadequate.

Reasons:
1. Organisation of the work related to replacing and improving the lifeboats on both KRI and VFB has meant that roles and responsibilities have been unclear, and have not been adequately fulfilled. One of the biggest challenges in this investigation has been to acquire a clear understanding of who has been involved, directly or indirectly, and what responsibility the people involved have had for the work of improving or replacing the lifeboats on KRI and VFB.

The formal responsibility for ensuring that the lifeboats comply with the applicable requirements and regulations (in the HSE regulations and SH's governing documents) rests with the system owner for these craft: the AI departments for KRI and VFB. Those involved in SH have had a relatively clear understanding of this responsibility. A significant "challenge", on the other hand, has been the way the work of improving or replacing the lifeboats on KRI and VFB is organised.

This is because, while AI has had formal responsibility for the lifeboats, the SH-LBP has played a key role in relation both to the design of the new and modified lifeboats and to following up and communicating with the supplier. When the project was presented to the EPN management on 26 March 2008, the following formulation was used under the heading: "Proposed job description for the lifeboat project manager:

> "*To coordinate further work on preparing the factual basis which is important for the overall risk picture for personnel on the affected installations*".

This job description was approved by the EPN management. Other than a copy of the presentation, the investigation team has not received documents which describe any other scope of work for the project. The investigation team takes the view that the description of the scope of work for the SH-LBP presented to the EPN management on 26 March 2008 gives the impression of a scope larger than the project management believes it to have been.

As described in section 1.2, the SH-LBP management has had a relatively clear perception and understanding that its scope of work was largely restricted to coordinating the "queue" of lifeboat projects and to ensure than the OLF-LBP's recommendations were implemented.

It has emerged from interviews with people outside the central SH-LBP management, but nevertheless involved in the work of replacing or improving the lifeboats for VFB and KRI, that perceptions of the SH-LBP's role and responsibility have varied. Although formal responsibility for the lifeboats has, as mentioned above, been relatively clearly understood, a view has established itself in parts of the organisation that the SH-LBP would in practice handle *the overall risk picture* or *all relevant conditions* related to freefall lifeboats.

Given the organisation of the SH-LBP and the understanding of project's scope of work by the SH-LBP management, the investigation team finds it difficult to see how the project was intended to secure and take care of operational experience across the various affected operations entities and fields covered by the SH-LBP. Other than communication between VFB and KRI in December 2008-January 2009, the team has been unable to identify that any activities were conducted to ensure transfer of experience across affected operating units and fields.

Apart from the conditions covered by the OLF-LBP, it has been up to the AI for each field, on an independent and stand-alone basis, to secure relevant operating experience with lifeboats. It has also been up to the AI for each field, on an independent and stand-alone basis, to review and ensure that the lifeboats ordered were designed and delivered in accordance with the applicable requirements in the HSE regulations.

2. Reference has been made during the interviews to SH's FR05, FR06 and WR0157 governing documents to identify roles, responsibilities and requirements concerning which processes and activities should be pursued in connection with initiating and executing modification projects on a general basis in SH. It has emerged that the work of improving and replacing lifeboats in the SH-LBP has been executed as a task force project. Such projects are not unambiguously defined in SH's governing documentation.

The investigation team takes the view that the above-mentioned documents for modification projects also applied to replacing and improving the lifeboats on KRI and VFB. This also accords with SH's corporate audit of the SH-LBP in 2008, though with the proviso that the corporate audit only covered the SH-LBP and not everyone involved in replacing and improving the lifeboats on VFB and KRI.

3. The requirements in FR06 have not been observed in connection with replacing and improving the lifeboats on KRI and VFB. An adequate planning and study phase has not been implemented, for instance. The basis for taking decisions on lifeboat replacement for VFB and KRI accordingly failed to conform with SH's governing documents.

4. The FR06 governing document is intended to ensure safe and efficient execution of modifications, with associated operational preparations. It specifies a number of activities to be implemented and documents to be prepared in a project. The following examples of non-conformity with FR06 have been identified:

- No project execution plan has been completed to ensure quality in deliveries and products in accordance with requirements.
- An HSE impact assessment of the new and modified lifeboats on KRI and VFB has not been implemented.
- No quality assurance of project documentation has been done in the respective disciplines.

5. Information obtained during the investigation shows that work practices (communication, collaboration and documentation) related to replacing and improving the lifeboats on KRI and VFB, at various levels and in different parts of the group, have not complied with the definition of these practices in the governing documents. Nor have established interfaces within SH and between SH and its suppliers functioned as intended in SH's governing documents, particularly with regard to ensuring that the lifeboats complied with the requirements in the HSE regulations.

6. In the investigation team's view, specialists from the AI departments have had an understanding of AI's role and responsibility as an "agenda-setter" and as "responsible for technical quality assurance". The understanding has been that the SH-LBP would deal with recommendations and guidelines from the OLF-LBP, and AI would handle other aspects. However, no activities have been conducted by the AI management (for either VFB or KRI) to ensure that technical involvement and deliveries by AI were adequate.

7. AI, as system owner, has not pursued activities to ensure that the lifeboats complied, as a safety-critical system, with applicable requirements in the HSE regulations. Nor have the contracts between the operations entities (VFB and KRI) and USD specified that the lifeboats should be designed and delivered in compliance with the requirements of the HSE regulations. The contract refers to "involving personnel to identify possible further field-specific additions". In the investigation team's view, such requirements, as well as the involvement of the SH-LBP, could have been interpreted by USD to mean that AI had ensured the craft were in compliance with the applicable lifeboat regulations. As noted in section 1.2, USH has not considered that it had a role in assessing the order and the delivery to the operations entities in relation to the HSE regulations.

8. The SH corporate audit in 2005 identified deficiencies in the certificates, in that these did not indicate the presence of non-conformities from the requirements. No systematic efforts were made to identify the non-conformities between the certificates and the requirements in the LSA code for the release mechanism and release pressure. Nor have the identified deficiencies led to a closer follow-up of the content of the certificates. The certificates issued in 2008 continued to contain errors. The lack of follow-up meant a failure to identify errors and deficiencies in the certificates for the freefall lifeboats delivered to VFB and KRI

Sources:
Reported in the interviews
/116/ FR06 Operation, maintenance and modifications, OMM, received as e-mail 13 January 2009
/22/ SH D&V 7 Anleggsforbedring, Arbeidsprosesskrav, WR0157, version 3.1, valid 8 August 2008
/43/ SH corporate audit: "T&P ANT MBM 01-05; Livbåter Umoe Schat-Harding As", item 2, second and fourth paragraphs, dated 2 May 2006.
/118/ IMO: Lifesaving appliances, 2003 edition, chapter IV, section 4.7.6

Requirements:
Sf section 3 on management of health, environment and safety: "The party responsible shall ensure that the management of health, environment and safety comprises the activities, resources, processes and the organisation necessary to ensure prudent activities and continual improvement, cf. section 13 of the framework regulations on the duty to establish, follow up and further develop a management system. Responsibility and authority shall be unambiguously defined at all times. The necessary steering documents shall be prepared, and the necessary reporting lines shall be established."

Sf section 21 on follow-up: "The party responsible shall follow up to see that all elements of his own and of other participants' management system are established and functioning as intended, and that a fully satisfactory level of health, environment and safety exists. This follow-up shall contribute to identifying technical, operational or organisational weaknesses, failures and deficiencies. Methods, frequency and extent of the follow-up, and the degree of independence in conducting it, shall be adapted to the significance of the element to health, environment and safety."

Sf section 10 on work processes: "The party responsible shall ensure that the work processes and the products thereof fulfil the requirements relating to health, environment and safety. Work processes of significance to health, environment and safety and interfaces between these shall be described. The level of detail in the description shall be adapted to the significance of the processes in relation to health, environment and safety."

Af section 22 on procedures: "The party responsible shall establish criteria for when procedures are to be used as means to prevent faults and situations of hazard and accident. It shall be ensured that procedures are established and used in such way as to fulfil their intended functions."

Rf section 14 on qualification and follow-up of other participants: "In the event of entering into a contract, the party responsible shall ensure that the contractors and suppliers are qualified to fulfil the requirements of rules and regulations relating to health, environment and safety, and shall follow up that the participants comply with the requirements during conduct of the work assigned in the

petroleum activities. The operator shall ensure that possible shortcomings in other participants' management of health, environment and safety are corrected and that necessary adaptive measures are taken with respect to one's own and other participants' management systems that are established according to these regulations section 13 on duty to establish, follow up and further develop a management system or according to other Norwegian legislation, in order to ensure the necessary wholeness."

Rf section 15 on verifications: "The party responsible shall decide on the extent of verifications, the method to be used in and the degree of independence of the verification in order to document that the requirements of the legislation relating to health, environment and safety have been met. When it has been decided that verifications are to be carried out, such verifications shall be carried out according to an overall and unambiguous verification programme and verification basis."

6.3 Deficient transfer of experience as a basis for improvement measures

Non-conformity:
Insufficient use has been made of experience as a basis for improvement measures.

Reasons:
1. Statoil conducted an in-depth study in the autumn of 2006 as a result of a functional fault with the FFH13 release mechanism on VFB. USH was not involved in the study, and no operational experience or information about failure mechanisms in the release mechanism was obtained from USH. The in-depth study recommended "a review of the whole release mechanism (resulting in modifications or a new design)". This was not adequately followed up in relation to identifying or preventing faults. The release mechanism was not redesigned or replaced with a new solution. No redesign was carried out in the period up to the 2008 conclusion of the case established in Synergi in connection with the 2006 incident. The in-depth study led SH to replace individual components or make minor modifications to the system on VFB. On the basis of the in-depth study, Statoil asked USH on 16 January 2007 to reassess the release mechanism. At that time, USH had also received reports from other customers that the system functioned poorly. SH correspondingly had another good opportunity to get to grips with the release mechanism when the problems on KRI arose in early 2008. SH has not conducted a more detailed study of the causes.

2. Statoil procedure D&V 7 Anleggsforbedring, Arbeidsprosedyrekrav, WR0157 version 3.1 states in its object that an overall improvement will be achieved through the structured collection and consideration of improvement proposals and technical operational inquiries. According to section 2.1, this will be done when changes in the facility are expected. No operational experience was obtained when the VFB and KRI lifeboat projects placed orders for new and modified craft. Nor were experience and recommendations from the in-depth study applied or taken into account.

3. The consequences for the release mechanism of changes to the weight and dimensions of the new and modified lifeboats on VFB and KRI were not analysed.

4. Faults were revealed during prototype testing of the lifeboats in August 2008. This was explained as a geometric deviation. It was only partly compensated for by grinding off some of the elevation on the lug at the stern of the lifeboat. No verification was conducted by SH to check that the modification was sufficient. The consequence of the changed external geometry and the weight increase for the new and modified lifeboats was not sufficiently analysed and taken into account, even though problems were observed during tests at the supplier. Nor was the importance of the link angle communicated by USH in connection with the installation procedure, even though this was known at the time. The modifications were insufficiently analysed. No system analysis was conducted.

5. Several modifications have been made to release-system components, with carbon steel replaced by stainless steel. The smaller the proportion of carbon to stainless steel, the greater the probability that

the remaining carbon steel components will act as sacrificial anodes for the stainless steel, thereby corroding and expanding. No corrosion assessment has been conducted on the consequences of this for the remaining carbon steel components. SH has not checked that USH possesses sufficient expertise with the functionality of the release mechanism, corrosion and choice of materials. No overall assessment of the release mechanism has been conducted on the basis of customer reports.

6. Before the two modified lifeboats were installed on VFB, no information was applied from KRI concerning experience with its new lifeboats. Nothing was done to acquire experience and follow that with an analysis of failure mechanisms.

7. The SH-LBP and the OLF-LBP were intended to restore confidence in freefall lifeboats on the NCS. Operational experience from SH or USH was not provided to the lifeboat projects in a systematic way, so that it could form the basis for improvement activities.

Sources:
Reported in the interviews
/1/ SH in-depth study, 18 October 2006, page 15
/26/ USH non-conformities and claims related to FFH13
/30/USH procedure: corrective measures, PR.04 dated 24 June 2004, section 5.0
/99/ USH safety reports

Requirements:
Sf section 18 on collection, processing and use of data: "The party responsible shall ensure that data are collected, processed and used to ... e) take corrective and preventive actions, including improvement of systems and equipment."

Sf section 22 on improvement: "Provision shall be made for using knowledge gained through experience from own activities as well as the activities of others in the improvement efforts."

Rf section 14 on qualification and follow-up of other participants: "In the event of entering into a contract, the party responsible shall ensure that the contractors and suppliers are qualified to fulfil the requirements of rules and regulations relating to health, environment and safety, and shall follow up that the participants comply with the requirements during conduct of the work assigned in the petroleum activities. The operator shall ensure that possible shortcomings in other participants' management of health, environment and safety are corrected and that necessary adaptive measures are taken with respect to one's own and other participants' management systems that are established according to these regulations section 13 on duty to establish, follow up and further develop a management system or according to other Norwegian legislation, in order to ensure the necessary wholeness."

Rf section 15 on verifications: "The party responsible shall decide on the extent of verifications, the method to be used in and the degree of independence of the verification in order to document that the requirements of the legislation relating to health, environment and safety have been met. When it has been decided that verifications are to be carried out, such verifications shall be carried out according to an overall and unambiguous verification programme and verification basis."

Sf section 21 on follow-up: "The party responsible shall follow up to see that all elements of his own and of other participants' management system are established and functioning as intended, and that a fully satisfactory level of health, environment and safety exists. This follow-up shall contribute to identifying technical, operational or organisational weaknesses, failures and deficiencies. Methods, frequency and extent of the follow-up, and the degree of independence in conducting it, shall be adapted to the significance of the element to health, environment and safety."

6.4 Inadequate discharge of compliance responsibility

Non-conformities:
SH has provided USH with a deficient specification for a delivery pursuant to the HSE regulations. SH's follow-up of the supplier has been inadequate for ensuring compliance with the requirements of the HSE regulations.

Reasons:
1. The PSA issued circulars to the industry on 10 November 2006 and 11 June 2007 to notify references to the maritime regulations as a norm for the design of freefall lifeboats have been removed from the facilities regulations, refs /121/ and /122/. In these circulars, the PSA called attention to the fact that the responsible parties must accordingly find other ways to document that compliance has been achieved with the regulatory requirements, including the ability to evacuate personnel on installations quickly and effectively to a safe area under all weather conditions.

On the basis of the documents received and information provided during interviews, the investigation team has been unable to establish that specific requirements have been set for the new and modified lifeboats other than the specifications detailed in the contracts between SH and USH, refs /17/, /18/ and /19/. Nor has documentation been submitted to show that the chosen solution accords with the HSE regulations.

The investigation team has been unable to establish that SH has conducted any documented assessment of the NMD, Solas and LSA requirements. The team accordingly considers that: SH has failed to respond to the removal of the reference to the maritime regulations announced by the PSA (in its circulars of 10 November 2006 and 11 June 2007). SH has prepared a deficient specification, which fails to satisfy the requirements of the HSE regulations. Nor have the requirements of the HSE regulations been enforced towards the supplier in other ways.

2. SH's follow-up of USH to ensure that it complies with the applicable HMS regulations has been inadequate. Although the PSA removed the reference to the maritime regulations in 2006 and 2007, USH applied these regulations. That relates to the assessment of the lifeboat as a unified evacuation system and to individual faults in the release mechanism.

3. SH has not noticed or followed up that USH fails to comply with its own management system based on ISO 9001:2000. A number of reports from customers and own employees concerning faults and deficiencies in the FFH13 release mechanism have been registered. The way USH applies its non-conformity system fails to satisfy the requirements in ISO 9001:2000, sections 8.3 and 8.4, since no analysis has been conducted of the reported non-conformities with the FFH13. In addition, USH has provided very little information to its customers about faults and deficiencies with the FFH13 release mechanism. Only two safety reports have been issued for this release mechanism, both as recently as 2008 and 2009. Lloyd's Register is responsible for certifying USH to ISO 9001:2000. Personnel at USH have also reported in interviews that they do not have time to sit down and solve the known problems. USH has nevertheless taken the view that the faults did not pose a safety risk. See also section 6.1 concerning individual faults in and design of the release mechanism.

4. During audits conducted in late 2005, refs /43/ and /46/, SH identified that the certificates for some lifeboats do not accord with the requirements. These findings related to USH and Lloyd's Register as well as to Norsafe and See-Berufsgenossenschaft.

5. The certificates for lifeboats delivered to KRI and VFB in 2008, refs /39/ and /40/, contain references to the LSA code /118/ and the NMD's lifesaving regulations (Regulation of 11 April 2003 number 492 concerning lifesaving appliances and evacuation of mobile offshore units), ref /119/. USH and Lloyd's Register do not refer to the latest and valid regulations, Regulation of 4 July 2007 no 853 concerning evacuation and lifesaving appliances on mobile offshore units, ref /120/.

References in the certificates for the new and modified lifeboats on KRI and VFB include Chapter IV, section 4.7.6 of the LSA code, ref /118/, where the following requirements are formulated:

> *"Each free-fall lifeboat shall be fitted with a release system which shall:*
> *1. Have two independent activation systems for the release mechanisms which may only be operated from inside the lifeboat…*
> *2. be so arranged as to release the boat under any condition of loading from no load up to at least 200% of the normal load caused by the fully equipped lifeboat when loaded with the number of persons for which it is to be approved."*

The FFH13 does not have two independent activation systems for the release mechanism. The lifeboats delivered and certified do not correspond with the requirement referred to in the certificate. Based on information received during the interviews, it has not been established that the release mechanism on the lifeboats delivered to KRI and VFB complies with the requirement that it must be possible to release the lifeboat under 200 per cent load. USH reported in the interviews that the normal release pressure was 120 bar, and SH writes in section 6.1 of the in-depth study /1/ that the normal release pressure was 160 bar. Given the available pressure (200-220 bar), no correspondence exists between the requirements referred to in the certificates and the lifeboats delivered.

The lifeboats are certified for a weight per person of 75kg, although SH says they were built for 90kg.

Handwritten changes have been made to the certificates in the form of erasures and editions, but it has not been possible to trace who has carried them out, when they were made and whether they are approved by Lloyd's Register as the certifying body.

The certificates do not reflect the removal of references to maritime regulations from the HSE regulations. Nor do they refer to supplementary requirements introduced to ensure correspondence between the OLF-LBP recommendations and the HSE regulations.

SH noted no deficiencies or faults in the certificates when taking delivery of the lifeboats in 2008.

SH, as the recipient of certified freefall lifeboats, has failed to conduct a sufficiently detailed review of:

- what the lifeboats are certified for
- how far only parts of or the freefall lifeboats as a unified evacuation system are certified
- which requirements and regulations the lifeboats are certified to
- how far all applicable requirements and rules (for equipment and its intended areas of application) are covered by the certificates.

Sources:
Reported in the interviews
/17/, /18/, /19/ Orders from VFB and KRI to USH.
/118/ IMO: Lifesaving appliances, 2003 edition, chapter IV section 4.7.6
/39/ and /40/ Lifeboat certificates
/43/ and /46/ SH audits conducted in late 2005

Requirements:
Rf section 5 on responsibility: "The party responsible shall ensure that requirements specified by the legislation relating to health, environment and safety are complied with. The operator shall see to it that everyone carrying out work for him, either personally, by employees, contractors or sub-contractors, complies with requirements contained in the health, environment and safety legislation.".

Rf section 14 on qualification and follow-up of other participants: "In the event of entering into a contract, the party responsible shall ensure that the contractors and suppliers are qualified to fulfil the requirements of rules and regulations relating to health, environment and safety, and shall follow up

that the participants comply with the requirements during conduct of the work assigned in the petroleum activities. The operator shall ensure that possible shortcomings in other participants' management of health, environment and safety are corrected and that necessary adaptive measures are taken with respect to one's own and other participants' management systems that are established according to these regulations section 13 on duty to establish, follow up and further develop a management system or according to other Norwegian legislation, in order to ensure the necessary wholeness."

Rf section 18 on documentation: "The party responsible shall ensure that documentation demonstrating compliance with requirements stipulated in or pursuant to these regulations, can be provided. The extent of the documentation shall be adapted to the characteristics of the enterprise and the activities carried out. When the party responsible makes use of a standard recommended in the guidelines to a provision of the regulations, as a means of complying with the requirements of the regulations in the area of health, working environment and safety, the party responsible may as a rule take it that the regulation requirements have been met. When other solutions than those recommended in the guidelines to a provision of the regulations are used, the party responsible shall be able to document that the chosen solution fulfils the requirements of the regulations. Combinations of parts of standards shall be avoided, unless the party responsible is able to document that an equivalent level of health, working environment and safety is achieved."

Sf section 21 on follow-up: "The party responsible shall follow up to see that all elements of his own and of other participants' management system are established and functioning as intended, and that a fully satisfactory level of health, environment and safety exists. This follow-up shall contribute to identifying technical, operational or organisational weaknesses, failures and deficiencies. Methods, frequency and extent of the follow-up, and the degree of independence in conducting it, shall be adapted to the significance of the element to health, environment and safety."

6.5 Inadequate assessment and analysis

Non-conformities:
The SH-LBP has been executed without risk associated with the lifeboats, as a unified evacuation system, being analysed and assessed in an acceptable and adequate manner. Furthermore, the FF13H release system has not been assessed and analysed in an acceptable and adequate manner in relation either to internal requirements or to requirements in the HSE regulations concerning individual faults, barriers, functionality and the performance of safety-critical components and systems.

Reasons:
Separate analyses or assessments have not been conducted by SH for risk, individual faults, barriers, functionality and the performance of safety-critical components and systems related to the new lifeboats on VFB and KRI. Nor has SH pursued any activities to assess and verify that other parties involved have implemented the necessary analyses and assessments of the lifeboats.

Source:
Reported in the interviews

Requirements:
Sf section 13 on general requirements for analyses, which specifies that the party responsible will ensure that analyses are carried out which provide the necessary decision basis in order to give due consideration to health, safety and the environment.

Rf section 15 on verifications: "The party responsible shall decide on the extent of verifications, the method to be used in and the degree of independence of the verification in order to document that the requirements of the legislation relating to health, environment and safety have been met."

6.6 Inadequate follow-up of safety-critical faults

Non-conformity:
Inadequate follow-up of safety-critical faults in the FFH13 release mechanism has been identified.

Reasons:
SH has established performance standards for safety-critical equipment, ref /66/. In section 2.3.5 on Performance Standard no 14 (Escape and Evacuation) and on the function *Release function for lifeboat does not work on test*, /66/ specifies requirements for acceptable failure rates and test intervals of 0.1 per cent (*target failure fraction)* and six months *(initial test interval).* Failure fraction here means the relationship between the number of tests which fail and the number of tests.

The requirements mentioned above specify a permitted level of one failure per 1 000 tests. With test intervals of six, four, three, two or one month, plus a test per week, this means that one failure per lifeboat is accepted every 500, 333, 250, 167, 83 or 19 (for weekly testing) years respectively. Merging tests for two/three lifeboats means that one lifeboat failure per installation is accepted every 250/167, 167/111, 125/83, 83/56, 41/28 or 10/6 years. In other words, 10/6 years, for instance means 10 years with two lifeboats and six years with three.

Given the history of the lifeboats on VFB, where a number of faults and deficiencies were identified in the 2006-08 period which affect the functionality of the release mechanism in connection with testing, and the requirements in GL0114 ref. /66/, no correspondence exists between the requirements specified for the release function and the results achieved through testing. How far GL0114, ref /66/, or similar requirements were applicable when the first lifeboats were installed on KRI and VFB has not been assessed. Nor has an assessment been made in this investigation of the way this has been followed up in SH. When replacing the lifeboats on VFB and KRI in 2008 and 2009, it was not discovered that the FFH13 release mechanism failed to satisfy the requirements specified for this type of equipment. This is based on the consideration that GL0114, ref /66/, has been in force from 2007.

Sources:
Interview
/66/ SH: HSE guideline, GL0114, safety critical failures, final version 1, valid from 19 June 2007

Requirements:
Sf section 18 on collection, processing and use of data: "The party responsible shall ensure that data are collected, processed and used to a) monitor and control technical, operational and organisational aspects ... e) take corrective and preventive actions, including improvement of systems and equipment."

Sf section 21 on follow-up: "The party responsible shall follow up to see that all elements of his own and of other participants' management system are established and functioning as intended, and that a fully satisfactory level of health, environment and safety exists. This follow-up shall contribute to identifying technical, operational or organisational weaknesses, failures and deficiencies. Methods, frequency and extent of the follow-up, and the degree of independence in conducting it, shall be adapted to the significance of the element to health, environment and safety."

6.7 Deficient testing and maintenance programme

Non-conformity:
Deficient testing and maintenance programmes have been identified for the FF1000S lifeboat and the FFH13 release mechanism.

Reasons:
1. A number of faults have occurred which have resulted in a failure to release or reset the lifeboats in the prescribed manner. This has meant the loss of the evacuation function. The established testing and

maintenance programmes for the freefall lifeboats have not been adequate for identifying critical faults. The preventive testing and maintenance programme for equipment must be configured to ensure that faults are identified before they become critical.

2. It has emerged from an interview with a USH representative that the normal release pressure for this type of lifeboat (FF1000S with FFH13) has been in the order of 120 bar. Section 6.1 of the 2006 in-depth study, ref /1/, states that the normal release pressure is 160 bar with an empty craft. It is further stated that the available pressure deliverable by the release mechanism is in the order of 200-220 bar, depending on the emergency valve on the pump.

Based on the information secured through its work, the investigation team takes the view that the release mechanism on the lifeboats delivered to KRI and VFB fails to comply with the requirement in the LSA code to be able to release the craft with 200 per cent of maximum load. A direct relationship exists between the weight of the lifeboat and the pressure required to release the hook. The test pressure for releasing an empty lifeboat must therefore be lower than the available pressure in order to compensate for the increase in weight when fully laden.

Nor has the investigation team been made aware of or provided with documentation which confirms that the required pressure for releasing the craft has been measured or assessed in relation to the requirements in the LSA code.

3. The test programme implemented before installing the FF1000S freefall lifeboat and FFH13 release mechanism on the installations has been insufficient to identify the relevant faults. This applies from the original prototype tests to the present day. The problems identified during testing at the manufacturer in 2008 concerning the geometric sensitivity of the lifeboat-link relationship were only partly revealed by the tests. Observations from the tests were not taken into account in the installation procedure or in the maintenance programme on the installation.

Because faults related to weight changes and altered geometry were first identified after the lifeboats had been installed, the investigation team takes the view that the established programme for lifeboat testing before and after positioning on the installation has been inappropriate. This is based on the fact that potential faults related to weight changes and alterations in geometry were known from testing the lifeboats at supplier USH in August 2008. However, these fault mechanisms were not adequately analysed, nor were adjustments made to the test programmes following the identification of these potential faults.

4. During the interview with the certification body, it was pointed out that a lifeboat is not fully certified and approved for use before a drop test has been carried out from the position in which the craft is to be used. This is specified under point 4 in the certificate: *Onboard testing in accordance with IMO resolution MSC 80 (70) part 2, paragraphs 5.3, remains to be completed*. The certification body also made it clear in the interview that the certificate become invalid if the lifeboat is moved to a different position or installation. In the event of a move, a new test must be conducted on board. Two of the lifeboats on VFB are converted KRI craft. Point 4 has been deleted by hand on the certificates for a number of the lifeboats for KRI and VFB (ref /39/ and /40/).

Sources:
Interview
/66/SH: HSE guideline, GL0114, safety critical failures, final version 1, valid from 19 June 2007
/1/ SH in-depth study 2006
/118/ IMO: Lifesaving appliances, 2003 edition
/39/ og /40/ Lifeboat certificates

Requirements:
Af section 42 on maintenance: "The party responsible shall ensure that facilities or parts thereof are maintained, so that they are capable of carrying out their intended functions in all phases of their lifetime."

Af section 44 on maintenance programme: "Fault modes which constitute a risk to health, environment or safety, cf. Section 43 on classification, shall be systematically prevented by means of a maintenance programme. The programme shall comprise activities for monitoring of performance and technical condition, which will ensure that fault modes that are developing or have occurred, are identified and corrected. The programme shall also contain activities for monitoring and control of failure mechanisms that may lead to such fault modes."

Af section 46 on maintenance effectiveness: "The effectiveness of the maintenance shall be evaluated systematically on the basis of recorded data for performance and technical condition in respect of facilities or parts thereof. The evaluation shall be used for a continual improvement of the maintenance programme."

If section 8 on qualification and use of new technology and new methods: "Where the petroleum activities involve use of new technology or new methods, criteria shall be prepared with regard to development, testing and use in order to fulfil the requirements to health, environment and safety. The criteria shall be representative of the relevant operational conditions, and the technology or the methods shall be adapted to already accepted solutions. Qualification or testing shall demonstrate that applicable requirements can be fulfilled by use of the relevant new technology or new methods."

7 Discussion of uncertainties

Conflicting information has been received from Lloyd's Register, USH and SH concerning requirements for testing lifeboats when they are installed on the installation. According to Lloyd's Register, conducting this test is a condition of the certificate. USH and SH do not take the same view, and do not conduct an installation test for all the new lifeboats. See also section 6.7 for more detailed discussion of this requirement.

8 Appendices

Appendix A: Observations of problems with the hook system

	VFB	KRI	USH
Recognition of the need for a total redesign of the release mechanism	18 Oct 2006 DS Dec 2006 16 Jan 2007	21 Aug 2008	3 Sep 2002 Dec 2006 16 Jan 2007 20 Dec 2007
Resetting	17 Aug 2006 18 Oct 2006 DS Jan 2007 Mar 2007 Aug 2007 18 Sep 2007 Jul 2008	6 Apr 2008	14 Aug 2002 7 Apr 2008
Fabrication	17 Aug 2006 18 Oct 2006 DS		3 Sep 2002 28 Apr 2004 10 Mar 2008 24 Apr 2008
Safety bolt	13 Aug 2006 Oct 2006		21 Aug 2003 20 May 2007 Dec 2006
User instructions, manual	18 Oct 2006 DS		28 Jul 2005
Piston rod or hydraulic cylinder – rust or leaks, for example	Aug 2007 Jan 2008 10 Mar 2008	Jan 2008 5 Mar 2008 6 Apr 2008 (12 Dec 2008)	24 Oct 2005 Dec 2006 9 Mar 2007 1 Jun 2007 Jan 2008 14 Mar 2008 24 Sep 2008
Rust on spring	18 Oct 2006 DS Mar 2007 30 Dec 2008		Dec 2006
Increased friction/corrosion	Oct 2006 18 Oct 2006 Mar 2007		Dec 2006
Geometric sensitivity	18 Oct 2006 DS Aug 2008 5 Jan 2009	Aug 2008 12 Dec 2008 17 Dec 2008	Aug 2008
Three-way valve		24 Jan 2007 12 Dec 2008	
Weight increase, requires larger opening moment	Aug 2008 31 Dec 2008 7 Jan 2009	Aug 2008 12 Dec 2008 17 Dec 2008	Aug 2008

DS = In-depth study dated 18 Oct 2006.

Appendix B: Documents received and references

The documents received (as is usual with an investigation) have only been assessed in relation to aspects considered relevant for this investigation, in the sense that only relevant parts of the documents have been assessed (in relation to specific details, for instance, or to confirm details which have emerged from interviews). The following documents have been received by this investigation (documents in Norwegian have not had their titles translated):

/1/ Statoil: Dybdestudie: Sikringsbolt/utløpsarrangement på sliskelivbåter Veslefrikk B, document no C025-S-FA76-S-RS, published 18 Oct 2006
/2/ SH - Presentation – Utløserkroker på nye livbåter på VFB, draft
/3/ SH – Letter – Informasjon om utløserkrok livbåt, dated 7 Jan 2009
/4/ OLF - Recommended guidelines for design of free fall lifeboats, OLF guidelines no 124
/5/ SH – Presentation – Kristin – Erstatning av eksisterende livbåter, underlag for beslutningsnotat til partnere, dated 26 Mar 2008
/6/ SH – Presentation – Oppgradering av FF1000S VFB – oppdatert koststatus, 28 May 2008
/7/ SH – Tegning – FMECA worksheet – livbåtkrok Schat Harding, utløsningsmekanisme
/8/ SH – Organisation chart, lifeboat project
/9/ USH – Organisation chart, dated 1 Dec 2008
/10/ SH – Presentation – Utløserkroker – DNV tester – Draft
/11/ USH – Presentation – krok med link
/12/ USH – Letter – Supply of new life boat type FF1000 S for the Kristin platform, dated 19 Feb 2008
/13/ USH – Letter – Supply for new life boat type FF1000 S for test/exchange VFB, dated 14 Mar 2008
/14/ USH – Letter – Supply of new life boat type FF1000 DR for the Troll C platform dated 14 Mar 2008
/15/ USH – Letter – Supply of new life boat type FF1000 DR for the Visund platform dated 14 Mar 2008
/16/ USH – Letter – Initialisation cost of improved delivery time to supply of 10 new lifeboats FF1000S/DR, dated 27 Mar 2008
/17/ USH – Letter – Modification VFB, lifteboat 1 and 2, dated 21 Apr 2008
/18/ SH – Order 4501508658, 3 nye livbåter FF10000S, dated 4 Apr 2008
/19/ SH – Order 4501508959, 1 ny livbåt type FF1000S ULS-versjon, dated 4 Apr 2008
/20/ SH – Order 4501618049, oppgradering livbåt Åsg B, dated 7 Oct 2008
/21/ SH – Synergirapport 404137
/22/ Statoil – D&V 7 Anleggsforbedring, Arbeidsprosesskrav, WR0157, final version 3.1, valid from 8 Aug 2006
/23/ SH – FV program, utført fra 2001 til dags dato, 1120-76-SA60A
/24/ SH – FV program, gjeldende pr dags dato, 1120-76-SA05
/25/ SH – FV program, utført fr 2001 til dags dato, 1120-76-SA60B
/26/ USH – Non-conformities and claims related to FFH13
/27/ SH – Presentation– DNV test livbåtkroker
/28/ - Presentation, SH - FF1000S livbåt feil på utløserkrok, 20 Jan 2009
/29/ SH – Dokumentgrunnlag for godkjenning av sliskebåter for operativ bruk, 15 Jan 2009
/30/ USH – Procedure PR.004 Korrigerende tiltak, 24 Jun 2004
/31/ SH – SAP utskrift av vedlikeholdssystemet vedr fjærpakker Veslefrikk
/32/ SH – Kompetanse Scandpower-personell som lager testrapporter
/33/ SH - Synergirapport for hendelse 16 Jan 2008 Kristin livbåt
/34/ SH - Synergirapport for hendelse 6 Apr 2008 Kristin livbåt
/35/ SH - Synergirapport for hendelse 12 Dec 2008 Kristin livbåt
/36/ Lloyd's Register – EC type examination (module B) certificate (hook certificate), 24 Jun 2008
/37/ Lloyd's Register – Certificate of "SOLAS" production testing for one totally enclosed free-fall lifeboat type FF1000S (FFLB certificate), 17 Nov 2005

/38/ SH – Utløserkrok type FFH13 Hook VFB – Historikk fra 2006-2008, 13 Jan 2007 (erroneously dated by SH)
/39/ USH – Test certificates for Veslefrikk B
/40/ USH – Test certificates for Kristin
/41/ Aker Reinertsen – Sikkerhetsgjennomgang 5 Aug 2008, utskifting av livbåter Kristin, Leiv Eriksson Centre.
/42/ SH – Governing document – Marginalfelt organisasjon, ledelse og kontroll, 1 Jul 2008
/43/ Statoil corporate audit – T&P ANT MBM 01-05; Livbåter Umoe Schat Harding AS – Revisjonsrapport 2 May 2006
/44/ SH – Verifikasjonsrapport UPN HMS verifikajoner – UPN HMS 06-08 Operasjonalisering av livbåtkrav – 18 Apr 2008
/45/ SH – HMS rekvalifisering 26 Sep 2008
/46/ Statoil corporate audit – T&P ANT MBM 01-05; Livbåter Norsafe AS – audit report 2 May 2006
/47/ Statoil – Rekvalifisering August 2007
/48/ SH – Funksjonsbeskrivelse av maritim leder, produksjonsleder og vedlikeholdsleder
/49/ USH – October 2006 avvik for VFB – servise raport Schat Harding livbåtkroker FF1000S Veslefrikk B – 17 Aug 2006
/50/ USH – Free fall hook FFH 13 static calculations, doc nr 631, 5 Oct 1999
/51/ USH – Prototype documentation, product type FFH13 rev 24, 3 Dec 2008
/52/ USH – Copies of certificates: NMD, EC, LRS
/53/ USH – Prototype dokumentasjon; FFH13
/54/ USH – Kopi av avvik på krok FFH13; Non-conformities and claims related to FFH13
/55/ USH – Datablad nye fjærer: D20471
/56/ SH – Værvarsel for Veslefrikk 2-7 Jan 2009
/57/ SH – Dybdestudie desember 2008 for hendelse 30 Dec 2008
/58/ SH – Historikk ifm. krokutløsersystem på Kristin
/59/ USH – WS-sertifikat på livbåt nr 3 – Kristin
/60/ USH – Utsendte PAN meldinger relatert til FFH13 (krok for FF1000S) doc no 1252 and doc no 1487
/61/ SH - Utskrift fra SAP for arbeidsordrer relater til feil på utløserkroker VFB
/62/ SH – Presentasjon av prosjektorganisasjon med beskrivelse av prosjektleders mandat
/63/ SH – Prosjekt risikomatrise – Risk register, livbåt utbedringer
/64/ SH – HSE management, valid from 1 October 2007
/65/ SH – Gjennomgang av sikkerhetskritiske feil Kristin for 2007, C074-ZAA-J-RF-0006
/66/ SH – HSE Guideline, GL0114, safety critital failures, final version 1, valid from 19 Jun 2007
/67/ Aker Kværner – HMS resyme, rev 03, C074-NB-S-FD-0001
/68/ Aker Kværner – Risikoanalyse av Kristin – Norsk sammendrag, rev 03, C074-NB-S-RA-0001
/69/ USH – Free-fall hook type FFH13 doc no 1252, 12 Feb 2008
/70/ Aker Kværner – Quantitative risk analysis, C074-NA-S-CA-0001, rev 08
/71/ Aker Maritime – Safety strategy, C074-NA-S-SA-0009, rev 08
/72/ SH – Performance standards for safety systems and barriers, TR1055 final version 3 valid from 2007-05-09
/73/ SH – HMS-kompetanse, WR1145 final version 7.1, valid from 24 Aug 2007
/74/ SH – Beredskap på norsk sokkel, Statoil egenoperert innretning, WR1156, final version 4, valid from 8 Jun 2006
/75/ SH – Tillegg til: Beredskap på norsk sokkel – Huldra & Veslefrikk, WR1156, final version 6, valid from 26 Jan 2009
/76/ SH – Tillegg til: Beredskap på norsk sokkel – Kristin, WR1156, final version 7, valid from 16 Jan 2009
/77/ SH – Krav til personlig utstyr for innsatslag og andre beredskapsfunksjoner, WR 1215, final version 2, valid from 20 Jan 2007
/78/ SH – Trening og øvelser for innsatslag i UPN, WR1235, final version 2, valid from 28 Jun 2006

/79/ SH – StatoilHydro principles for emergency preparedness, WR1775, final version 3, valid from 4 Sep 2008
/80/ SH – Beredskapsanalyse for Veslefrikk 2001, Appendiks A, vedlegg 1 – DFU register, F&T MST-01077
/81/ SH – Beredskapsanalyse for Veslefrikk 2001, Appendiks A, vedlegg 2 – Scenariebeskrivelser, F&T MST-01077
/82/ SH – Beredskapsanalyse for Veslefrikk 2001, Appendiks B Ytelseskrav Veslefrikk, F&T MST-01077
/83/ SH - Beredskapsanalyse for Veslefrikk 2001, Appendiks C Beredskapsregister Veslefrikk, F&T MST-01077
/84/ SH – Beredskapsanalyse for Veslefrikk 2001, Appendiks D, Fare for skadet personell
/85/ SH – Beredskapsanalyse for Veslefrikk 2001, Appendiks E Opplukkingskapasitet fra sjø, F&T MST-01077
/86/ SH – Minutes of meeting, StatoilHydro 28 Mar 2008
/87/ SH – HSE management FR10, final version 2, valid from 1 Oct 2007
/88/ SH – HMS-kompetanse, WR1145, final version 7.1, valid from 24 Aug 2007
/89/ SH – Beredskap på norsk sokkel, Statoil egenoperert innretning, WR1156, final version 4, valid from 28 June 2006
/90/ SH – Tillegg til: Beredskap på norsk sokkel – Huldra & Veslefrikk, WR1156, final version 6, valid from 26 Jan 2009
/91/ SH – Tillegg til: Beredskap på norsk sokkel – Kristin, WR1156, final version 7, valid from 16 Jan 2009
/92/ SH – Trening og øvelser for innsatslag i UPN, WR1235, final version 2, valid from 28 Jun 2006
/93/ SH – StatoilHydro principles for emergency preparedness, WR1775, final version 3, valid from 4 Sep 2008
/94/ USH – Technical specification FF1000S freefall survival craft
/95/ Hydex sylinderteknikk - Sertifisering av ny hydraulikk sylinder
/96/ USH – Arbeidsbeskrivelse, dokument nr 1494, installasjonstest av krok type FFH13 på Kristin
/97/ SH 0903 forespørsel om informasjon vedrørende barrierer etablert for evakueringssystemer på Kristin og Veslefrikk – received by e-mail
/98/ Aker Maritim – Safety strategy
/99/ USH – Product awareness notice, doc no 1252, date 12 Feb 2008 Fee-Fall Hook type FFH13
/100/ SH – Beredskapsanalyse for Veslefrikk 2001 Hovedrapport F&T MST-01077
/101/ Scandpower – Sammendragsrapport Totalrisikoanalyse for Huldra Veslefrikk, Statoil document no C025-S-0000-S-RS-005
/102/ Scandpower – Veslefrikk design accidental load specification
/103/ SH – Veslefrikk evakueringsfilosofi og evakueringsmidler, C025-S-0076-S-SD-001
/104/ SH - 2W FV program rev 040209
/105/ SH - Før-FV oversikt og 6M FV program for livbåter VFB
/106/ SH – Konsern konsept – FF livbåt vedlikehold
/107/ Odfjell Drilling – Arbeidsbeskrivelse for test av livbåt utløserkrok på Veslefrikk B
/108/ Oversikt FV program pr. januar 2009
/109/ USH – Document no 1488, vedlikeholdstest av krok type FFH13 på Veslefrikk B revisjon 24 Jan 2009
/110/ SH – Minutes of meeting 28 Apr 2008, gjennomgang av tekniske forbedringer ifbm. pågående oppgradering av FF1000S sliskelivbåter VFB
/111/ SH - 600115 – VFB sliskelivbåter: Kapasitet på sliskestruktur, innfesting og kranfundament
/112/ SH – Forsterke sliskelivbåter Veslefrikk
/113/ SH - Notifications M2, M3, LB3
/114/ SH - Work orders PM01, PM02, LB3
/115/ SH – WR0155
/116/ SH - FR06 Operation, maintenance and modifications (OMM).
/117/ OLF: Livbåtnettverket, nettverksmøte 01/2009 – 11 Feb 2009

In addition to the documents received and listed above, the following references have been used or referred to in this report.

/118/ IMO Lifesaving Appliances, Edition 2003, International Lifesaving Appliance Code, Resolution MSC.48(66) and Testing and Evaluation of Lifesaving Appliances Resolution MSC.81(70)

/119/ NMD: Regulation of 11 April 2003 no 492 on lifesaving appliances and evacuation of mobile offshore units (Lifesaving regulation)

/120/ NMD: Regulation of 4 July 2007 no 853 concerning evacuation and lifesaving appliances on mobile offshore units (Lifesaving regulation)

/121/ PSA: Orientering om endring i veiledning til innretningsforskriftens bestemmelse om evakueringsmidler, 10 Nov 2006

/122/ PSA: Orientering om endring i veiledning til innretningsforskriften, 11 Jun 2007

Appendix C: Overview of people interviewed

- *Not for publication*

Appendix D: Glossary

Hook counterweight: Rotatable hook for suspending a lifeboat from the link

HSE regulations: Requirements specified in the framework HSE, management, activity, facilities and information duty regulations

Hydraulic system: System for activating the release mechanism when launching a lifeboat

Link: Connection between the installation structure and the lifeboat's release hook

Release hook: The function of the release hook is to detach the lifeboat from the platform when the hook is hydraulically activated. It is installed on the lifeboat and comprises the hook counterweight, the spring and the release rod

Release mechanism: System for launch and suspension of freefall skid lifeboats. Comprises the release hook, link and hydraulic system

Release rod: Connection between the hook counterweight and the hydraulic system for activating and releasing the hook counterweight

Safety bolt: Bolt installed on the release hook for use in:

- resetting the release hook.
- preventing the release of the lifeboat after a function test. SH uses it as a permanent safety barrier to prevent unintentional launch of the lifeboat in the event of operational error

Spring: Mechanism for returning the release rod so that the hook counterweight is locked in a safe position

Appendix E: Analysis of missed opportunities to make improvements

The investigation team has recorded a number of "opportunities" to expose faults and deficiencies with the FFH13 in the 2004-09 period had adequate assessments been made of whether the FF1000S-type lifeboats complied with applicable HSE regulations:

- When establishing specifications for and ordering lifeboats installed on VFB in 2004
  - Checks in relation to applicable regulatory requirements for the petroleum activity, requirements in Solas and the LSA code and in-house requirements for safety-critical equipment (redundancy, individual faults, barriers, performance, functionality)
- When establishing specifications for and ordering lifeboats installed on KRI in 2005
  - Checks in relation to applicable regulatory requirements for the petroleum activity, requirements in Solas and the LSA code and in-house requirements for safety-critical equipment (redundancy, individual faults, barriers, performance, functionality)
- For each individual fault exposed or work order issued (VFB and KRI) in connection with periodic testing of the release mechanism over the period until new lifeboats were installed in 2008/2009, confer section 6.6 and appendix A. This applies particularly to the incident on VFB in 2006 and recommendations made by the in-depth study after that incident.
  - Checks in relation to applicable regulatory requirements for the petroleum activity, requirements in Solas and the LSA code and in-house requirements for safety-critical equipment (redundancy, individual faults, barriers, performance, functionality)
- When following up and reviewing safety-critical faults described in SH HSE Guideline, GL0144, ref /66/.
- When establishing the OLF-LBP
  - By expanding the scope of work for the project to cover the whole evacuation system represented by freefall lifeboats.
- When establishing the SH-LBP
  - By expanding the scope of work for the project to cover the whole evacuation system represented by freefall lifeboats.
- When establishing specifications for and ordering new/modified lifeboats for VFB in 2008
  - Checks in relation to applicable regulatory requirements for the petroleum activity, requirements in Solas and the LSA code /118/ and in-house requirements for safety-critical equipment (redundancy, individual faults, barriers, performance, functionality)
  - In-house review of observed faults and deficiencies in SH, and acquisition of the experience gained by USH with the FFH13.
- When establishing the VFB-LBP
  - By expanding the scope of work for the project to include verification and checking in relation to applicable regulatory requirements.
- When establishing specifications for and ordering lifeboats installed on KRI in 2008
  - Checks in relation to applicable regulatory requirements for the petroleum activity, requirements in Solas and the LSA code /118/ and in-house requirements for safety-critical equipment (redundancy, individual faults, barriers, performance, functionality)
  - In-house review of observed faults and deficiencies in SH, and acquisition of the experience gained by USH with the FFH13.
- When establishing the KRI-LBP
  - By expanding the scope of work for the project to include verification and checking in relation to applicable regulatory requirements.

In addition to the opportunities available to SH, the investigation team takes the view that USH has had the same opportunities – either alone or together with SH. See also appendix D.

The importance of installing new and modified lifeboats as quickly as possible could not have been a weighty reason for failing to discover the faults and deficiencies in the FFH13 release mechanism.

The purpose of the above list is primarily to demonstrate that,

> in the investigation team's view, many opportunities have existed to expose the faults before the incidents in December 2008 and January 2009.