NOU Official Norwegian Reports 2008: 8

The Loss of the "Bourbon Dolphin" on 12 April 2007

Norges offentlige utredninger
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The Loss of the "Bourbon Dolphin" on 12 April 2007

Report from a Commission appointed by Royal Decree of 27 April 2007.
Submitted to the Royal Norwegian Ministry of Justice and the Police on 28 March 2008.

Translation from Norwegian. For information only.

Government Administration Services
Information Management

Oslo 2008

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Abbreviations

Abbreviations of the Regulations

Building Regulations, the	Regulations No. 695 of 15 September 1992
Certification Act, the	Act No. 42 of 5 June 1981 on Posts requiring Certification on Norwegian Ships
COLREG	The Convention on International Regulations for Preventing Collisions at Sea, 1972
ISM Code, the	The International Management Code for the Safe Operation of Ships and Pollution Prevention, adopted by the IMO in 1993
ISM Regulations (for cargo ships), the	Regulations No, 822 of 6 August 1996
ISPS Code, the	International Code for the Security of Ships and of Port Facilities, 2002
Load Lines Convention, the	The Load Lines Convention, 1966
LSA Code, the	Life-Saving Appliance Code 1996
Manning Regulations, the	Regulations No. 175 of 17 March 1987
Maritime Safety Act, the	Act No. 9 of 16 February 2007 on Maritime Safety
MARPOL 73/78	The International Convention for the Prevention of Pollution from Ships, 1973/78
Navigation Regulations, the	Regulations No. 701 of 15 September 1992
NWEA guidelines	Guidelines for the safe management of offshore supply and anchor handling operations NWEA (North West European Area)
POSMOOR	DNV-OS-301 Position Mooring. October 2004
Qualification Regulations, the	Regulations No. 687 of 9 May 2003
Radio Regulations, the	Regulations No. 1855 of 17 December 2004
Rescue Regulations, the	Regulations No. 1856 of 17 December 2004
Seaworthiness Act, the	Act No. 7 of 9 June 1903 on State Control of the Seaworthiness of Ships etc.
SOLAS Convention, the	Convention on Safety of Life At Sea, adopted by the IMO in 1974
STCW Convention, the	The International Convention on Standards of Training, Certification and Watch-keeping for Seafarers, adopted by the IMO in 1978
Work and Rest Time Act, the	Act No. 50 of 3 June 1977 on Working Hours and Rest Time on Ships
Working Environment Regulations, the	Regulations No. 8 of 1 January 2005

Other abbreviations

ACOP	Approved Code of Practice
AHTS	Anchor Handling, Tug and Supply
AHT	Anchor Handling and Tug
AHV	Anchor Handling Vessel
BP	Bollard Pull
DNV	Det norske Veritas (Norwegian classification society)
DP	Dynamic Positioning
DTI	Department of Trade and Industry (now DBERR)
GM	The distance from the vessel's centre of gravity to the metacentre
GZ curve	Curve for correcting arm as function of heeling moment
HAZID	Hazardous Identification
HAZOP	Hazardous Operability
H&SE	Health and Safety Executive
IMO	International Maritime Organization
KG limit curve	Maximum distance between keel (baseline) and centre of gravity to meet stability requirements
LR	Lloyd's Register
NIS	Norwegian International Ship Register
NOR	Norwegian Ordinary Ship Register
NWEA	North West European Area
MOB-boat	Man Overboard Boat
MODU	Mobile Offshore Drilling Unit
OIM	Offshore Installation Manager
OLF	Norwegian Oil Industry Association
PCP	Permanent Chaser Pennant
PSV	Platform Supply Vessel
QA	Quality Assurance
QC	Quality Control
RMP	Rig Move Procedure
ROV	Remote Operated Vehicle
SMS	Safety Management System
SOSREP	Secretary of State Representative for Marine Salvage and Intervention
SWL	Safe Working Load
TCG	Transverse Centre of Gravity (transverse distance from centreline to centre of gravity)
UKOOA	United Kingdom Offshore Operators Association
UTC	Universal Time Centre (GMT)
VCG	Vertical Centre of Gravity (vertical distance from centreline to centre of gravity)

To the Ministry of Justice and the Police

The Commission of Inquiry into the loss of the "Bourbon Dolphin" on 12 April 2007 was appointed at a meeting of the King-in-Council on 27 April 2007, on the authority of Section 485 of the Maritime Act.

The Commission of Inquiry hereby submits its report. The report is unanimous on all points.

Key supporting documents are published as two separate annexes.

Oslo, 28 March 2008

Inger Lyng
Chair

Dag Andreassen

Gisle Arnold Hansen Fiksdal

Guro Høyaas Løken

Yngve Skovly

Terje Hernes Pettersen

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Chapter 1
Summary

In this Summary the Commission provides a brief account of the accident itself and a summary reproduction of key conclusions of the report. For the record, the Commission would note that certain nuances will be missing in such a summary.

1.1 The Accident

The "Bourbon Dolphin" was delivered to the company, Bourbon Offshore Norway, at the beginning of October 2006 by the shipyard Ulstein Group in Ulsteinvik, Møre og Romsdal county. The vessel was designated DP2 Anchor Handling Tug Supply Vessel, built and equipped to perform anchor handling, towing and supply operations in deep water. She had a gross tonnage of 2,974 tonnes, was 75.2 metres long and 17 metres wide. The vessel had a continuous bollard pull of 180 tonnes and a tension on the main winch of 400 tonnes. The vessel was put into operation immediately; up to the accident, she had completed 16 assignments.

From the end of March 2007 the "Bourbon Dolphin" was on contract to the oil company Chevron. The contract concerned anchor-handling in connection with the move of the drilling rig "Transocean Rather" on the Rosebank oilfield, west of Shetland.

The ocean depth in the area concerned is 1,100 metres. The rig is moored with eight anchors. The distance between the rig and the mooring positions was around 3,000 metres. The mooring lines were about 3,500 metres, of which about 900 metres was of 84 mm chain and about 920 metres of 76 mm chain, plus 1,725 metres of 96 mm wire. Deployment of anchors was done by means of the vessel running out the rig's chain, connecting it to chain that the vessel had on board, whereupon the rig ran out wire. The anchor that was fastened to the vessel's chain was thereafter lowered down to the seabed with the aid of the vessel's winch and wire. During the last part of the deployment, another vessel participated by grabbing hold of (grappling) the chain so as to distribute the weight of the mooring and relieve the strain on the rig.

Around 09:00 on Friday 12 April 2007 the "Bourbon Dolphin" began to run out chain for the last anchor (no. 2). Around 14:45 all the chain was out. The "Bourbon Dolphin" then drifted considerably off the mooring line and asked the rig for assistance. The "Highland Valour" was sent to assist the "Bourbon Dolphin", but did not succeed in securing the chain. The "Bourbon Dolphin" drifted eastwards towards the mooring of anchor no. 3. The rig instructed the vessels to proceed westwards, away from anchor no. 3. During an attempt to manoeuvre the vessel towards the west, at the same time as the chain's point of attack over the stern roller shifted from the inner starboard towing-pin to the outer port towing-pin, the vessel developed a serious list to port. The engines on the starboard side stopped. The vessel at first righted herself, but soon listed again and at 17:08 rolled over on her port side.

The capsizing happened suddenly and without much warning. Of those on the bridge, only one of the first officers managed to get out. The crew members who had been in the deck area managed to get hold of life-jackets, climb onto the vessel's side and jump into the sea before she rolled right over. Two persons who had been in the mess got themselves out onto deck and into the sea.

Full alarm was immediately sounded on the rig and the vessels in the area were at once set to searching for survivors. Helicopters from the British coastguard were alerted and arrived on the spot after about an hour. Other vessels in the vicinity also proceeded to the casualty.

The "Bourbon Dolphin" had a crew of 14 persons. Also on board was the master's 14-year-old son. Seven persons were saved. The bodies of three persons were found in the sea, the remaining five persons are still missing.

The casualty remained some days afloat, bottom-up, until she sank on Sunday 15 April. The "Bourbon Dolphin" has subsequently been locat-

ed on the seabed, where she is lying in an almost upright position.

1.2 The structure of the report

Most chapters contain partial and main conclusions related to the matters under discussion. The summary ought therefore to be read in conjunction with the main presentation.

Chapter 2 describes the establishment and appointment of the Commission, its qualifications and terms of reference, the work of the Commission of Inquiry, including the implementation of open hearings and the collection of evidence, the use of expert witnesses, the addressing of the adversarial principle and requirements as to public access to documents.

Chapter 3 presents regulatory requirements for anchor-handling vessels and anchor-handling operations. By way of introduction, the international regulations and Norwegian legislation on maritime safety are explained. Thereafter follows a review of the requirements for the vessels' design and equipment, safety management system, manning and qualifications. Next are reviewed the requirements for control, inspection and certification. An explanation is given of the British regulatory system for anchor-handling operations and of the guidelines for this that the industry organisations have adopted for the North-West European Area. Finally, operational standards for the performance of marine operations and regulatory requirements related to the mooring system for the rig are reviewed.

Chapter 4 provides a description of the company, Bourbon Offshore Norway. The chapter also discusses the crews during the operation, the company's safety management system, certification and audits.

Chapter 5 gives a factual description of the vessel "Bourbon Dolphin". Design, construction process and commissioning, the vessel's tank arrangement, engines, anchor-handling equipment and winch system with emergency release function are reviewed relatively thoroughly. The chapter also discusses the vessel's stability book and load calculator. Rescue equipment and navigation equipment are additionally dealt with. In conclusion, the vessel's operating history is described.

Chapter 6 reviews the rig move that the "Bourbon Dolphin" was helping to perform. By way of introduction the Commission will describe the players on the commissioning side – the oil company, the rig company and the consultancy firm, specifications for the rig and an overview of personnel on the rig during the operation. A relatively thorough review of the planning of the rig move is also made – the choice of mooring system and installation method, requirements for the vessels, weather criteria and risk assessments and plans for alternative situations (contingency planning).

Chapter 7 presents key data for the vessels that were selected by the operator for the rig move.

Chapter 8 provides a review of the rig move up to the capsizing, including the crew change on the "Bourbon Dolphin".

Chapter 9 presents the incidents that on 12 April 2007 ended with the capsizing of the "Bourbon Dolphin". First comes an explanation of the running-out of the diagonal anchor (no. 6); then a presentation of the attempt to assist made by another vessel. Then an account of the actual accident is given, including for the external forces that affected the vessel in the decisive phase.

Chapter 10 provides, by way of introduction, an account of the crew's evacuation. This is followed by a chronological presentation of the rescue operation's individual phases and implementation, including available resources and use of various rescue aids. The chapter also deals with the roles played by Norwegian authorities and the company during the rescue operation.

Chapter 11 describes the measures taken in an attempt to salvage the casualty. By way of introduction the Commission provides a list of observation of the casualty's positions. There follows a presentation of occurrences until the signing of the salvage contract, of the bodies involved and the decisions taken along the way.

In Chapter 12 the Commission undertakes summarising analyses and considers the direct and indirect causal relationships and the report's approach to questions of responsibility.

In Chapter 13 the Commission makes its recommendations.

1.3 Key conclusions

A selection of key conclusions of the report is here presented. The order does not say anything about their importance in relation to the accident and the Commission's terms of reference.

Key conclusions are:

- The vessel was built and equipped as an all-round vessel AHSV (Anchor Handling Supply

Vessel). Uniting these functions poses special challenges. In addition to bollard pull, anchor-handling demands thruster capacity, powerful winches, big drums and equipment for handling chain. Supply and cargo operations demand the biggest possible, and also flexible, cargo capacities both on deck and in tanks. The "Bourbon Dolphin" was a relatively small and compact vessel, in which all these requirements were to be united.

- The company had no previous experience with the A 102 design and ought therefore to have undertaken more critical assessments of the vessel's characteristics, equipment and not least operational limitations, both during her construction and during her subsequent operations under various conditions. The company did not pick up on the fact that the vessel had experienced an unexpected stability-critical incident about two months after delivery.
- The vessel's stability-related challenges were not clearly communicated from shipyard to company and onwards to those who were to operate the vessel.
- Under given load conditions the vessel did not have sufficient stability to handle lateral forces. The winch's pulling-power was over-dimensioned in relation to what the vessel could in reality withstand as regards stability.
- The anchor-handling conditions prepared by the shipyard were not realistic. Nor did the Norwegian Maritime Directorate's regulatory system make any requirement that these be approved.
- The ISM Code demands procedures for the key operations that the vessel is to perform, Despite the fact that anchor-handling was the vessel's main function, there was no vessel-specific anchor-handling procedure for the "Bourbon Dolphin".
- The company did not follow the ISM code's requirement that all risk be identified.
- The company did not make sufficient requirements for the crew's qualifications for demanding operations. The crew's lack of experience was not compensated for by the addition of experienced personnel.
- The master was given 1½ hours to familiarise himself with the crew and vessel and the ongoing operation. In its safety management system the company has a requirement that new crews shall be familiarised with (inducted into) the vessel before they can take up their duties on board. In practice the master familiarises himself by overlapping with another master who knows the vessel, before he himself is given the command.
- Neither the company nor the operator ensured that sufficient time was made available for hand-over in the crew change.
- The vessel was marketed with continuous bollard pull of 180 tonnes. During an anchor-handling operation, in practice thrusters are always used for manoeuvring and dynamic positioning. The real bollard pull is then materially reduced. The company did not itself investigate whether the vessel was suited to the operation, but left this to the master.
- The company did not see to the acquisition of information about the content and scope of the assignment the "Bourbon Dolphin" was set to carry out. The company did not itself do any review of the Rig Move Procedure (RMP) with a view to risk exposure for crew and vessel. The company was thus not in a position to offer guidance.
- The Norwegian classification society Det norske Veritas (DNV) and the Norwegian Maritime Directorate were unable to detect the failures in the company's systems through their audits.
- In specifying the vessel, the operator did not take account of the fact that the real bollard pull would be materially reduced through use of thrusters. In practice the "Bourbon Dolphin" was unsuited to dealing with the great forces to which she was exposed.
- The mooring system and the deployment method chosen were demanding to handle and vulnerable in relation to environmental forces.
- Planning of the RMP was incomplete. The procedure lacked fundamental and concrete risk assessments. Weather criteria were not defined and the forces were calculated for better weather conditions than they chose to operate in. Defined safety barriers were lacking. It was left to the discretion of the rig and the vessels whether operations should start or be suspended.
- In advance of the operation no start-up meeting with all involved parties was held. The vessels did not receive sufficient information about what could be expected of them, and the master misunderstood the vessel's role.
- The procedure demanded the use of two vessels that had to operate at close quarters in different phases during the recovery and deployment of anchors. The increased risk exposure

of the vessels was not reflected in the procedure.

- The procedure lacked provisions for alternative measures (contingency planning), for example in uncontrollable drifting from the run-out line. Nor were there guidelines for when and in what way such alternative measures should be implemented and what if any risk these would involve.
- The deployment of anchor no. 2 was commenced without the considerable drifting during the deployment of the diagonal anchor no. 6 had been evaluated.
- Human error on the part of the rig and the vessels during the performance of the operation.
- Communication and coordination between the rig and the vessel was defective during the last phase of the operation.
- Lack of involvement on the part of the rig when the "Bourbon Dolphin" drifted.
- The roll reduction tank was most probably in use at the time of the accident.
- The inner starboard towing pin had been depressed and the chain was lying against the outer starboard towing pin. The chain thereby acquired a changed angle of attack.

Chapter 2
The Commission of Inquiry and its work

2.1 Introduction

On 27 April 2007 the Ministry of Justice decided, on the authority of Section 485 of the Maritime Act, to appoint a special commission of inquiry into the loss of the "Bourbon Dolphin" on 12 April 2007.

The Commission's composition was as follows:

1. Court of Appeals Judge Inger Lyng, Chair
2. Specialist engineer Guro Høyaas Løken
3. General Manager Gisle Fiksdal
4. Marine Coordinator Dag Andreassen
5. Police Prosecutor Yngve Skovly

The secretary to the Commission was Terje Hernes Pettersen, Senior Advisor in the Ministry of Trade and Industry.

2.2 More on the members of the Commission of Inquiry

The Commission considers it appropriate to give the education and professional background of the members.

Inger Lyng

Year of birth 1947
Cand. jur. qualifying examination in law 1976
Senior Executive officer in the Ministry of Justice
Assistant Judge
Junior Police Prosecutor
Legal Advisor
Municipal Attorney of Tromsø
Chairman of the County Appeal Tribunal
Judge in Hålogaland Court of Appeals from 1997

Guro Høyaas Løken

Year of birth 1972
Graduate in Naval Architecture from the Norwegian University of Science and Technology (NTNU), 1996 – Specialisation in hydrodynamics /marine structures.
Aker Marine Contractors AS Naval Architect 1997 – 1998, CSO Aker Engineering Inc./Technip Inc. Houston, Senior Specialist, 1998 – 2002, Aker Marine Contractors Inc. Houston, Principal Naval Architect 2002 – 2005, Aker Marine Contractors AS 2005, Specialist Engineer – Planning and execution of marine operations, platform design, mooring design, movement analyses, model test correlations and rig upgrade studies. Course instructor, Marine Works Manager and Engineering Manager.
Has given a number of lectures/papers focusing on mooring design in deep water.

Gisle Arnold Hansen Fiksdal

Year of birth 1961
Graduated in engineering from the Norwegian Institute of Technology (the precursor of the present Norwegian University of Science and Technology) Trondheim 1984, and in management from the Norwegian School of Management (BI) 1990.
MARINTEK, researcher, 1986-2001, Lodic AS, General Manager, 2001-
Development/maintenance of software for hydrostatics and stability – Shipshape
Preparation of stability books for various types of ship
Development of the load calculator ShipLoad and Lodic, for use on board various kinds of vessel
Stability studies for "The Commission of Inquiry into the loss of Western"
Development of decision-making support systems for ships in a damaged state (EU projects)

Assistance in salvage operation/investigation after the "Rocknes" accident.

Dag Andreassen

Year of birth 1946
Ship's master examination 1981
DNV Incident Investigation Training
ExxonMobil Risk Analysis Training Level II
Marine specialist ExxonMobil 1987–2008: Planning, the implementation of mobile installations, vessel inspections
1973–1987: Practical experience from offshore operations. Ship's master from 1981.

Yngve Skovly

Year of birth 1962
Cand. jur qualifying examination in law 1988
Police attorney, Hardanger
Assistant Judge in Sunnmøre
Assistant Chief of Police/Police Prosecutor Sunnmøre
Advisor, crisis management aid project "*Styrkebrønn*" ("Well of Strength"), Georgia

Terje Hernes Pettersen

Year of birth 1968
Cand. jur. qualifying examination in law 1996
Master of Law 1997
Project Manager, The Norwegian Maritime Directorate
Member, Maritime Safety Act Committee
Advisor/Senior Advisor, The Norwegian Maritime Directorate
Senior Advisor, Ministry of Trade and Industry

2.3 The Commission of Inquiry's competence and terms of reference

The Commission of Inquiry's mission is governed by the Regulations No. 7 of 28 November 1980 pertaining to commissions of inquiry under the Maritime Act.

The mission is defined in the Commission's terms of reference, which are worded as follows:

> "The Commission of Inquiry shall undertake the investigations it finds necessary to clarify the course of events and causal factors, and report on factors of significance for preventing such accidents in future. This includes the coordination between the ship and the rig, operation of the ship and factors related to the ship's design and certification.
>
> The Commission of Inquiry shall also provide an assessment of the attempted salvage operation during which the ship sank. The Commission shall further consider factual circumstances that can be envisaged as justifying criminal liability for individuals or enterprises or other liability in connection with the accident. The deadline for the Commission's report is 1 February 2008."

The report deadline was later extended to 1 April 2008.

The accident happened in the UK Sector of the North Sea and involved, in addition to the Norwegian-registered vessel, a British oil company, a drillrig owned by a company registered in the Cayman Islands, a British consultancy firm and several foreign-registered vessels with their crews.

The Commission has endeavoured to find a reasonable balance between the imperative of considering all the questions that the accident provides occasion to evaluate, and the imperative of making the report as quickly as proper and possible. Regarding the questions the Commission has raised, it has spent the time it thought necessary for a thorough analysis and addressing of the interests of affected parties.

It is part of the Commission's terms of reference that it should consider factual circumstances that can be envisaged as justifying criminal liability for individuals or enterprises or other liability in connection with the accident.

It is widely known that the Norwegian prosecution authorities, under the leadership of the Public Prosecutor of Møre og Romsdal County, have launched an investigation in the case. Investigations are in progress also on the British side, under the aegis of the Health and Safety Executive (Aberdeen). Neither the Norwegian nor the British investigations have been concluded.

The Commission is not a court. The Commission understands its terms of reference as meaning that the presentation of the facts of the case is a sufficient presentation of relevant circumstances. Any assessment of the facts in relation to criminal law with a view to criminal sanctions or in relation to rules for administrative measures or reactions in civil law is a matter for the prosecution authority, other authorities, the parties and anyone else affected to decide upon, if necessary through court proceedings.

The Commission has, however, considered it appropriate in some contexts to evaluate and characterise the behaviour of individuals and institutions on the basis of proven facts. The Commission has not thereby taken a position on whether criminal law or other sanction-bearing rules have actually been contravened.

The rescue operation, which was led by British authorities, was not a part of the Commission's terms of reference and has not been the object of further investigation. The Commission has, however, considered it right to provide a summary presentation of the rescue work as well.

2.4 The work of the Commission of Inquiry

The Commission of Inquiry has held regular working meetings every other week since the appointment, all together 20 working meetings with a total of 57 meeting days. The Commission has held five open hearings for receipt of testimony from involved parties, confer the discussion below in Section 2.5.

The Commission has collectively, or via individual members, undertaken several site visits. The "Bourbon Dolphin" was the first vessel to be built to an Ulstein A 102 design. The Commission was therefore unable to make a site visit to a similar vessel. So as to receive a quick general introduction to the methodology of anchor-handling, the Commission visited the anchor-handling vessel "Normand Master" belonging to Solstad Rederi, while she was berthed at Stavanger.

Commission Member Gisle Fiksdal has visited the shipyard, Ulstein Verft. Commission Member Dag Andreassen has, together with Captain Frank Reiersen, undertaken a review and testing of rescue equipment corresponding to that which was on board the "Bourbon Dolphin".

The Commission chose not to visit the company, Bourbon Offshore. The Commission held briefing interviews with representatives of the company immediately after the appointment. The company's representatives were summoned to an open hearing on the same basis as other informants.

The Commission has held meetings with the next of kin and their attorney. The Commission's members held several telephone conversations and handled other approaches from the next of kin.

The Commission has otherwise held meetings with the Norwegian Maritime Directorate, the Petroleum Safety Authority, Det norske Veritas, the insurers, the prosecution authority and representatives of the British Health and Safety Executive so as to receive their input.

The Commission has been given a ROV (minisub) inspection video film to review, taken of the wreck at 1,100 metres depth on 8 December 2007.

The Commission has received a number of inputs from interest organisations, the media and the public.

The Commission's secretariat has been in Oslo. The Secretary to the Commission has been relieved of half of his permanent post in the Ministry of Trade and Industry. It was necessary to reinforce the secretariat with hired consultants. The Chair of the Commission was relieved of all her other duties. The remaining members have worked on an hourly basis.

An English version of the Commission's report also exists. The Commission has not been involved in the translation, and does not guarantee this version.

2.5 Collection of the evidence

The maritime inquiry following the accident was held in Sunnmøre District Court on 25 April 2007. The Commission has held five open hearings as a supplement to this maritime inquiry. In June 2007 the Commission heard testimony from the crews of the "Bourbon Dolphin", the company's representatives and the masters of the "Olympic Hercules" and the "Vidar Viking". The Commission also held conversions with the next of kin in a closed forum. In August 2007 the Commission questioned the sole surviving officer of the "Bourbon Dolphin", the vessel's two regular masters and the first engineering officer from the shift that was not on board during the accident. At the end of August the Commission questioned Det norske Veritas' local representative in Aberdeen and four officers from the "Highland Valour". In September 2007 the Commission heard testimony from representatives of Chevron, the "Transocean Rather" and Trident, in all 11 persons, who had been responsible for the planning and the implementation of the rig move operation and the subsequent rescue and salvage operation. In October 2007 the Commission questioned three persons from Ulstein Verft and three persons from the Norwegian Maritime Directorate.

All together the Commission heard testimony from 38 persons. Everyone called in for question-

ing appeared of their own free will in Norway. Audio recordings were made of all testimony and these were made available to the parties. The testimony was continuously interpreted/translated to or from English. For the Anglophone witnesses, it is the English version that is valid. The Commission's minutes of the testimony have been reviewed and approved by the witnesses, after which they were distributed and made available to the public. In addition, the minutes were incorporated into a special Annex 2 (questioning) to the report.

The Commission has had access to the police's case documents, including testimony taken by the police and by the Health and Safety Executive in the United Kingdom.

Immediately after its appointment, the Commission received all documents and illustration material that the maritime inspector in Trondheim had collected. The Commission had asked for, and continuously had submitted, a number of documents from those involved. This concerns documentation related to the construction and certification of the vessel, and governing documents from the company. Key documents related to the rig move, raw data for the trackplot, ROV film of the vessel after she sank and video clips taken on mobile phones from the rig as the accident was in progress, have also been received.

The Commission has also received written accounts and reports from Smit, who had the salvage contract.

Key documents are included in a special Annex 1 (key documentation) to the Commission's report.

The Commission has subscribed to a media monitoring service for all Norwegian media channels.

2.6 Methodology and the use of expert witnesses

The Commission has undertaken its own MTO (Man/Technology/Organisation) analysis with a review of the course of events, from the planning of the vessel's construction to her loss, in order to uncover safety barriers and breaches thereof. The planning and the implementation of the rig move was reviewed in a corresponding manner.

Given its composition, the Commission possesses within its own ranks professional expertise that was considered largely sufficient to analyse the case. For this reason it was also the Commission's working method that the individual Commission Member, either alone or in groups, had a special responsibility for analysing and describing a part of the case complex.

In certain fields, however, the Commission found it expedient to make use of special expert witnesses.

Research Fellow Hanne Sofie Logstein has authored a legal opinion in which she undertook a review of the British regulatory system in relation to the anchor-handling operation in which the "Bourbon Dolphin" was lost. Her opinion has been reviewed by Professor and *dr juris* Knut Kaasen of the University of Oslo. Logstein's opinion has been incorporated in its entirety as Part 7 of Special Annex 1 to this report.

The company Ship & Offshore Surveyors AS has undertaken a technical assessment of the propulsive machinery of the "Bourbon Dolphin"; their report is included as Part 8 of Special Annex 1.

The Commission has made use of statements from expert witnesses in meteorology. Meteorological data have been included in Special Annex 1 Part 5.

2.7 The stability meeting and stability calculations

The parties have hired their own experts to report on, calculate and evaluate the vessel's stability at the time of the accident. In accordance with the Commission's own desire and at the request of the parties, on 7 December 2007 Commission members Fiksdal, Andreassen and Løken held a meeting with the stability experts to review relevant data and establish agreed premises for undertaking stability calculations. Minutes from the meeting have been incorporated into the Special Annex 1, Section 1.10.

Commission Member Gisle Fiksdal has performed stability calculations for estimated load conditions in the period just before the accident. These have been incorporated into Special Annex 1, Section 1.12.

The stability calculations that Commission Member Gisle Fiksdal undertook and that underlie the evaluation in Section 9.10 have been verified by Professor Bjørn Sillerud of the NTNU.

2.8 Quality assurance and the right to be heard

After the end of the evidence collection, the affected parties were given the opportunity to make final comments on the evidence and several of them took that opportunity.

The Commission submitted a draft of the factual presentations to those who were directly affected by the presentation. British authorities have received relevant chapters for review. These were given the opportunity to comment. The objections received have been considered, but not necessarily followed.

Chapter 3
Regulatory requirements for anchor-handling vessels and anchor-handling operations

3.1 Introduction

Safety at sea is governed by a very extensive regulatory system. This chapter provides a paramount description of the rules that apply to anchor-handling vessels and anchor-handling operations. More detailed assessments of whether the regulatory requirements were met will follow in the subsequent chapters, whereas Chapter 13 contains recommendations for changes in the regulatory system.

By way of introduction to the chapter, an overview is provided of the international regulatory system and Norwegian legislation on maritime safety. Sections 3.2 to 3.4 provide descriptions of requirements directed at ships, while Section 3.5 describes the system of ship supervision.

Section 3.6 provides a brief account of the British regulatory system in relation to anchor-handling operations. This text is based on the legal opinion of Research Fellow Hanne Sofie Logstein, see Annex 1 Part 7. Section 3.7 discusses guidelines for the safe management of offshore supply and anchor-handling operations (NWEA); this text is also based on Logstein's opinion. Section 3.8 provides a brief description of operational standards for performance of marine operations. These rules are directed at the operator and rig. In conclusion, Section 3.9 provides a description of the requirements for the mooring system of the rig "Transocean Rather".

3.1.1 The international maritime safety regulations

A number of international conventions lay down requirements for inter alia ship design and equipment, for those working on board ship, for the protection of the environment and for the working and living conditions of seafarers. The Law of the Sea Treaty contains general rules on the rights and duties of the flag state and the coastal state, and lays the primary responsibility for supervision of ships on the flag state. Most of the maritime conventions have been adopted by the UN's International Maritime Organisation (IMO). The organisation was created in 1948 and is committed to enhancing safety at sea, preventing pollution of the marine environment, and anti-terror measures in maritime activity. The IMO has 167 member-states. Below follows a list of important IMO conventions:

- SOLAS – The Safety of Life at Sea Convention, 1974
- MARPOL 73/78 – The International Convention for the Prevention of Pollution from Ships, 1973/78
- STCW – The Convention on Standards of Training, Certification and Watch-keeping for Seafarers, 1978
- The Load Lines Convention, 1966
- COLREG – The Convention on International Regulations for Preventing Collisions at Sea, 1972

The IMO conventions contain so-called "minimum standards". There is thereby nothing to prevent the flag states from promulgating stricter provisions, but it is established practice for the flag states to follow the IMO conventions, inter alia for reasons of competition. The international Convention on Safety of Human Life at Sea, SOLAS, is the most important of all the IMO conventions. The main purpose of SOLAS is to stipulate minimum requirements for design, equipment and operation of ships, thereby enhancing maritime safety. The flag state is responsible for ensuring that ships sailing under its flag satisfy the requirements of the convention, confer Article II. The convention fixes the number of certificates the ships must have as evidence of their having satisfied the requirements. Via the conventions, the IMO has also adopted a number of codes,

which usually contain technical amplifying detail on the conventions. As examples might be mentioned the Intact Stability Code, the LSA Code (rescue equipment), the ISPS Code and the ISM Code, confer Section 3.3.

Many of the requirements of the IMO's regulatory system are generally drafted and apply in principle to all ships. Roughly speaking, a distinction is made between requirements directed at cargo ships, passenger ships and fishing-boats. Anchor-handling vessels fall under the category of cargo ships. Within the regulatory system that applies to cargo ships, certain specific requirements are made for certain categories of cargo ships, such as oil tankers, contingency vessels, towing vessels etc. The stability requirements for supply vessels are also applied to anchor-handling vessels. The great majority of the requirements in the IMO's regulatory system apply only to ships that are undertaking an international voyage, that is to say, a voyage between ports in different states. For traffic that is exclusively national, the legislative jurisdiction is to a large extent left to the flag state. For mobile installations the IMO has only to a small extent issued binding norms, but the organisation has adopted the so-called MODU Code (Mobile Offshore Drilling Unit Code) as an advisory standard.

3.1.2 Norwegian maritime safety legislation

The conventions are currently implemented by authority of the Act No. 9 of 16 February 2007 on maritime safety (the Maritime Safety Act). Most of the statutory regulations are promulgated by the Norwegian Maritime Directorate. The statutory regulation system has to a large extent implemented international standards by means of references (incorporation). At the time of the accident of 12 April 2007 it was the Act No. 7 of 9 June 1903 on State Control of the Seaworthiness of Ships etc. (the Seaworthiness Act) that was in force.

The main duty-holders under the Seaworthiness Act were the ship's masters, confer Section 106 first paragraph. The provision laid down that the responsibility for conforming to provisions made to secure the ship's seaworthiness or to address the safety or welfare of persons on board rests upon the ship's master, unless otherwise consequent on the relevant Act or provision.

Section 106 second paragraph of the Seaworthiness Act prescribed duties for the company or anyone acting on behalf of the company. The provision was incorporated by Amendment No. 70 of 2 August 1991 as a follow-up of the "Scandinavian Star" disaster. It mandated the company to establish routines that ensured that a ship was in sound and regulation condition and that she was inspected in accordance with the rules.

Also Section 106 third paragraph made the company a duty-holder. The provision was added by Amendment No. 67 of 10 June 1977 in order to provide a clearer formulation of the lines of responsibility between company and ship's master regarding safety matters. It lays down that the company must not unlawfully cause or be accessory to causing an unseaworthy ship to put to sea or to the ship being used in contravention of public permits. The *travaux préparatoires* maintained that the provision was not intended to change the current state of the law, under which the ship's master had the prime responsibility on board for the operation of the ship. Nor was it the intention to extend the company's responsibility. The Seaworthiness Act also contained some special provisions that imposed duties on persons other than the ship's master and the company, see for example Section 11 second paragraph, which for ships being built in Norway imposed on the shipyard a duty to notify the supervisory authority.

The Seaworthiness Act was repealed on 1 July 2007 and replaced by the Maritime Safety Act. The new law has toned down the duties of the ship's master and to a much greater extent makes it clear that it is the company that has the paramount responsibility for the safety of the ship, confer Section 6.

3.2 Requirements for the vessel's design and equipment

The key provisions for ship design are to be found in SOLAS Chapter II-1, which makes requirements for the vessel's hull, strength and stability, whereas Chapter II-2 deals with fire safety. The flag states have issued supplementary requirements to SOLAS. Moreover, SOLAS Chapter III, IV and V contain requirements for respectively rescue equipment, radio communication and navigation equipment. Detailed requirements for load line and freeboard are to be found in the Load Lines Convention.

Statutory Regulations No. 695 of 15 September 1992 (the Building Regulations), laid down by the Norwegian Maritime Directorate, are the key implementing regulations for Chapter II-1 of SOLAS and the Load Lines Convention. The Regula-

tions contain some special requirements for anchor-handling vessels, for example for towing and anchor-handling equipment in Section 48, which lays down rules for winch, wire and chain-stoppers, spooling apparatus, towing-pins and crucifix.

The Regulations contain no specific requirements for anchor-handling operations, as regards neither stability requirements nor set-up of load conditions. Stabilitywise, an anchor-handling vessel is regarded as an ordinary supply ship, confer Section 43 first paragraph.

Section 43 second paragraph contains specific requirements for the stability of ships engaged in towing. These requirements address the fact that the vessel can be exposed to a list moment in consequence of the tow operation (which the ordinary requirements for supply ships do not do). Under the Norwegian Maritime Directorate's practice, anchor-handling operations are not evaluated in relation to these requirements in stability approval.

Section 43 third paragraph makes requirements for load conditions that are to be submitted for approval (rule conditions). No requirements are made for load conditions for anchor-handling operations being prepared and considered in relation to stability. It is up to the company and the shipyard/designer to include such conditions in the stability book (example conditions). The guidelines for stability in IMO Resolution A.469 (XII) are not directly implemented in the Norwegian regulatory system for anchor-handling vessels. The resolution recommends, indirectly through Section 2.4.2 as an alternative if Section 2.4.1 is not complied with, that stability ought to be calculated for the "worst anticipated operating conditions". This is reflected in the Building Regulations Section 12 first paragraph, where a worst expected operating condition, confer the resolution, will have be included as one of "all relevant load conditions" in which the vessel is designed and intended to operate.

The load conditions, including the anchor-handling conditions, must be representative of the relevant operations. If the load condition for anchor-handling deviates from what must be included in the stability book, the crew must perform their own stability calculations with the tools available on board for this.

The Norwegian Maritime Directorate does not require the stability book to contain special load conditions for anchor-handling. If these are nevertheless covered by the book, it is checked only that the submitted conditions for anchor-handling meet the stability requirements of Section 43 first paragraph. No evaluation is made of to what extent the conditions are applicable to the operation in question, provided that they not contain obvious errors. The conditions are thus not subject to the Directorate's approval. Pursuant to the Building Regulations Section 8, 13th paragraph, stability information shall be prepared that in a rapid and simple manner enables the ship's master to enjoy precise guidance about the ship's trim and stability under different sailing conditions.

The Building Regulations Section 15 sixth paragraph demand that when vessels are equipped with roll reduction tank(s), account shall be taken of the stability reduction caused by their use. It is also demanded of the company that instructions be prepared for the use of the tank(s), plus load conditions that correspond with the instructions, if the tanks for stability-related reasons cannot be used in all load conditions.

Requirements for rescue equipment for cargo ships follow from Statutory Regulations No. 1856 of 17 December 2004 (the Rescue Regulations). The Regulations implement the SOLAS Chapter III and LSA (Life Saving Appliance) Code in Norwegian law as regards cargo ships. They include provisions on rescue vessels and hydrostatic release mechanisms for rescue floats, confer Sections 8 and 9. Annex 1 to the Regulations contains further detailed requirements for rescue vessels: among other things a rescue float shall float free, and, if it is inflatable, shall inflate automatically if the ship sinks. On the "Bourbon Dolphin" six inflatable rescue floats had been installed.

SOLAS Chapter IV and V is implemented by Statutory Regulations No. 701 of 15 September 1992 on navigational aids (the Navigation Regulations) and Statutory Regulations No. 1855 of 17 December 2004 on radio communication on cargo ships (the Radio Regulations). The Commission has not found it necessary to go further into matters concerning navigation and the radio communication system of the "Bourbon Dolphin", and no more detailed description of this regulatory system is therefore given.

3.3 Requirements for the safety management system

"The International Management Code for the Safe Operation of Ships and Pollution Prevention" (the ISM Code), was approved by the IMO on 4 No-

vember 1993 via Resolution A.741(18). The Code is anchored in SOLAS Chapter IX. The ISM Code makes requirements for a Safety Management System (SMS) on ships and for companies. Introduction of the ISM Code made the company's responsibility for the safety of the ship clearer.

The background to the Code was a desire to develop a better safety culture in the maritime sector. It was desired to enhance safety at sea by focusing on safety for those involved on board and onshore, among other things via routines for quality assurance. Investigations following major shipping accidents in the 1980s and the beginning of the 1990s demonstrated serious administrative failures, both on board ship and in the companies' shoreside organisations. The ISM Code has been characterised as innovative in maritime safety work, since for the first time it aimed at a holistic approach that looked at the ship and her owners and the interaction between human beings, technology and organisation. The preamble to the Code proclaims inter alia that it is based on general principles and objectives, since no two companies are the same and ships operate under different conditions.

The object of the ISM Code is to promote safety at sea, prevent personal injury or loss of human life, avoid damage to the environment, particularly the marine environment, and to property, confer the Code's Rule 1 Section 2.1. The ISM Code's Rule 1 Section 2.2.2 demands that the company, via the safety management system, introduce a protection against all identified risks. The risks to which vessel and personnel can be exposed shall therefore be charted and controlled within the company's organisation. More detailed requirements for risk assessments, including safe job analyses, are contained in Statutory Regulation No. 8 of 1 January 2005 (the Working Environment Regulations). This has, however, a more specific focus on hazards that may arise for the individual employee on board during the performance of work operations.

The core of the ISM Code is Rule 1 Section 4, regarding functional requirements of safety management systems. It is laid down that all companies shall develop, implement and maintain a safety management system that includes the following functional requirements: a policy for safety and environmental protection, instructions and procedures to ensure safe operations and protection of the environment in line with international law and the flag state's legislation, defined authority levels and communication links between and among personnel onshore and on board, procedures for reporting of accidents and non-conformances with the ISM Code, procedures for preparation for and reaction of emergencies, and procedures for internal auditing and management review.

The subsequent provisions of the Code amplify and specify what lies in the individual functional requirements. Of these may be mentioned Rule 2, that the company prepare a "safety and environmental policy" that is to be implemented and maintained on all levels of the organisation, both on board and onshore. Rule 4, on the Designated Person Ashore, may also be mentioned; in order to maintain safe operation of the ship and to ensure contact between the company and those on board, every company shall designate one or more persons onshore, and these shall have direct contact with the top level of management.

Another important section of the ISM Code is Rule 6 Section 5, which demands that the company identify training levels in support of the safety management system. This entails a requirement that the company evaluate what qualifications are necessary for the vessel's personnel in relation to the activity/operations to be executed over and above the minimum requirements in the STCW Convention. Whereas for many functions it will be sufficient to possess qualifications pursuant to the requirements of the STCW Convention, execution of certain maritime operations will demand an extended expertise if the work is to be done in a safe manner.

It follows from the Code that the safety management systems shall be documentable, confer Rule 11, and be verified and reviewed, confer Rule 12. The ships shall also be operated by a company that is certified with a "Document of Compliance", i.e. with a certificate of approval, confer Rule 13 Section 1. The ships shall be equipped with a "Safety Management Certificate", confer Rule 13 Section 7.

The prime responsibility for safety lies with the company, confer Rule 3. Rule 1 Section 1.2 defines the company as the ship's owner or any other organisation or person, for example a shipping company or turnkey charterer who has taken over responsibility for the operation of the ship from the company and who has on takeover of the responsibility consented to take over all duties and all responsibility imposed on him by the Code. For cargo ships the ISM Code is implemented in Statutory Regulations No. 822 of 6 August 1996 on safety management systems for car-

go ships. For offshore vessels over 500 tonnes the Code entered into force on 1 July 2002.

Requirements for safety management systems are described only briefly in the Seaworthiness Act, but in the Maritime Safety Act this has been given a central significance. The amending bill Proposition No. 87 to the Odelsting (2005-2006) on Maritime Safety emphasised the importance of safety management systems, and the Ministry of Trade and Industry stated in that connection:

> "The significance of the fact that the safety and environmental work in the companies is established in a structured, systematic and documentable manner, cannot be over-emphasised. It is crucial that the individual company formulates clear objectives for the safety and environmental work and a policy for how the objectives are to be attained by the company. The Ministry would also emphasise the importance of the company's top management prioritising and ensuring that both the company's safety management system and the individual ships of the company, functioning as designed and being continuously improved. Without a clear prioritisation and follow-up on the part of company management, it will be difficult to achieve the full effect of having a safety management system."

The ISM Code's main intentions are enshrined in the Maritime Safety Act Section 7 first paragraph:

> "The company shall see to the establishment, implementation and further development of a documentable and verifiable safety management system in the company's organisation and on the individual ships, so as to chart and control risks and ensure compliance with requirements laid down in or pursuant to the Act or in the safety management system itself. The safety management system's content, scope and documentation shall be adapted to the needs of the company and the activity it conducts."

3.4 Requirements for manning and qualifications

SOLAS Chapter V Rule 14 demands that a ship have sufficient manning. Amplifying manning requirements are made in IMO Resolution A 890 (21), which is applied by Norway and is employed in the Statutory Regulations of 17 March 1987 (the Manning Regulations). It is the Norwegian Maritime Directorate that determines the manning requirements for the individual vessel via issue of a manning schedule, which is a kind of certificate. It follows from the Regulations that cargo ships with a gross tonnage over 50 shall have stipulated manning. The requirements made by the Directorate are a minimum manning (safety manning) and the company must itself decide whether it is necessary to increase the manning further.

The International Convention on Standards of Training, Certificates and Watch-keeping for Seafarers (the STCW Convention of 1978) makes qualification requirements for personnel on ships. The convention is implemented in Statutory Regulations No. 687 of 9 May 2003 (the Qualification Requirements). At the time of the accident the regulations were authorised by the Act No. 42 of 5 June 1981 on Certification of Personnel on Norwegian Ships (the Certification Act), which was a pure enabling act. Among other things the Convention and the Regulations make qualification requirements for personnel on the bridge and in the engine-room, and various other functions on board. The requirements are by and large general, and to a small degree vessel-specific. For personnel on anchor-handling vessels, no special requirements are made over and above the general minimum requirements.

The Qualification Requirements Section 1-3 second paragraph d) makes requirements for familiarisation on (induction into) a new vessel when the crew reports for duty on a ship, and lays down that the company and the ship's master shall ensure:

> "that seafarers, when they are set to serve on board the ship, are made acquainted with their various duties and with all the ship's arrangements and installations, all equipment and all procedures and special aspects of the ship that are of relevance to their duties, whether routinely or in emergencies; and…"

Among other things, the Act No. 50 of 3 June 1977 on Working Hours and Rest Time on Ships made requirements for 77 hours rest time a week and 11 hours rest time a day for those working on board ship. The Act was repealed when the Maritime Safety Act entered into force, and the most important material requirements have been incorporated into Sections 23 and 24.

3.5 Requirements for control, inspection and certification

Ships are subjected to comprehensive supervision by both the public authorities and their classification societies. The supervision commences even before a ship is built, in the form of approval of drawings and other documentation, and continues through the construction process and thereafter regularly in the ship's operating phase. In the operating phase the ship shall maintain valid certificates showing that she has been inspected by the authorities and the class. The introduction of the ISM Code meant that supervision was no longer directed solely at the ship's technical condition, but also at the safety work of the company. Seafarers' qualifications are moreover subject to public control.

The roles of the public authorities and the classification societies in supervision of ships are complementary, so as to avoid duplication of work. Whereas supervision of for example stability and manning is part of the public supervision, hull and engines are examples of factors that have traditionally been something supervised by the classification societies under the class' own rules. As described in greater detail below, in Norway and abroad it has long been standard practice that the classification societies have been delegated responsibility for parts of the public supervision work. The degree of delegation varies from state to state and in the case of Norway with what kind of ship is concerned, and whether the ship is registered in NIS (the Norwegian International Ship Register) or NOR (the Norwegian Ordinary Ship Register). For example, supervision of safety management system for passenger ships registered in NOR is done by the Norwegian Maritime Directorate, whereas for cargo ships registered in NOR this is delegated to the classification societies. In this role the classification societies act as if it were the authorities themselves who undertook the supervision.

3.5.1 The Norwegian Maritime Directorate as a supervisory body

As mentioned, the Law of the Sea Treaty lays down that supervision of ship safety is first and foremost an obligation upon the state in which the ship is registered (the flag state). In Norway the Norwegian Maritime Directorate is the designated supervisory body. The Norwegian Maritime Directorate is the administrative and executive body for work on safety at sea and has delegated authority from the Ministry of Trade and Industry. In cases concerning pollution and protection of the marine environment, the Directorate has delegated authority from the Ministry of the Environment. The Directorate's paramount objective is to achieve a high level of safety for life, health, vessel and the environment.

The Norwegian Maritime Directorate's supervision of Norwegian ships and mobile installations consists of various elements, such as approval of the design, control of drawings and calculations, inspections during the construction period (construction supervision), periodic inspections of ships in traffic, surprise inspections, and audits of the safety management systems on ships, mobile installations and the companies' operating organisation onshore, plus issue of certificates for these matters. Control of documentation is done mainly by personnel at head office, and inspections mainly by the Norwegian Maritime Directorate's 19 stations, whereas the audits are performed by personnel from both the stations, the vessel departments and the seafarer department. In addition, the stations undertake inspections of foreign ships that call at Norwegian ports in the form of port state control and host state control. Supervision of foreign mobile installations on the Norwegian Shelf for issue of a "Letter of Compliance" is performed in collaboration between the offshore department and inspectors from the stations.

In addition the Norwegian Maritime Directorate performs audits and spot-checks of the approved classification societies, approved control enterprises, approved radio enterprises and others who perform supervisory tasks on behalf of the Directorate.

The Norwegian Maritime Directorate also performs certification of Norwegian maritime personnel and control of the qualifications of foreigners who are to serve in posts in Norwegian ships where certificates are required. Seafarers' medical fitness for service on Norwegian vessels is controlled by approved seafarers' physicians at home and abroad.

3.5.2 Classification societies as supervisory bodies

The Ministry of Trade and Industry has made agreements for delegation of supervisory authority with five classification societies: Det norske Veritas (DNV), Lloyd's Register (LR), Bureau Ver-

itas (BV), Germanischer Lloyd (GL) and American Bureau of Shipping (ABS). As regards control of mobile installations, the Ministry of Trade and Industry has made agreements with DNV and LR for delegation of supervisory authority. The background to the delegation is that the purposes to be served by the classification society and the government maritime authorities are to a large extent identical. The rules enforced by both, respectively the class rules and public acts and regulations, build upon and complement one another.

When the classification societies are the delegated authority, they act on behalf of the flag-state authority. The control is based on the public regulatory system of the flag state and international obligations the flag-state concerned has ratified. On the basis of their own class rules, the classification societies perform their own inspections on board the same ships with the same purpose. Delegation can thus prevent duplication of work. Historically, it has also been natural to work through delegation, as the classification societies began their safety work long before the authorities established supervision in the area.

The degree of delegation varies. For NIS ships, delegation is more comprehensive; it means that the classification society is authorised to perform all inspections on all kinds of ship, including passenger ships, that are classed in the society concerned. This also includes assignments in design approval, inspections and issue of certificates to ships pursuant to Norwegian regulations and international conventions (SOLAS and others) to which Norway is a signatory. Manning schedules are, however, issued by the authorities. For the NOR fleet the delegation is more limited, and concerns first and foremost control of hull, engines and load line. Delegation does not apply to measurement, stability, outfitting (including escape routes), the design of the bridge, rescue equipment, radio communication, navigational aids, pollution prevention, manning and working conditions. Delegation also covers only certain inspections and the issue of only certain certificates.

Finally, the agreements involve the right of Norwegian authorities to control the work of the classification societies through audits, including visits to their offices and inspections of the ships so as to determine to what extent the work has been done in conformity with the delegation agreement. In this connection the Norwegian Maritime Directorate has the right of full access to documentation and other relevant matters. The classification society has an extensive duty to report on its ongoing work.

In consequence of the above-mentioned delegation, the five classification societies perform a substantial portion of the public Norwegian certification and supervision work.

3.5.3 The Norwegian Maritime Directorate's control

3.5.3.1 Introduction

The Norwegian Maritime Directorate performs control and supervision in the following areas:

- Control of vessels
- Control of mobile installations
- Control of seafarers' qualifications
- Control of the environment
- Verification control of safety management systems
- Audits of classification societies and approved enterprises (smaller fishing-boats)

3.5.3.2 More on the division between direct and paramount control

The Norwegian Maritime Directorate's control consists of both direct and paramount control. In recent years the Norwegian Maritime Directorate has had a strategic goal of turning the supervision in the direction of a more paramount control, and this is also enshrined in the Norwegian Maritime Directorate's strategy plan. Direct control means that the Norwegian Maritime Directorate itself approves designs, including controlling drawings, undertaking inspections, issuing and renewing certificates, etc. Paramount control, also called indirect control, covers everything else done by the Norwegian Maritime Directorate. The term paramount control involves holistic assessments of the overall effect of the measures on whether the desired level is achieved, whether the measures are expedient and whether safety conditions have been improved as a whole. Paramount control therefore covers standards work, supervision techniques and methodology, plus attitude and behaviour correction measures. Paramount control presupposes active application of available accident statistics as a corrective to both standard and supervision changes. The Directorate prepares accident statistics annually.

The concept of paramount control also involves control of delegated supervisory authority.

The control is performed as an audit to make sure that those who have received delegated su-

pervisory authority, for example classification societies or approved enterprises, perform their delegated duties in a satisfactory manner. The classification societies may have received delegated assignments to, for example, control drawings of newbuildings and rebuildings, and safety management systems (ISM) on board and in the company. In principle the classification societies can perform the same control as the Norwegian Maritime Directorate, provided that they have received delegated authority for it. In Norway, port state control is not delegated to classification societies.

3.5.3.3 *More on control of vessels and mobile installations*

The control responsibility assigned to the Norwegian Maritime Directorate covers all categories of vessel over a certain size and all mobile installations. The approval and control work is carried out as long as the entity is flying the Norwegian flag. If the work has been delegated to the classification society, the latter will perform all the approval and control work. This is the situation for the NIS fleet. For NOR, on the other hand, most of the work is done by the Norwegian Maritime Directorate itself. The individual phases of the control system are as follows:

Building notification

As soon as a contract for construction or rebuilding of a vessel has been signed, it shall be notified to the Norwegian Maritime Directorate. This was stated in the Seaworthiness Act Section 11.

Approval of the design

Drawings are then submitted for approval of design, control of calculations and approval of arrangement, stability book etc., confer the Building Regulations Section 8.

Construction supervision/initial inspection

Before ships or mobile installation subject to control are put into service, it shall be controlled that the entity was built and equipped in conformity with the approved drawings. This work is done at the constructing shipyard and with subcontractors throughout the construction period. The Directorate shall among other things be present and approve the heel (roll) test.

Certification

When, at the end of the construction period, it has been determined that the vessel or installation satisfies the requirements laid down in legislation, regulations and international conventions applicable to Norwegian entities, the mandatory certificates are issued. The Norwegian Maritime Directorate then stipulates the requirements for the crew's qualifications for all ships subject to control and the minimum manning on passenger ships, cargo ships and mobile installations.

Periodic inspection

The ship is inspected regularly, and on this basis the certificates are renewed. In good time before the expiry of the certificate period (no later than 14 days before), the company is obliged to request inspection for renewal of the certificate.

Intermediate inspection and annual inspections

For most certificates with a long period of validity, intermediate inspections of the ship are mandatory, and usually also annual inspections in order to ascertain whether the mandatory technical standard is being maintained in the certificate period. For most certificates, it is usual for the intermediate inspection to take place in the course of the third year.

ISM audits

Companies that operate cargo ships in international traffic, passenger ships and mobile installations are mandated to have a safety management system under the ISM Code. The authorities confirm, through issuance of certificates, that the safety management system satisfies the main requirements of the ISM Code; and they perform system audits both of company offices and on board the individual vessel/installation, so as to make sure that the systems are actually used and function as intended.

Surprise inspections

In addition to the periodic inspections that follow directly from the regulatory system, surprise inspections on board may be performed. The surprise inspections cover fishing-boats and passenger ships, plus delegated and non-delegated cargo ships in NOR and NIS. In addition the classifica-

tion societies are mandated to perform 10 % surprise supervision of that portion of the NIS fleet that they have been delegated.

Port State Control

Pursuant to the Paris Memorandum of Understanding (MOU) and EU directive 95/21 as subsequently amended, Norway is obliged to control at least 25% of individual foreign ships that call in Norwegian ports. In principle the control consists of ensuring that the ship has valid international certificates, but a more detailed inspection may be performed if there is a suspicion that a ship does not satisfy the international regulatory system.

Other kinds of supervision

The Norwegian Maritime Directorate also performs supervision in connection with the issuance of sailing permits, towing permits, moving certificates, measurement certificates, proof of identity and certificates on insurance against liability for oil spill damage. Vessels are in addition inspected if they have suffered accident or damage. The Norwegian Maritime Directorate also conducts supervision of equipment suppliers' service stations for inflatable rescue equipment (such equipment shall be controlled by approved service stations at regular intervals).

3.5.3.4 *The Norwegian Maritime Directorate's control of classification societies and approved enterprises*

As mentioned in Section 3.5.3.2, the Norwegian Maritime Directorate undertakes control of delegated supervisory authority. This indirect/paramount control aims at reassurance that systems and working forms employed function as designed and lead to the intended results. This indirect control consists mainly of three kinds of controls:

– *System audits*. Audits check that the classification societies have a satisfactory system for addressing the assignments agreed. In addition, spot checks are performed at head offices and field stations in order to check that the classification societies' representatives are following the preconditions stated in the delegation agreement, in the international regulatory system, in the companies' own rules and instructions and in the procedures and instructions issued by the Norwegian Maritime Directorate.
– *Vertical audits*. Here representatives of the Norwegian Maritime Directorate will follow an inspection performed by a classification society in connection with certificate renewal so as to reassure themselves that the classification society has performed its duties as agreed. Representatives of the Norwegian Maritime Directorate can also let the class inspector undertake his control first and make his comments, and then themselves inspect afterwards and make their own comments, which can be compared with what the classification society has found.
– *Surprise supervision*. In addition to the periodic inspections, surprise inspections on board are also undertaken in order to confirm that the vessel's technical standard is in conformity with regulatory requirements. Here the Norwegian Maritime Directorate inspects the ship without the classification society being present. After the inspection an expert panel in the Directorate considers the results and findings of the control, and if necessary undertakes follow-up of the classification society.

3.5.3.5 *Control of seafarers*

The Norwegian Maritime Directorate performs certification of Norwegian maritime personnel after a prior control of documentation in accordance with the STCW Convention.

3.5.3.6 *Control of the environment*

Control that stipulated requirements for design and operation related to prevention of pollution are being complied with are a part of the ordinary vessel control.

3.5.4 The classification societies' own work outside the public regulatory system

As mentioned above, the classification societies began their work before the public sector. Det norske Veritas was established in 1864, and other societies were active even before that time. At sea, therefore, the private sector was the first to do safety work. The driving force behind this development was the marine insurance business. The classification society can in principle perform its services on all ships irrespective of nationality and waters. Valid class certificates are a precondi-

tion for the ship being able to obtain inter alia insurance and flag-state registration.

The classification societies base their work on self-developed rules for ship design and equipment as regards strength, integrity and safe operations. The rules of the classification societies take account, however, of the international conventions and to a large extent make supplementary provisions to these. The Norwegian regulatory system has made the classification societies' regulatory system binding by means of referring to the latter in these areas. This means first and foremost rules for the ships' integrity, hull, engines and other technical installations on the ship. The classification service means that the ship's design is to be approved, that the ship shall be inspected throughout the construction period, that subcontractors' deliveries of equipment, as for example main engines, boilers, electrical systems, pumps, etc. are to be approved before delivery to the shipyard, and after delivery from the shipyard the ship is to be inspected via periodic and other inspections throughout her lifetime. On this basis the class certificate is issued, to certify compliance with regulatory requirements.

In principle classification is voluntary for the company and neither international nor national provisions make direct requirements for classification of ships.

The "Bourbon Dolphin" was classed in DNV and had consequently to satisfy their regulatory system.

3.6 Brief summary of the British regulatory system for anchor-handling operations

3.6.1 Introduction

The applicable regulatory system is extensive and consists, besides acts and regulations, of several other sources of law as well. As in Norway, there is a division between the maritime legislation, the petroleum legislation and the shoreside legislation. In both countries the shoreside regulatory system has been given application to petroleum activity, and in addition a number of rules have been promulgated for the offshore activity in particular.

The methodology of the regulatory system is in many ways similar to what we find in the safety regulation of the petroleum activity in Norway, in which acts and regulations are formulated as functional requirements (in the UK labelled a "goalsetting regime"). This means that the rules present goals and principles in which it is stated what the authorities wish to achieve through the regulatory system. The rules are thereby to a large extent vaguely formulated, which creates difficulties for the work of finding out what needs to be done to meet the regulatory system's requirements on the basis of acts and regulations alone.

Like the Norwegian regulatory system, the British regulatory system also makes requirements for health, environment and safety. The regulatory methodology is broadly speaking a matter of issuing general, formal rules in which the objective is formulated, whereas the players have a certain discretion as regards how the objectives are to be achieved. For some regulatory systems, a *guidance* or *approved code of practice* (ACOP) has been prepared. These codes are not legally binding and it is up to the players whether they will make use of the recommended solutions, in the sense that they may select other solutions as long as the selected solutions meet formal requirements in acts or statutory regulation. It is difficult to determine whether a selected solution will meet the requirements of extremely vague standards, and this must be done through a concrete assessment. As the last link in the chain, work standards or recommendations have been prepared; these may be regarded as constituting "relevant good practice", and are usually more concrete in their content. The standards are not binding, but are relevant as long as they provide an indication of how the vaguely formulated requirements of the binding regulatory system can be met. They may be prepared by the authorities or by various private organisations.

3.6.2 General requirements for safety and health

The key piece of legislation in British safety regulation is the Health and Safety at Work etc. Act of 1974. This corresponds in many ways to the Norwegian Working Environment Act, and consequently shows the signs of having to govern many different work situations, from railway transport to mining. There exists no *approved code of practice* or *guidance* to the Act, but a number of statutory regulations have been promulgated under its authority.

Statutory Regulations concerning the scope of the Act have been promulgated under the title of "The Health and Safety at Work etc. Act 1974 (Application outside Great Britain) Order 2001 No.

2127" (abbreviated as AOGBO), of which Section 4 (1) states that the Act applies to "any activity in connection with an offshore installation …". Towing operations have nevertheless been exempted from the Act via regulations, but the operation with which the "Bourbon Dolphin" was in progress on 12 April cannot be regarded as a towing operation, so that the exception is not applicable. The rig's drilling activity was a part of Chevron's exploration operations and appraisal of a petroleum field. It is therefore most natural to view the operation of moving and mooring the rig as a whole and therefore as part of the petroleum activity, rather than as a maritime operation in which each individual vessel's behaviour is considered in isolation under maritime rules. The conclusion is thereby that the Act is applicable to the operation in question.

By way of introduction, the Health and Safety at Work etc. Act 1974 Part 1 indicates a number of general duties incumbent on the employer or the self-employed in relation to the safety of employees and others.

Section 2 deals with an employer's general duties in connection with his employees' health, safety and welfare. The employer has a duty under the provision, as far as is "reasonably practicable", to safeguard the health, safety and welfare of his employees in working hours. A number of aspects are listed that the general provision particularly covers, including having systems, premises, information and training and so forth designed to safeguard health and safety.

Section 3 deals with the liability of employers and the self-employed vis-à-vis persons other than their own employees. Here it is a requirement that the employer and the self-employed perform their tasks in such a manner that they ensure, as far as is "reasonably practicable", that third parties are not exposed to any risk in relation to health and safety. The term "reasonably practicable" is central to interpreting the requirement for respectively safeguarding the employees' health, safety and welfare (Section 2) and not letting others than employees be exposed to risks in relation to health and safety (Section 3). "Reasonably practicable" is considered to be a narrower concept than what is actually physically possible; the term means that one must undertake a calculation of the magnitude of the risk on the one side and the effort required to prevent the risk – whether in money, time or other input – on the other. If there is a disproportion between these quantities, the burden of proof lies on the responsible party to demonstrate that it was not "reasonably practicable" for measures to be taken. If an employer did not know about, or had no reason to be aware of, a risk, it may be that it was not "reasonably practicable" to take measures against it. The loss of a vessel is an accident of such dimensions that there is no room for considering whether it is "reasonably practicable" to do whatever is necessary to avoid the loss.

The conclusion is therefore that an employer has a wide-ranging responsibility also for others than his own employees not being exposed to risk as regards their health and safety.

That the operation was being performed in a limited area, with a view to moving the rig through a coordinated operation, means that the assignment must be deemed to be performed within the principal's area, both geographically and actually.

This means that the operator, as the ultimate principal and responsible for an anchor-handling operation, has a responsibility for the safety also of the crew on a hired anchor-handling vessel with which he does not have a direct contractual relationship.

The Management of Health and Safety at Work Regulations 1999, which is also applicable to offshore installations and connected activities, contains provisions on risk assessments in general, confer Section 3. An *Approved Code of Practice* has been issued in relation to the Regulations.

The ACOP describes risk in terms of the probability that a potential loss or injury will occur: the scope of the risk will depend on the probability for the loss or injury occurring, the gravity of the loss or injury (or the negative health effect) and the number of people who may be affected. The risk assessment shall inter alia identify how the risk may arise and take effect, so that decisions on how to handle the risk may be taken in a well-informed, rational and structured manner and so that the measures implemented are proportionate. The risk assessment shall cover everybody who might be affected.

There are no hard-and-fast rules for how a risk assessment is to be done, since this will depend on the nature of the work or the activity and the type of danger or risk, but under the ACOP it is a requirement that whatever the risk assessment uncovers shall be written down. When necessary, for example because it is found that the risk is changing, the risk assessment shall be revised.

3.7 Guidelines for the safe management of offshore supply and anchor-handling operations in the NWEA

3.7.1 General

The Guidelines for the safe management of offshore supply and anchor handling operations NWEA (North West European Area) deal with anchor-handling operations and apply to the area in which the rig move took place. They entered into force in February 2006 and replaced the UKOOA in the British Sector.

The guidelines are additional to national requirements made by the Shelf state. NWEA does not replace national requirements, but "adherence …. will provide strong indication to national administrations that the health and safety legislation is being met and due diligence taken", confer NWEA Section 1.5.2.

The scope is not restricted to individual countries' continental shelves or ships, but includes "all those involved in interaction between offshore installations, bases and offshore service vessels related to offshore operations in the NWEA", confer Section 1.4 2.

Masters are "at all times responsible for the safety of their crews, vessel and cargo…" and "must stop operations that threaten the safety of the vessel…", confer Section 2.2.1 and Section 6.1.5 first paragraph. Both in this provision and elsewhere in the guideline it is pointed out that the master's professional judgment with regard to the safety of the vessel and crew must not be affected.

For its part, the company is responsible for the vessel being "correctly manned and equipped for the assignment" and that "an operational plan is prepared for all anticipated onboard operations and services provided by the vessel". Pursuant to Section 2.2.3.3 the company shall "prepare operational conditions for the vessel" and "define requirements for safe operation of the vessel under all conditions, and any vessel limitations" and ensure that a copy of the guidelines are "kept on board" and that "their crew are familiar with the content".

Section 6 contains specific rules for anchor-handling and towing. By way of introduction, there is a warning that anchor-handling operations and towing may be dangerous and that the installation personnel must be aware of the vessel's operational limitations, confer Section 6.1.

Section 6.1.2 makes the operator company responsible for obtaining the necessary anchor-handling vessels, deploying of equipment and personnel, obtaining weather and wave data, organising the rig move meeting and briefing the masters before the vessel leaves port. Under Section 6.1.3 the rig owner is responsible for preparation of rig move procedures, but this task may also be performed by the operator.

Section 6.5.3, Other necessary information for rig move procedures, includes provisions on weather criteria, weather window and time estimate.

Section 9 contains provisions on training, qualifications and manning.

Sections 9.2.4.2 and 3 lay down the following:

> "Masters with no previous A/H experience should perform at least five rig moves together with an A/H experienced master, or a suitable combination of rig moves and simulator training, before they may command an A/H assignment. Ship Owner shall document Master's compliance with this. A/H experience gained in a chief officer role is acceptable.
>
> …
>
> Officers require relevant expertise. They shall be familiar with operational guidelines on safety, and with safe use of equipment and limitations of equipment."

3.7.2 Risk assessments

Chapters 6 and 7 of the NWEA guidelines contain provisions that risk assessments shall be performed for the operation, and Section 6.9 gives a reminder that handling of anchors in deep water carries "significant additional hazards". Section 7.1 maintains that "good risk management is a key component to successful safety management", whereas Section 7.2 states that the objective of risk assessment and safe job analyses is to eliminate or minimise to a controllable level hazards and risks." If risks or hazards cannot be controlled, the work should not be carried out, confer Section 7.1.1.

All parties involved in an operation are obliged to ensure that risk assessments are done correctly and that the personnel has received training in doing so, confer Section 7.2.3.

The players' responsibility for preparation of risk assessments is allocated as follows:

- The operator is responsible for adequate planning and risk assessment for the entire anchor-handling operation, confer Section 6.1.2.2.
- The rig owner is responsible for the rig move procedures being reviewed with participating

vessels and key personnel, that this is understood and the risk assessment is performed, confer Section 6.1.3.4.
- Oil Installation Managers are responsible for ensuring that risk assessments are performed for operations on board their installation and liasing over RAs involving vessels, confer Section 7.2.3. In the event of alteration of or deviation from the rig move procedure, the OIM is responsible for performing new risk assessments.
- Masters are responsible for risk assessments for the operation being performed on board their vessel and for liasing with the installation and the bases, confer Section 7.2.3.

Risk assessments shall be prepared before the operation commences. If an operation is changed in relation to the original plan for which the risk assessment was performed, the participants in the operation must review the hazards and risks of the amended operation.

3.8 Operational standards for performance of marine operations

For performance of marine operations operator companies must observe industrial guidelines for among other things to identify probable forces. This section will illuminate operational limitations, requirements for weather windows (i.e. weather forecasts that mean that the operation can be performed) and the significance of the weather conditions for the vessels' available bollard pull.

Critical elements for offshore operations are use of time and expected weather. Planning of marine operations should be based on an operation's reference period defined as: Operation reference period (TR) = Estimated time of operation + Estimated unforeseen time.

If unforeseen time has not been identified, the operation reference period is normally set at twice the estimated operation time. Marine operations with a reference period less than 72 hours can be defined as weather-limited operations. These operations can be planned independently of statistical data and based only on weather forecasts.

For weather-limited operations, critical factors such as forces, movements and acceleration shall be calculated in a rather worse weather condition (design criterion) than the weather in which it is planned to perform the operation (operational criterion). This is due to the unreliability of weather forecasts, weather that suddenly blows up, and the uncertainties surrounding the assessment of the weather condition. The longer the planned operation lasts, the greater the difference between the operational criterion and the design criterion. The relationship between the operational criterion and the design criterion is defined as the á factor, ref. Table 3.1. The variations in the alpha factor also take account of the fact that it is harder to estimate the wave height for small sea conditions than for larger sea conditions. Values referred to in the DNV Rules for Marine Operations, Part 1, Chapter 2, Planning of operations, are shown in Table 3.1. As an example, operation planned to take 20 hours with a design criterion of significant wave height (Hs) 2.5m will yield an operational criterion of 2.5 * 0.71 = 1.8m. Significant wave height is defined as the mean of the 1/3 highest waves. The maximum wave is about 1.86 times Hs (depending on the period).

Recognised industrial standards say that account shall be taken of the fact that the vessel's continuous bollard pull will be reduced by weather forces during the operation.

3.9 Requirements for the mooring system of the "Transocean Rather"

The drilling rig "Transocean Rather" is classed in DNV. The rig does not have the POSMOOR class notation from DNV. For this reason DNV does not have responsibility for follow-up with respect to the mooring system over and above its use for emergency mooring.

DNV is also engaged by Transocean (UK) as an Independent Competent Person (ICP) in connection with statutory shelf-state verification (HSE). Transocean Rather Safety Case (no. 1729, 2004) was accepted by the HSE.

Table 3.1 Significant wave height alpha values

Operational period (hours)	Design wave height (m) 1 Hs 2	2 < Hs 4	Hs >4
TR < 12	0.68	0.76	0.80
TR < 24	0.63	0.71	0.75
TR < 48	0.56	0.64	0.67
TR < 72	0.51	0.59	0.63

For significant waves (Hs) the alpha factors referred to in Table 3.1 shall be taken into account.
For wind (10 min, mean), an alpha factor of 0.8 shall be taken into account

As a technical reference for the mooring system Department of Energy 4th Edition Guidance Notes 32.2, MODU Code part 4.11.8 and internal Transocean specifications was chosen by Transocean.

In addition, Clevron demanded that the mooring system satisfied the POSMOOR requirements.

Chapter 4
The company

4.1 Organisation

Bourbon Offshore Norway AS is a Norwegian company with about 500 employees, of whom most work on the company's vessels. It is headquartered at Fosnavåg, Møre og Romsdal County, Norway. The company's vessels are formally owned by Bourbon Ships AS, but this company is wholly-owned by Bourbon Offshore Norway AS. The company currently has 16 vessels in its fleet, of which five are anchor-handling vessels. The other vessels of the company are supply ships (Platform Support Vessels, PSV) and Multi Purpose Supply Vessels (MPSV). The company currently has ten vessels under construction. In 2006 Bourbon Offshore Norway AS posted sales of about NOK 880 million. The company is a part of, and is owned by, the multinational Bourbon Group, with about 4,200 employees and 280 vessels in its fleet, headquartered in Marseilles.

Bourbon Offshore Norway AS' organisational structure is shown in Figure 4.1.

4.2 Crews during the operation

The "Bourbon Dolphin" was set up with two shifts that went five weeks on and five weeks off. Frank Reiersen was master when the vessel was char-

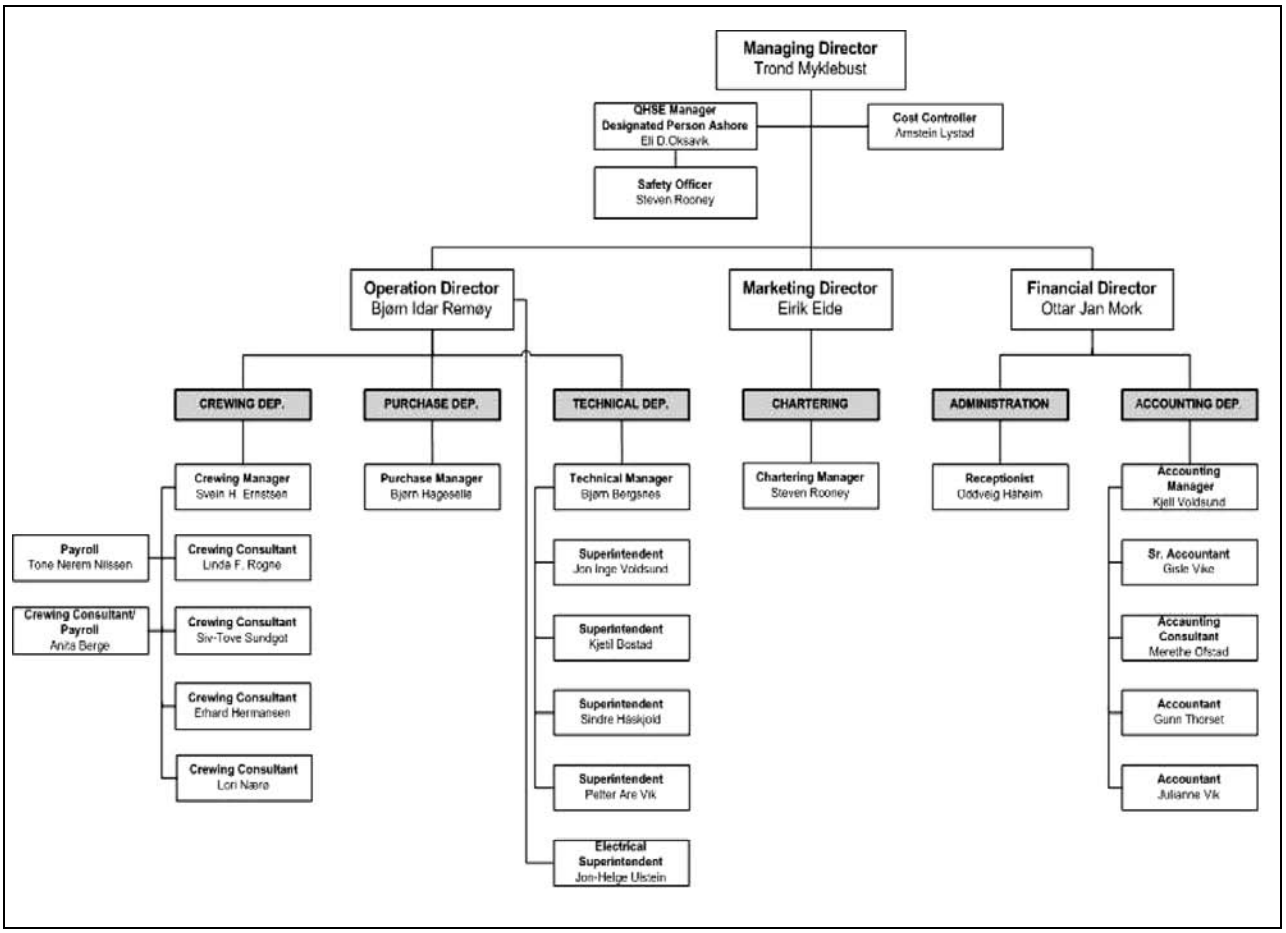


Figure 4.1 Organisational chart for Bourbon Offshore Norway AS, April 2007

tered and during the first part of the operation, see Section 8.3. After the crew change (see Section 8.2) on 30 March 2007, the crew comprised the following 14 persons:

Watch 1
Oddne Remøy (Master)
Kjetil Rune Våge (First Officer)
Frank Nygård (Chief Engineer)
Per Jan Vike (Able Seaman)
Tor Karl Sandø (Able Seaman)

Watch 2
Bjarte Grimstad (Chief Officer)
Geir Tore Syversen (First Officer)
Ronny Emblem (First Engineering Officer)
Øystein Sjursen (Ordinary Seaman)
Egil Atle Hafsås (Able Seaman)

Day crew
Ånje Nilsen (cook)
Søren Kroer (electrician)
Thomas Arnesen (engine-room trainee)
Kim Henrik Brandal (engine-room trainee)

The first watch worked from 06:00 to 12:00 and thereafter from 18:00 to 24:00. Nilsen, Kroer, Arnesen and Brandal stood regular 10-hour watches from 08:00 to 18:00.

Oddne Remøy was the regular master on the "Bourbon Borgstein", but at his own request and by agreement with the company had exchanged watches with the other regular master on the "Bourbon Dolphin", Hugo Hansen. The company considered the "Bourbon Borgstein" an equivalent ship and the exchange of captaincies was regarded as not being any kind of problem. This was Remøy's first voyage with the "Bourbon Dolphin". His fourteen-year-old son, David Remøy, was along as a passenger and as work experience from lower secondary school.

First Officer Geir Tore Syversen, who had been a bridge trainee on the "Bourbon Orca", was also on his first voyage with the "Bourbon Dolphin", whereas Chief Officer Bjarte Grimstad, who stood watches together with Syversen, had been sailing with the "Bourbon Dolphin" from 14 October 2006. The "Bourbon Dolphin" was the first anchor-handling vessel on which he had served. The rest were the usual crew of the "Bourbon Dolphin". Able Seaman Øystein Sjursen had come on board with Captain Frank Reiersen's watch, but stayed on because the mustering crew were one man short.

On the basis of information from the company the Commission finds that the deck officers' experience of anchor-handling was as follows: Remøy 16 months, Grimstad six months, Våge 15 months and Syversen six weeks. Remøy and Våge had participated in a number of rig moves previously, whereas Grimstad had been on nine assignments, of which four were regular rig moves. Remøy and Våge had experience from deep-water operations, whereas Syversen and Grimstad had no corresponding experience.

When Oddne Remøy took up the post of Chief Officer on the "Bourbon Borgstein", he had not participated in five rig moves. A month later he was promoted to master without having participated in five rig moves as Chief Officer. At the time of the accident he satisfied the requirement. Bjarte Grimstad, who joined the "Bourbon Dolphin" as Chief Officer in October 2006, had a background from supply ships and – so the Commission has been told – had no experience of rig moves. When the accident occurred, Grimstad had participated in four regular rig moves and taken part in an assignment to reset an anchor.

Chief Engineer Nygård had nine years service, whereas First Engineering Officer Emblem had four years service. The deck crew's experience of anchor-handling was: Sandø six years, Vike nine months, Hafsås five months and Sjursen five months.

The Commission would particularly note that no information has been received that would suggest that the crew members were not physically and mentally fit to stand watch on the day of the accident. The Commission finds that the provisions on working and rest time had been observed. This applied to both watches.

4.3 The company's safety management system

Bourbon Offshore Norway AS has a safety management system that by and large is the same for the entire fleet, but with certain adaptations for anchor-handling vessels. The system was established in 2003 and has been subject to continuous amendment since. The system, which is in English, is divided into twelve sections. The first sections deal with the company's safety policies, division of responsibility and authority. Thereafter comes a description of the master's responsibility, resources and personnel, and ship's operations and preparedness. The last sections of the system

concern reporting, maintenance, documentation and the company's own review and evaluation of the safety management system.

By way of introduction, the system prescribes that it shall conform to the ISM Code, ISO 9001 and ISO 14 001. Among the company's objectives are the satisfaction of the obligatory regulatory system, and to "address applicable codes, guidelines…". The company also has it as an objective to create adequate safety barriers against all identified risks in the activity. The company shall also continuously improve sailing and shore-based personnel's knowledge of both the company and the vessel as regards the use of the safety management system. This applies to preparations for handling emergencies that are both safety and environment-related, plus safe handling of vessel and working environment. In order to handle this, the company's intention is to establish "functional elements" in its safety management system: among other things procedures for identifying, evaluating and reducing risk that can lead to hazardous situations, errors and undesirable incidents, confer Section 1.2 of the safety management system.

The company is organised with a Managing Director (Trond Myklebust) leading the company. Under him is the Operation Director (Bjørn Idar Remøy) to whom the masters of the vessels report.

Technical Manager Bjørn Bergsnes was appointed to Bourbon Offshore on 1 April 2005. Between 2001 and 2002 he had been employed in the design department of the Ulstein Verft. In 2002 he became design manager.

The Designated Person Ashore, confer ISM Code Rule 4, is Eli Oksavik, with whom the sailing personnel can take direct contact. Oksavik reports direct to the Managing Director. The Designated Person Ashore's responsibility includes monitoring of safety and prevention of pollution during the operation of the vessel, and ensuring that shore-based support is available when required. Under the safety management system the Designated Person Ashore is also assigned responsibility for performing internal audits. The Designated Person Ashore also has independence and authority to report non-conformances to company management and take remedial measures for such non-conformances.

Section 5.1. provides a job description for the master. Among other things he has the responsibility for implementing the safety management system on board and for motivating the crew to comply with the company's safety policy by displaying expertise and a positive attitude to the safety management system. It is also stated that the master has "overriding authority" to address safety and the environment and the efficient operation of the vessel. It also follows from 5.1.1 that the master represents Bourbon Offshore Norway and has the responsibility for protecting the interests of the company. The master shall also create good relations with the charterer's personnel and "strictly follow all orders given of the Charterer", provided that these are in conformity with the flag state's rules and decisions of public authorities.

It follows from Sections 6.2 and 6.3 that personnel on board shall satisfy the STCW Convention. There are, however, no written qualification requirements for bridge personnel over and above the requirements of the STCW Convention. It is stated that new personnel shall be familiarised with the vessel's safety system and job descriptions, and that it is the master's responsibility to ensure that this is done before the vessel leaves port. The safety management system does not affect overlap for new personnel, nor are there express requirements for this in the SM Code. The company has prepared checklists for familiarisation (Safety Induction Checklist). See Annex 1 Section 2.4.

It is also stated in Section 6.5 that the company shall continuously identify necessary training of crew and company personnel in support of the safety management system.

Section 7.5 makes requirements that work assignments that are not covered by the ship's regular procedures, and where there is a potential risk, be analysed in order to determine whether the risk can be reduced or removed by changing the work method.

Under the system the risk analysis shall be performed in the following manner:

Assess the risk:
- What can go wrong?
- What are the consequences if something should go wrong?

Analyse how the risk can be reduced:
- Does the personnel have the necessary skills to perform the job safely?
- Is there a need for further training?
- Is the correct personal safety gear being used?
- Is the correct equipment available?

The company has an electronic system (Premaster) to support the performance of risk analyses.

Section 8 deals with contingency procedures and drills and among other things demand that a fire and evacuation drill be held once a month, whereas drills simulating damage to the hull, grounding or collision hazard shall be done at least once a year.

Reporting, investigation and closing of non-conformances are described in Section 9. Accidents and non-conformances that affect the vessel's operational abilities or safety shall be reported, investigated and closed by the master after the corrective measures have been taken, with a view to the incident not repeating itself. For its part, the company shall monitor non-conformances and follow up the corrective measures.

Section 10 lists detailed routines for the maintenance of the vessel and equipment, with a number of appurtenant procedures, whereas Section 11 deals with document-handling.

Section 12.1 prescribes that annual internal audits shall be performed by the company in order to verify that the system has been implemented correctly. In the course of a five-year period, the entire system must have been revised. The Master's Review, which is a continuous process, shall give company management sufficient information about how the system is implemented on board, confer Section 12.2. At least once a year, company management shall go through the system (Management Review) and consider how it is implemented, confer Section 12.3.

The company also has an Anchor Handling & Towing Manual, see Annex 1, Section 2.2. The manual is general and affects only some of the fundamental principles of anchor-handling on a paramount level. The manual is not vessel-specific and lacks a description of operations in deep water.

It is not apparent from the safety management system that the NWEA guidelines for anchor-handling are to be followed, but the company has stated that in the autumn of 2006 they sent the guidelines to all its vessels.

The foregoing description of the safety management system is based on how it appeared at the time of the accident. Extracts from the system have been incorporated into Annex 1 Section 2.1.

4.4 Provisional certification of 3 October 2006

Provisional certification of the "Bourbon Dolphin" was made on 3 October 2006 by DNV, when the vessel was taken over by the owner. As mentioned above, the company's safety management system is roughly speaking the same for all the vessels in the company, and a corresponding system was established on the "Bourbon Dolphin". No audit of the system was undertaken on delivery, and the vessel received provisional certificates with six months' validity in conformity with the ISM Code.

4.5 Internal audit of 9 March 2007

Safety Officer Steven Rooney from the company office performed an internal audit on the vessel on 9 March 2007 and prepared a report dated 15 March, see Annex 1 Section 2.5. In the audit, Rooney reported three non-conformances and five observations. Two non-conformances concerned "security", confer the ISPS Code, whereas the third non-conformance concerned defective signature of the handover form. Rooney testified before the Commission that handover was always performed, and that it was thus only the actual signature that was missing. Two of the observations concerned risk assessments and reporting routines. Regarding risk assessments it was stated:

> "The risk assessment system could be better used. It has mostly been used before start-up of anchorhandling work" *(original in English)*

The observation related to reporting routines concerned the use of the system Premaster in non-conformance reporting. The internal audit report pointed out that there was little reporting through the system, particular as regards improvement proposals and undesirable incidents, and that this could be improved by all departments on board.

4.6 DNV's audit of 17 March 2007

Certification of the company's safety management system is a flag-state responsibility that the classification societies discharge on behalf of Norwegian authorities for cargo ships registered in NOR. With its delegated authority, DNV performed the certification of the safety management system of the "Bourbon Dolphin". The initial audit was done by Chief Auditor Richard Taylor at DNV's local office in Aberdeen on 17 March 2007, see Annex 1 Section 2.6. He stated before the Commission that he had only once before audited the safety management system of an anchor-handling vessel.

In his witness testimony to the Commission (confer Annex 2 Part 5), Taylor stated that he had spoken with several of the officers, among others Captain Reiersen, and some of the deck crew. During the audit he was shown the internal audit dated 9 March. In his testimony Taylor mentioned that the audit methodology was to do spot checks on various components of the system in order to ensure that it was functioning in a satisfactory manner as a whole.

The audit uncovered four non-conformances in the system. The first non-conformance concerned defective compliance with routines related to the familiarisation (induction) of new crew, confer the ISM Code's Rule 6 Section 3. The safety management system's Section 7.2 demands that new personnel should immediately familiarise themselves with the "Vessel Induction Booklet" and be given an introduction by the vessel's Safety Officer. The non-conformance in the report was related to the fact that the company had prepared specific checklists for deck and engine-room that were not being used. The company has stated that the specific checklists, which were an improvement measure for familiarisation, were introduced in January 2007. The company has, however, a general checklist for familiarisation that is always gone through. In his testimony Taylor defined "new personnel" as crew who had never worked on the vessel previously or who had not been on board for a while. In the introductory part of the Safety Induction Checklist, new personnel are defined as those who have never been on the vessel before, or who have not been on board for twelve months. The Qualification Requirements Section 1-3 second paragraph d) demand that new personnel shall be familiarised with the vessel, equipment and their duties.

The other non-conformances concerned defective definition of training level for certain positions, inter alia the winch operator and personnel who worked on deck. The STCW Convention and the Qualification Requirements do not make special requirements for personnel on anchor-handling vessels, but the ISM Code's Rule 6 Section 5 demands that the company identify the training necessary as support for the safety management system. This means that the company must undertake an independent assessment of whether their personnel possess the qualifications necessary for the operations and duties to be performed.

During the hearing in Ålesund Bjørn Idar Remøy stated that the company demanded that both the master and the chief officer have participated in five rig moves before they can obtain promotion to these posts. Such a requirement is not, however, enshrined in the safety management system. The NWEA guidelines recommend that the master should have completed at least five rig moves. This issue is described in greater detail in Section 3.7.

The third non-conformance concerned a defective procedure for anchor-handling. As mentioned above, the company has an Anchor Handling & Towing Manual for anchor-handling operations, but Taylor testified before the Commission that this was very general. The ISM Code's Rule 7.0 demands that there be a procedure for all "key operations". Anchor-handling was the main purpose of the vessel. Taylor had therefore expected that a detailed procedure for anchor-handling specific to this vessel would be established in the safety management system. Taylor also testified that the difference between a manual and a procedure was that, whereas a manual is usually general, for example developed by a manufacturer for their equipment, procedures describe vessel-specific processes. For its part, at the hearing in Ålesund the company disputed the basis for the non-conformances, and considered that the manual had to be regarded as being a procedure. Bourbon Offshore later argued that anchor-handling procedures were usually prepared by the operator, and that the company's own anchor-handling procedures and manuals could therefore be general. The company pointed out further that they had been audited a number of times previously by DNV without this being classified as a non-conformance.

The last non-conformances concerned the analysis of the company's corrective measures. Taylor had uncovered through the audit that there existed recommendations from both the Master's Review and the Safety Committee regarding the need for crew training. The company, however, closed these recommendations without undertaking any further analysis of the reason for the observation, and referred to the planned simulator training, which for its part had been delayed due to delays in the delivery of the simulator.

The short-term certificates were issued with validity to 16 August 2007. They are normally replaced by a full-time certificate with a validity of five years, issued by DNV's head office.

4.7 Evaluation

4.7.1 Familiarisation/overlap

The ISM Code's requirements for familiarisation (induction) of the crew were addressed by the use of checklists that were controlled by the master. The company also has forms for handover at crew change. The system has, however, defective routines for familiarisation of the master, and not least for who has the responsibility for the implementation of this. In practice the master must go overlap in order to verify familiarisation. By overlap is meant that the person about to serve sails for a period together with the crew members he is to relieve, so as to acquire better knowledge of the vessel's characteristics, her equipment and crew. It is also unsatisfactory that the system does not demand overlap when new officers come on board.

The company defines in its forms "new personnel" as those who have never worked on the vessel or who have not been on board for the last twelve months. In the assignment in question two of the officers, Captain Oddne Remøy and First Officer Geir Tore Syversen, were on their first tour of duty on board and were thus new personnel. Through testimony from Captain Reiersen and Syversen it is clear that a certain form for familiarisation was given to the two new people. For Captain Remøy, this was on the handover on 29 March, a briefing that lasted about 1 ½ hours. Hugo Hansen testified in response to questioning from the Commission that he had held a telephone conversation with Oddne Remøy in advance. They also held conversations after the operation was under way.

The Qualification Requirements demand that new personnel be familiarised with the vessel and their duties on board, confer Section 3.4. The vessel's operational characteristics, including manoeuvring and stability characteristics, are key elements of such a familiarisation.

In the Commission's opinion, it is necessary that at least personnel in senior posts go overlap for a certain period. It is, moreover, common practice in the industry that officers go overlap, anything from a few days to a couple of weeks. The Commission would also emphasise that they were facing a demanding operation in deep water. The time used was clearly an insufficient familiarisation basis within the meaning of the Qualification Requirements. For subordinate crew such a timeframe may be sufficient, but particularly for a master, with paramount responsibility for the safety of the crew and vessels, overlap of a certain period will be necessary. Also for First Officer Syversen, the Commission considers that the familiarisation given was insufficient. In its testimony the company has noted that Remøy and Syversen had worked on similar vessels (the "Bourbon Borgstein" and the "Bourbon Orca") and were familiar with the company's safety management system. Here the Commission would point out that there are material differences between the "Bourbon Borgstein", the "Bourbon Orca" and the "Bourbon Dolphin", for example with regard to equipment and vessel characteristics. But even if the vessels had had the same design, it would not have been proper for the master not to get familiarisation in the form of overlap.

It was first and foremost the company's defective routines that meant that Remøy and Syversen did not receive the necessary familiarisation, and particularly in the case of Captain Remøy, the Commission considers that this failure led to his not having sufficient knowledge of the vessel.

4.7.2 Identification of training needs

The company's safety management system has to a small extent identified what level of training is necessary in order to perform anchor-handling over and above the minimum requirements of the STCW Convention. DNV's non-conformances concerned defective definition of the training needs of winch and deck personnel. As regards Syversen, who was winch operator, he had undergone a six-week bridge trainee period on the "Bourbon Orca". The Commission would also point out that training needs had not to any great degree been identified for deck officers either, related to the duties the personnel are to perform.

The guidelines for anchor-handling for the North West European Area (NWEA), recommend that, in order to function as master of an anchor-handling vessel, a person shall have participated in at least five rig moves. As mentioned above, Bjørn Idar Remøy told the hearing in Ålesund that the company demands that both the master and the chief officer must have participated in five rig moves before they can gain promotion to these posts, but no such requirement is enshrined in the safety management system.

When Oddne Remøy took the post of Chief Officer on the "Bourbon Borgstein" he had not participated in five rig moves. A month later he was promoted master without having participated in five rig moves as Chief Officer. Bjarte Grimstad,

who joined the "Bourbon Dolphin" as Chief Officer in October 2006, had no experience of rig moves. This shows that the company, in promoting people to leading deck officer posts, did not follow its internal requirements as stated to the Commission. In these case the lack of identification of training levels in the company's system meant that posts such as master and chief officer were being filled by personnel without sufficient experience from rig moves.

In the Commission's opinion, it is crucial that companies are fully aware that anchor-handling is a risky, complex and demanding operation and that for both deck officers and deck crew it is not sufficient to satisfy the STCW Convention. The necessity of identifying different levels of training and manning in conformity with these, is therefore a great one.

The Commission would also emphasise the importance of the authorities having a conscious relationship to qualification levels (confer the ISM Code) in companies engaged in anchor-handling and following this up through audits.

The Commission has also noted that the Bourbon Group has part-financed a simulator in Norway and has its own simulators in Marseille and Singapore. These are used for training of the company's personnel, which is regarded as a highly positive measure for the future.

4.7.3 Anchor-handling procedure

An anchor-handling procedure can describe what is to be done, in what way the operation is to be done, what forces the vessel can handle and how they are to be handled, operational limitations, who is to do what, when the various operations are to take place and so on. The procedure, which is a necessary aid to identification and handling of the risks, should be vessel-specific.

In the Commission's opinion the company's general manual cannot replace an anchor-handling procedure, not even when supplemented by an RMP.

In the Commission's opinion the absence of an anchor-handling procedure is a system failure that created uncertainty on board. Not least, the deployment of anchor no. 2 shows that the crew lacked operational instructions for corrective measures against uncontrolled drifting and handling of big external forces.

As mentioned above, Bourbon Offshore Norway has a safety management system that in its general lines is identical for all the anchor-handling vessels of the company. The system was established in 2003 and ten or more audits must have been held of the company's vessels and the company office since then. It is therefore difficult to understand why the lack of an anchor-handling procedure was not pointed out in previous audits by DNV. This also indicates a weakness in the Norwegian Maritime Directorate's audits of DNV.

4.7.4 Other aspects of the safety management system

In addition to the non-conformances uncovered by DNV's audit, there are two aspects of the company's safety management system that should be emphasised.

The first concerns routines for preparation of risk assessments. As mentioned above, the company itself has stated that one of the objectives of the safety management system is to establish safety barriers against all identified risks. The system also describes how all risks are to be assessed and analysed in such a way that these risks are as far as possible reduced. This is in line with the requirement in the ISM Code's Rule 1 Section 2.2.2 on introducing protection against all identified risks affecting personnel, vessels and environment alike.

The risk assessments prepared on the background of standardised forms were in reality safe job analyses related to the dangers of working on deck and other hazards that could cause injury to the personnel on board. Training in the preparation of risk assessments, as prescribed by the guidelines for anchor-handling operations NWEA Section 7.2.3, was not given

In the Commission's opinion, the implementation of the company's safety management system on board suffered failure. They apparently had a system that was to identify every risk, but knowledge and understanding of risks to which the vessel as such might be exposed, seemed to be lacking. Here the consequences for the vessel of drifting away from mooring lines could have been subjected to a risk assessment.

In the internal audit of 9 March 2007 it was observed that the preparation of risk assessments was defective, but this audit did not reveal that risks to which the vessel was exposed were not being handled, Annex 1, Section 2.7. The company was supposed to have a continuous follow-up of its vessels, and the lack of implementation of risk assessments ought to have been uncovered at a far earlier date.

In meeting with the Commission on 10 September 2007 the Norwegian Maritime Directorate stated that they regarded it as unusual to perform risk assessments for the vessel as such during anchor-handling operations, even if this, in the Directorate's opinion, follows from the ISM Code. This impression has been confirmed by questioning of witnesses on other vessels participating in the operation. The scope and quality of risk assessments for anchor-handling operations have apparently been defective in the industry.

The other weakness concerned defective non-conformance reporting. This, too, was an aspect touched on in the internal audit. The Commission has no reason to assert that there has been a systematic failure of the non-conformance reporting, but will concentrate on the heeling off Mongstad in December 2006, which was not reported. The vessel sustained a list or roll of 5-7° when a 18-tonne Stevpris anchor slid across the deck, an incident that ought to have been reported to the company, as demanded in Section 9 of the safety management system. This could have been an occasion for investigations within the company regarding the vessel's stability characteristics.

In conclusion the Commission will make some observations on the non-conformance action in the company. The shipyard prepared load conditions among other things for anchor-handling, which following the heel test were sent to the company for comments. These comments were prepared by Captain Reiersen. He made specific feedback on changes, so that they to a greater degree described relevant operations, and a desire for supplementary conditions. The Commission notes that this did not elicit further information from the shipyard, nor was any requested by the company. Nor did Captain Reiersen, as far as the Commission is aware, receive any feedback on his enquiry.

4.7.5 The crew

Seen in relation to the demanding deep-water assignment the vessel was facing on the Rosebank field, the expertise of the deck crew as a whole appears insufficient. Other players in the operation also observed inexperience on the part of the officers on the bridge, among other things towmaster Ross Watson pointed to lack of experience with the use of anchor-handling equipment in deep water.

In February 2007 the crew asked for expertise enhancement in a simulator course, without the company having granted their request prior to the accident.

As mentioned above, one reason why the vessel had a bridge manning that was relatively inexperienced with this kind of operation, is that Section 4.7.2 of the safety management system to a small extent identified what qualification requirements the company ought to impose on officers over and above the STCW Convention. It may thus be said that defects in the company's system permitted a composition of officers without the necessary anchor-handling competence.

The crew's limited experience of anchor-handling in general, and of deep-water operations in particular, must also be seen in the context of insufficient familiarisation. As pointed out in Section 4.7.1, the familiarisation of Captain Oddne Remøy was insufficient. He was thereby given command over a vessel he did not know and a crew he had not worked with. The time available for handover was moreover insufficient in relation to the complexity of the operation which they were to commence, see Section 8.2.

More experience among the officers on the bridge might have helped to prevent the escalation of the course of events or caused other choices to have been made during the operation that would have reduced the chances of the capsizing. Here the Commission is thinking of the fact that the operation to deploy anchor no. 2, following the problems encountered by the "Olympic Hercules" under the prevailing wave, wind and current conditions, was started at all. It is also thinking of the fact that the bridge personnel permitted the vessel to develop such a considerable drift, and that the operation was not suspended when they became aware that the vessel was not managing to hold her position, also the fact that the requests from the engine-room to reduce thruster use were not granted. This is described further in Chapter 9.

Chapter 5
The "Bourbon Dolphin"

5.1 Introduction

The vessel was a new ship type designated A102 (see Figure 5.1), developed by Ulstein Design, which is a part of the Ulstein Group. The vessel was built by Ulstein Verft with building number 274 and was of the AHTS type (Anchor Handling Tug Supply).

Construction of vessels must satisfy requirements made by the flag state, Norway, and the classification society. In addition come other specifications that the company finds it necessary to incorporate in relation to the vessel's area of operation as part of the construction contract. In this case, compliance with IMO Resolution A.469(XII) and IMO Resolution A.534(13) was a part of the contract.
The vessel was to be built in conformity with the following rules:

- The Building Regulations, confer Section 3.2.
- DNV Rules for Classification of Ships (issued in July 2004), with following class notation:
  X 1A1 with the following supplementary notations:

Figure 5.1 Ulstein's presentation of the A102 design

  - Tug
  - Supply Vessel SF
  - E0
  - NAUT-OSV(LOC)
  - Dynpos AUTR
  - Clean
  - Comf. V(3)
  - Firefighter I
  - DK(+)
  - HL(2.5)
- In addition it was agreed that the vessel should satisfy the following IMO requirements:
  - Resolution A.469(XII) – "Guidelines for the design and construction of offshore supply vessels"
  - Resolution A.534(13) – "Code for safety for Special Purpose Ships"

The vessel's stability was to satisfy requirements for supply ships pursuant to the rules of the Norwegian Maritime Directorate (confer Section 3.2). These rules are based on IMO Resolution A.469 (XII), with the exception of the fact that a supplement for towing operations has been prepared. In addition the vessel was to fulfil DNV's own requirements for towing and firefighting. The rules address both requirements for intact and damaged stability.

The Norwegian Maritime Directorate can delegate approval of the vessel for some technical construction areas to a classification society, in this case DNV. The areas delegated to DNV are hull, engines, winches and load lines. For a fuller description, see Section 3.5.

The Norwegian Maritime Directorate has itself approved the areas of stability, fire, navigation and rescue equipment.

Both the Norwegian Maritime Directorate and DNV had personnel at the shipyard during the construction period so as to supervise and ensure that the vessel was built in accordance with the rules.

5.2 Contracting and construction

On 11 March 2005 Bourbon Ships AS signed a contract with Ulstein Verft AS for the construction of the "Bourbon Dolphin".

The "Bourbon Dolphin" was by and large constructed in line with the original A102 design with the exception of the winch package, which was tailored to Bourbon's specifications. According to the deputy CEO of Ulstein Verft, Harald Møller, there was no innovation in this design. It was for a conventional anchor-handling vessel based on tried-and-true solutions and technology.

The vessel was built as a multifunctional vessel that could perform anchor-handling and towing plus supply and services. The vessel was to be capable of operating worldwide with the exception of certain areas such as the Arctic and Antarctic, "US inland waters" and other areas with special restrictions and requirements.

The vessel was designed to have a continuous bollard pull of 180 tonnes and was certified for this by DNV on 3 October 2006, see Annex 1 Section 1.5.

An outline specification for construction of the vessel was prepared in parallel with the development of the design, see Annex 1 Section 1.1. Prior to the contracting, construction specifications were prepared in line with the company's changes in relation to the design.

According to the ship construction register, building began on 1 March 2005. The bows and stern were built by Maritim Ltd. of Gdansk, Poland, under supervision of Ulstein Verft AS. The keel was laid in the autumn of 2005. The hull was thereafter towed to Ulsteinvik. The vessel was launched for the first time on 25 June 2006. Registered date for end of construction was 1 August 2006. It is also stated in the register that Ulstein Verft AS was the owner of the vessel in the construction period.

When the vessel was commissioned on 3 October 2006, she was deleted from the ship construction register without encumbrances, and registered in the Norwegian ordinary ship register (NOR) with Bourbon Ships AS as owner and Bourbon Offshore Norway AS as operating company.

Some minor changes were made to the chain arrangement during the construction process, over and above this, according to Møller, the changes were minimal. The Commission notes that certain (design) measures were taken to keep the gross tonnage under 3,000 (according to the minutes of a meeting between the shipyard and the company). In outline specifications the gross tonnage was given as 2,600, while in the construction specifications this was changed to 2,900. On delivery it appears from measurement certificate that the gross tonnage was 2,985.

Delivery of the vessel was delayed in consequence of delays by the subcontractors. The hull was delivered about 1 month late and the main engines were eight weeks late.

The heel test was performed on 20 August 2006 and approved by the Norwegian Maritime Directorate on 23 August 2006, see Annex 1, Section 1.2.

The vessel's lightship weight was higher than initially calculated. The original estimate was 2,810 tonnes (confer Ulstein's weight reports). In the heel test the weight was determined as 3,202 tonnes. The main reason why the vessel became heavier was that, according to Møller's testimony, there was inadequate control of the equipment weights.

The vessel's vertical centre of gravity was initially calculated at 7.17 m over baseline. In the heel test the centre of gravity was calculated at 7.43 m. The vessel's GM in lightship condition was 0.29 m.

A swing test as part of the sea trials was performed in September 2006. During this test a roll angle of about 17° was registered. The vessel was then, according to Per Gullik Strand of Ulstein, loaded in such a way that, with the prescribed draught of five metres, she should have the optimum (GM = 0.98 metres). In a new swing test with lower speed and less rudder, a smaller roll angle was registered. The Norwegian Maritime Directorate was not present during these tests.

On 2 October 2006 the Norwegian Maritime Directorate approved the vessel's stability as regards limit curves, damaged stability, lightship data and rule conditions, and the vessel was immediately commissioned. She then had all the necessary certificates, see Annex 1 Section 1.4.

5.3 The vessel's arrangement

The vessel had a traditional arrangement for AHTS vessels – a superstructure with bridge and various crew room forward, and an open deck area aft, ending in an open stern with a bipartite stern roller. Over and above the superstructure forward, the vessel did not have buoyancy volumes above the main deck. The deck had an area of 485 m2.

Table 5.1 Tank capacities

Type	Capacity (m^3)
Fuel Oil	1205
Fresh Water	433
Water Ballast	1765
Brine	583
Liquid Mud	627
Slop	306
Base Oil	173
Dry Bulk	162
Rig Chain Lockers	522

The completed vessel had a deadweight capacity of 2,130 tonnes and the maximum deck cargo with a centre of gravity 1 m over the deck could be 740 tonnes. This deviated from the building specifications, which operated with a deadweight capacity of 2,500 tonnes and maximum deck cargo of 800 tonnes. The outline specifications give the maximum deck cargo at 1,000 tonnes.

Winches were placed aft of the superstructure, over three decks. The winch package is described in more detail in Section 5.6.

The vessel's engines consisted of four main engines (each of 3,000 kW) placed two by two on each side, linked to their own nozzle propeller. The vessel had three fixed tunnel thrusters, two aft and one forward, plus a submersible azimuthal thruster forward. See Section 5.5 for a more detailed description.

The general arrangement is shown in Figure 5.2.

A number of tanks could be used for various kinds of liquid:

- 4 tanks could be used for Water Ballast, Brine or Liquid Mud
- 2 tanks could be used for Water Ballast and Rig Chain Lockers
- 2 tanks could be used for Water Ballast, Rig Chain Lockers and Brine
- 2 tanks could be used for Liquid Mud and Slop
- 1 tank could be used for Fresh Water and Water Ballast
- 2 tanks could be used for Fuel Oil and Base Oil

The tank plan may be seen in Figure 5.3.

Ballast tanks were arranged with a view to compensation for roll angle and trim, which is generally necessary in anchor-handling.

Two of the ballast tanks were made as roll reduction tanks. One of these could also be used for fresh water. The outline specifications state that there were to be three roll reduction tanks, but the midships tank was not built and the space was used for other purposes. The outline specifications also indicate different total tank capacities.

The roll reduction tanks are used to alter the vessel's sailing characteristics. If roll reduction tanks are used correctly, the roll will be reduced in the relevant wave periods. The purpose is to improve comfort on board and secure better work-

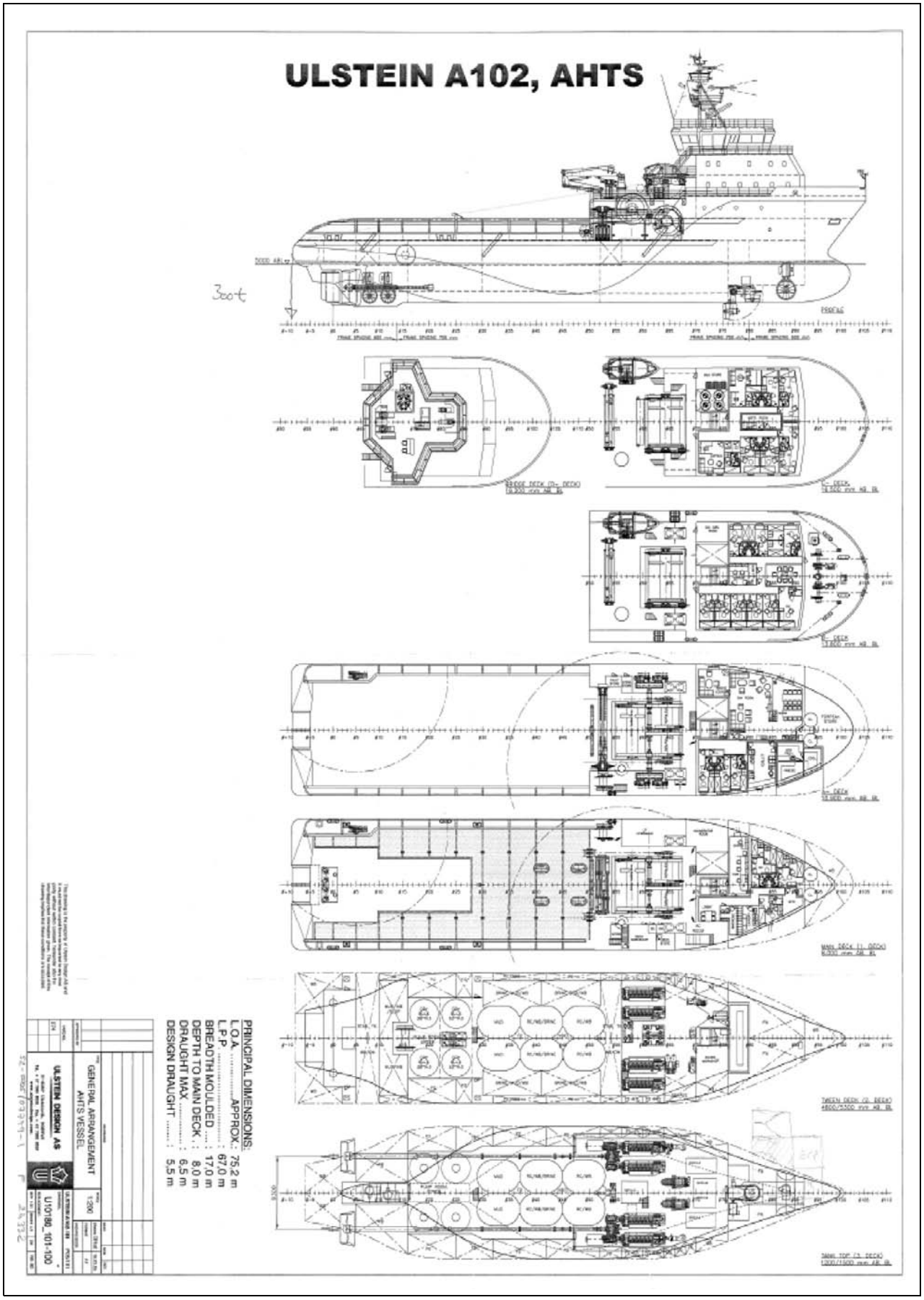


Figure 5.2 General arrangement

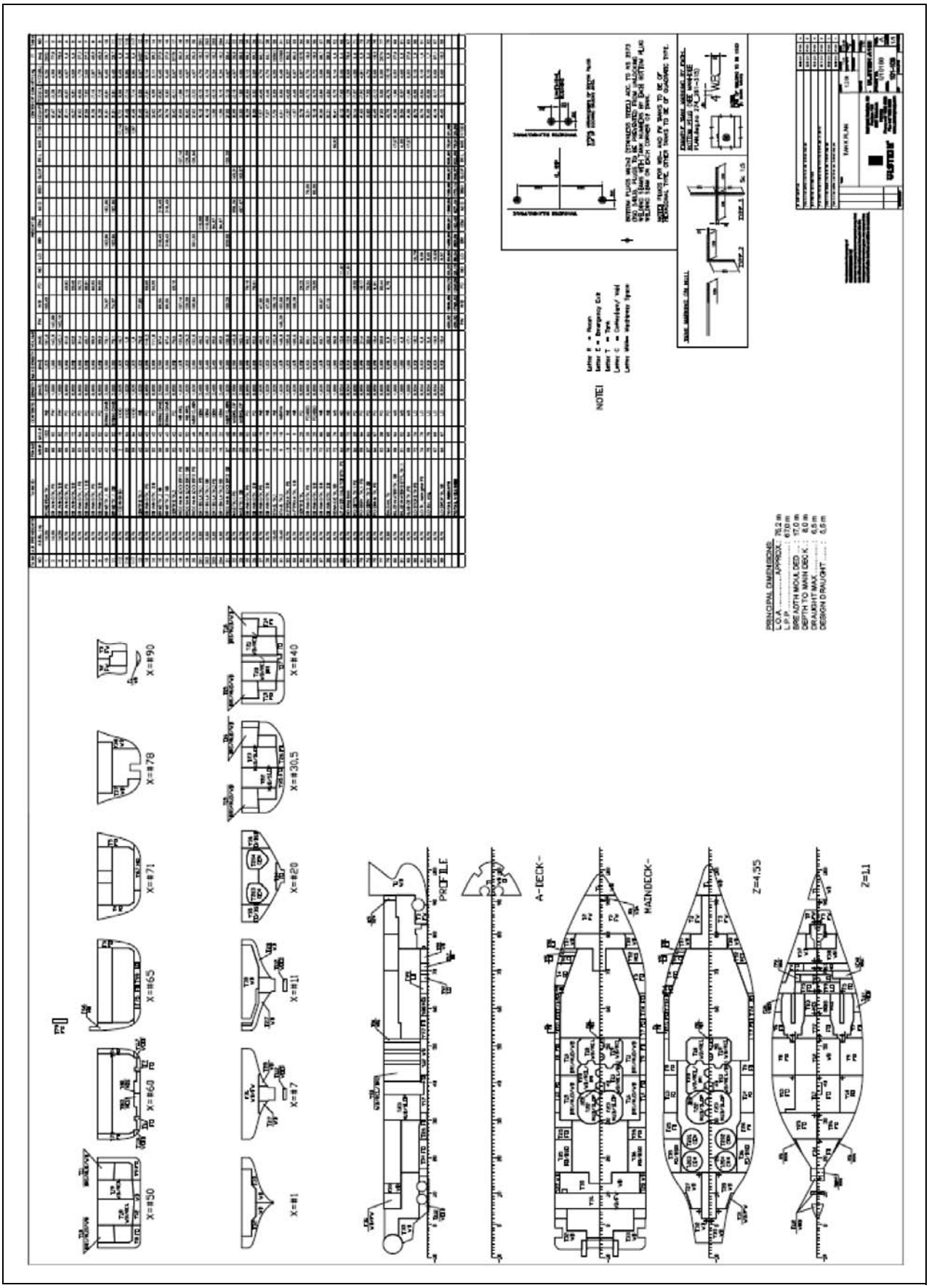


Figure 5.3 Tank plan

ing conditions for the crew, for example in connection with work on deck.

Rig chain lockers were placed about midships. They have loose hatch covers that are recessed into the vessel's main deck. The rig chain lockers can be filled with seawater.

5.4 Stability

5.4.1 The stability book

The vessel had an approved stability book, including Instructions for Master.

The stability book is prepared so as to describe the vessel's stability characteristics and to be a tool whereby the crew can control the vessel's stability in varying load conditions. The structure of the book follows a template that Ulstein uses for anchor-handling vessels.

On 31 May 2006 the shipyard prepared a preliminary stability book based on estimated lightship weight with centre of gravity. The heel test was performed on 20 August 2006 and was approved by the Norwegian Maritime Directorate on 23 August 2006. With this as a basis, a final stability book was prepared on 28 August 2006 (confer Annex 1 Section 1.3). The Norwegian Maritime Directorate approved the vessel's intact and damaged stability as supply ship on 2 October 2006 (confer Annex 1 Section 1.4). The certificate of approval also states that the content of the stability book satisfies IMO Resolution A.469 (XII). The Norwegian Maritime Directorate has stated that this was done for the sake of there being no doubt, in port state control, which international regulatory system was used for the approval.

The stability book includes calculations for a number of different categories of load conditions. The load conditions are prepared for what can be regarded as rule conditions for supply and towing operations plus some example conditions of anchor-handling. The content and structure of the rule conditions are laid down in the regulatory system. A rule condition may, for example, combine 10% bunkers and maximum deck cargo. The various rule conditions are designed with a view to possible critical load conditions being documented in relation to stability. The example conditions have a content that is meant to embrace typical operations that the vessel can perform. No

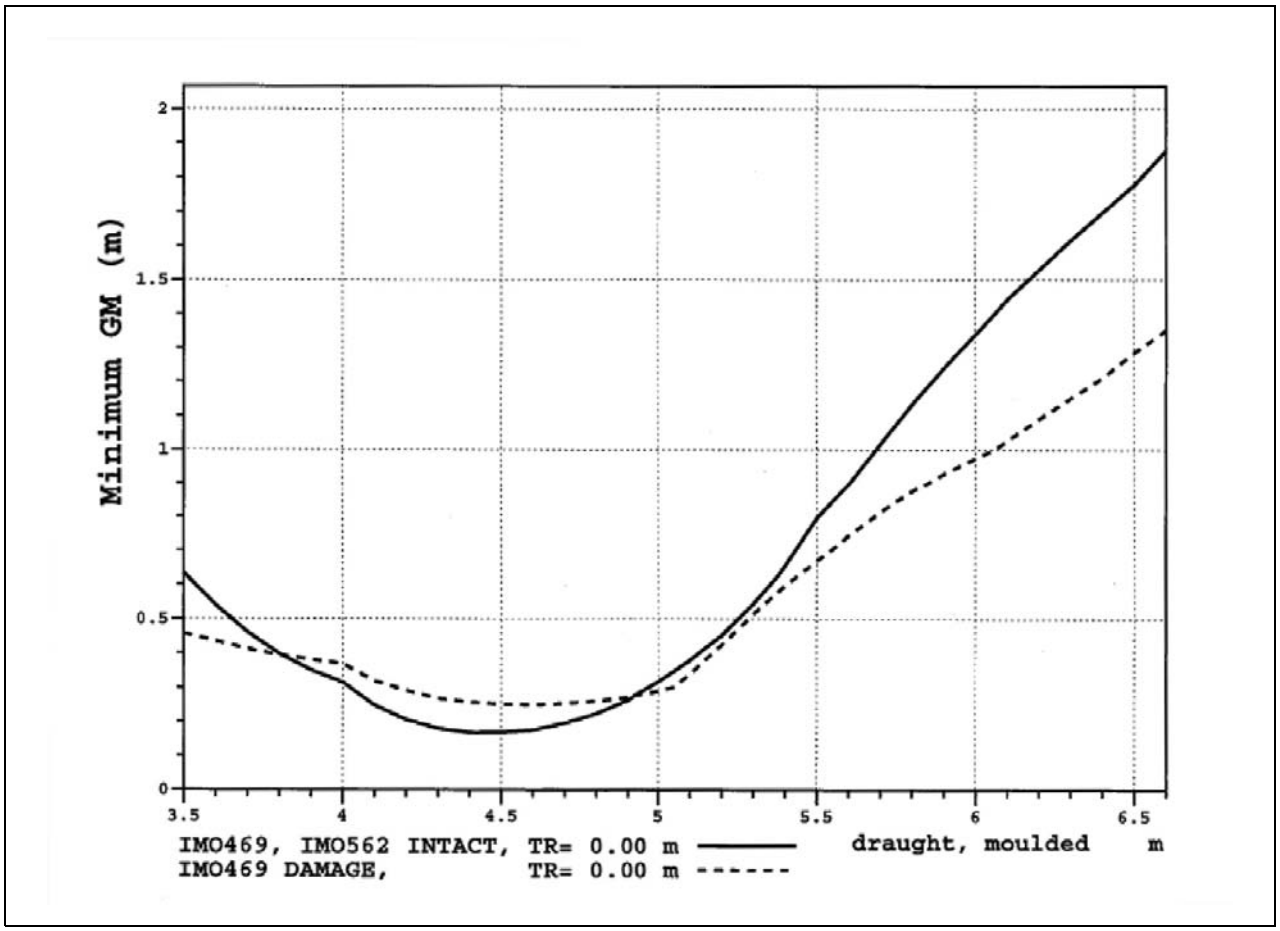


Figure 5.4 GM min curve

specific requirements for the example conditions for anchor-handling in the stability book are laid down by the regulatory system, but it was agreed that the vessel was to fulfil IMO Resolution A.469 (XII), which contains provisions on the preparation of "the worst anticipated load conditions". It must therefore be expected that the stability book contains such conditions. See otherwise Section 3.2 for a more detailed description of the regulatory system.

As mentioned above in Section 3.2, the stability book shall also contain information that in a quick and simple manner enables the master of the vessel to obtain precise guidance about the vessel's trim and stability under different sailing conditions.

The stability book also discusses the use of roll reduction tanks, though not in the form on instructions. The discussion is general and points out what factors are important to the use of the tanks. In order to find out whether the tank can be used for a given type of load conditions, for example anchor-handling, one has to either make one's own calculations or check to see whether each individual type of load condition is in the book about the tank or not.

5.4.2 Control of stability on board

Control of stability on board is done primarily by the use of KGmax or GMmin limit curves. The curves and a guideline for their use appears in the stability book.

The KGmax curves show how high the centre of gravity can be over the vessel's baseline (keel). The GMmin curves show how low GM can be. GM is vertical distance between the vessel's centre of gravity and her initial roll centre. The curves are prepared for varying draughts. If KG or GM are on the right side of the curves, the vessel's stability will be satisfactory.

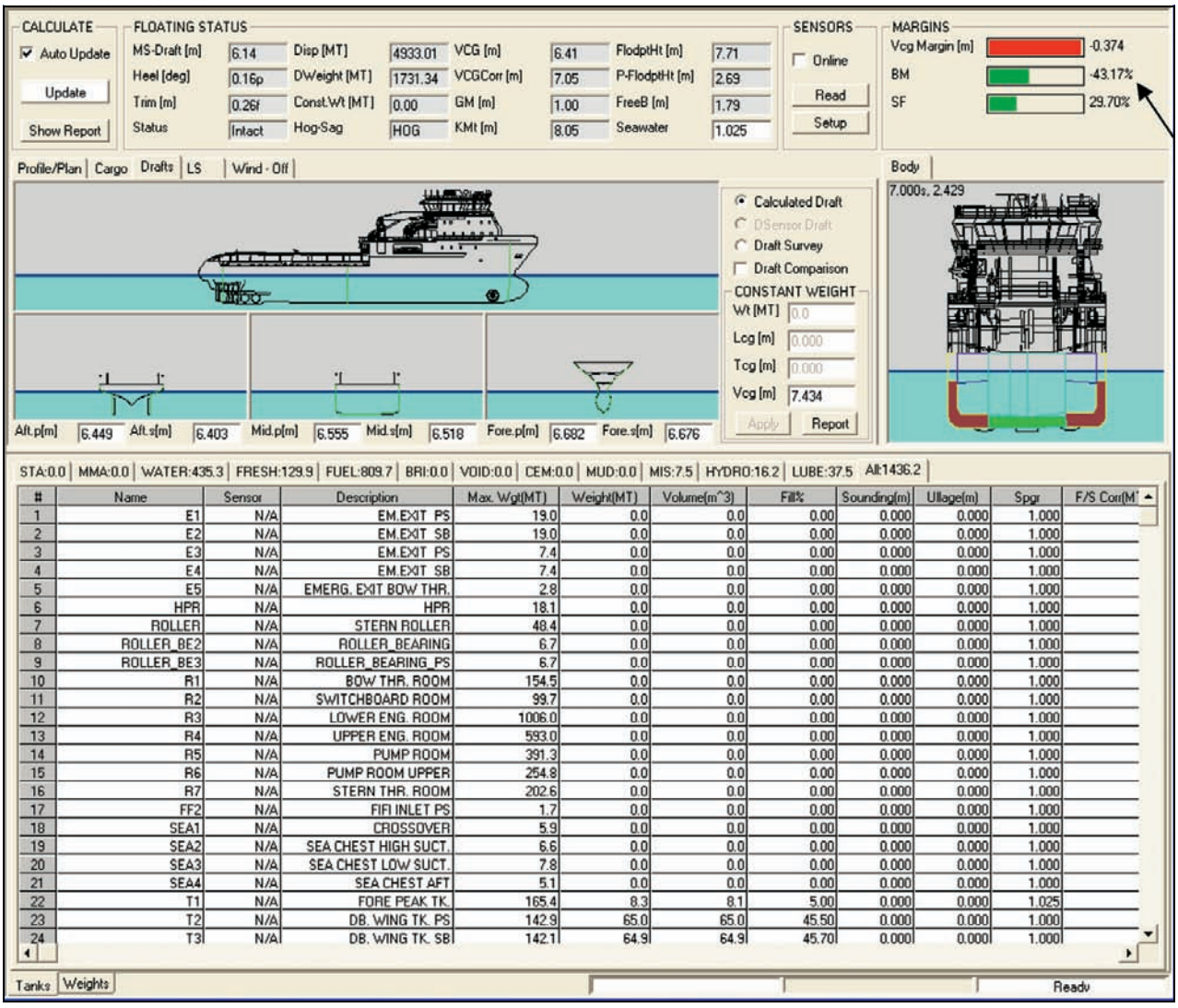


Figure 5.5 Screen capture from load calculator

Curves are created for a set of trim values. The vessel's GMmin curves (one for intact and one for damaged stability) for trim = 0.0 m are shown in Figure 5.4.
The limit curves are prepared in line with requirements applicable to supply ships and address both requirements for intact and damaged stability. In principle the limit curves cannot be used for control if the vessel is loaded in such a way that she lists (initial listing). This may often be the case for anchor-handling conditions, which makes the control assignment more challenging.

5.4.3 The load calculator

A load calculator was installed on board. This is a computer program that the crew can easily use to make stability calculations. One enters all known weights for load in tanks and on deck, wire on drums, external forces (static point stress) etc., finds the vessel's total weight and centre of gravity, and checks the stability by use of the GMmin limit curve. A red or green "light" shows whether stability is satisfactory or not.

The load calculator on board had the primary screen page shown in Figure 5.5. The area called "Margins" (top right) contains the "lights" that indicate whether stability (top bar) and strength (the two next bars) are satisfactory.
Load in tanks can be registered by use of level meters in the tanks and automatically read off in the load calculator. All other weights, such as cargo on deck, chain weight over the stern roller, chain in lockers, wire on the winch etc., must be entered manually, and if necessary be updated during an operation.

In the load calculator in question, control of stability is done primarily by the use of the GMmin limit curves. If the vessel's load condition had an initial list, the system could calculate a GZ curve for the case in question. The crew would thereafter have to do their own check as to whether this GZ curve fulfilled the stability requirements for an intact ship. See Annex 1, Section 1.3 for a more detailed description of the GZ curve and stability requirements.

A load calculator of the type AutoLoad was supplied by CoastDesign in Oslo. Autoload is type-approved by DNV and others. The load calculator for a specific vessel is normally subject to approval by the classification society. In this case there was a requirement for such approval from DNV. Documentation of the load calculator had not yet been approved by DNV, and this was addressed in a memorandum that said that it ought not to be put to use until it had been approved and tested on board. DNV has subsequently confirmed that the documentation for the load calculator was satisfactory, but because it had not been tested on board, DNV cannot certify that it actually functioned as it was supposed to. In practice the load calculator was used by the crew. There are, moreover, no formal requirements for training of the crew for the use of the load calculator.

5.5 The engine and propulsion system

The vessel's main propulsion system and electrical power system consisted of four main engines, each of 3000kw. The main engines are fitted in pairs on the starboard and port side. Each engine pair has an attached axle generator of 2,400kw. In addition, two diesel auxiliary generators are installed, each of 700kw.

For her propulsion the vessel has two main propellers. Using the main propeller alone, a bollard pull of 180 tonnes is achievable. In the vessel's Certificate of Bollard Pull, issued by DNV, this is indicated as continuous bollard pull, see Annex 1 Section 1.5.

In order to handle lateral forces the vessel has a tunnel thruster and an azimuthal thruster (360° swivelling submersible propeller) forward, and two tunnel thrusters aft. The azimuthal thrusters can also be used to increase the vessel's bollard pull, which would then yield a maximum of 194 tonnes.

The management/distribution of the power resources happens in two different operating modes for use in different operation priorities. In maximum bollard pull (Operating Mode 1) the auxiliary generators supply the vessel's consumption power and also current to the azimuthal thruster. The vessel's axle generators are used in such a way that all power from the main engines can be transferred to the vessel's propeller.

In Operating Mode 2, employed in operations with use of thrusters, each axle generator supplies power to a fore-and-aft thruster plus electrical motors for one winch set. The vessel's two auxiliary engines supply current to the other consumers. The axle generators have capacity to meet 100 % of the needs of the thrusters and winch motors.

When load is placed on the axle generators, the bollard pull will be reduced, because the propeller gradient is automatically adjusted to control

100 % load on the main engines that work with constant RPM. The higher the load on the axle generators, the less is left over for bollard pull. For example, with maximum use of thrusters and maximum load on winch motors,62 % of maximum performance will be left over for the main propellers. The bollard pull is thus reduced from 180 tonnes to as little as 125 tonnes.

The vessel's propulsion system, including the electrical power system, is of a tried and tested design that has been used for many years on anchor-handling vessels. This means that the vessel's certified bollard pull will appear more as a theoretical than as a real reference in anchor-handling operations where heavy use of thrusters can be expected.

Low oil pressure in the gearbox, for example in heeling, may trigger autostop on the appurtenant main engines, associated axle generator, thruster and main propeller.

The vessel is equipped with a dynamic positioning (DP) system, IMO Class 2. The vessel's installed engine and propulsion system is classed by DNV. The DP system was not in use at the time of the incident.

See otherwise the detailed description of the engine system in the report from Ship & Offshore Surveyors AS, Annex 1 Part 8.

5.6 Winches and other anchor-handling equipment

The vessel was equipped with a Rolls Royce/Brattvåg towing and anchor-handling winch of waterfall type/ BSL400/SL400W-3P. The winch package consists of following units:

- One 400 tonne AH winch with capacity 5,000m x 77mm wire
- Two 400 tonne AH /towing winches with capacity 2500m x 77mm wire
- One 138 tonne secondary winch of type ALMX3138U with capacity 1,600m x 8" (203 mm).

All the winches were equipped with spooling devices with lateral pressure capacities, respectively 60, 40 and 20 tonnes.

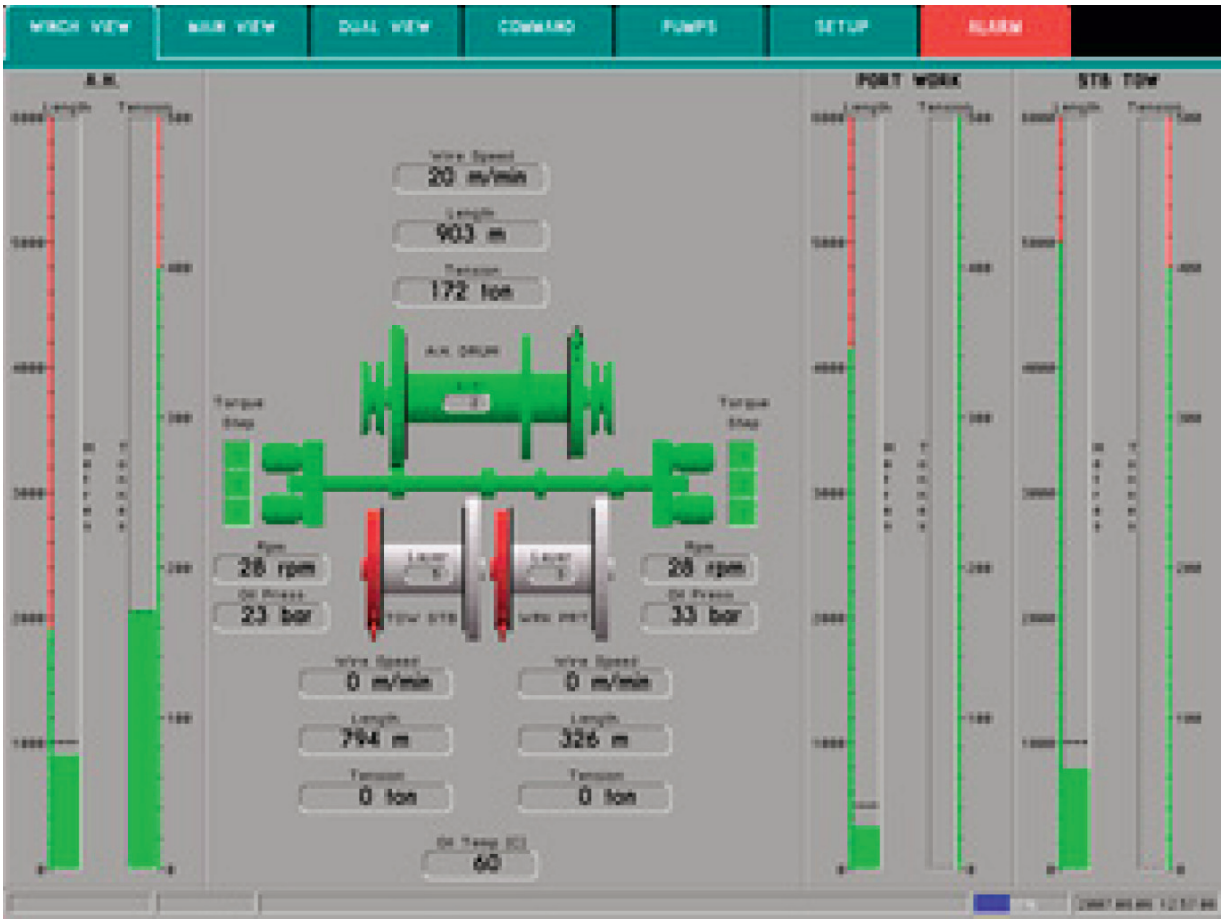


Figure 5.6 Winch work station – screen capture

Figure 5.7 Winch layout

Photo: Tony Hall

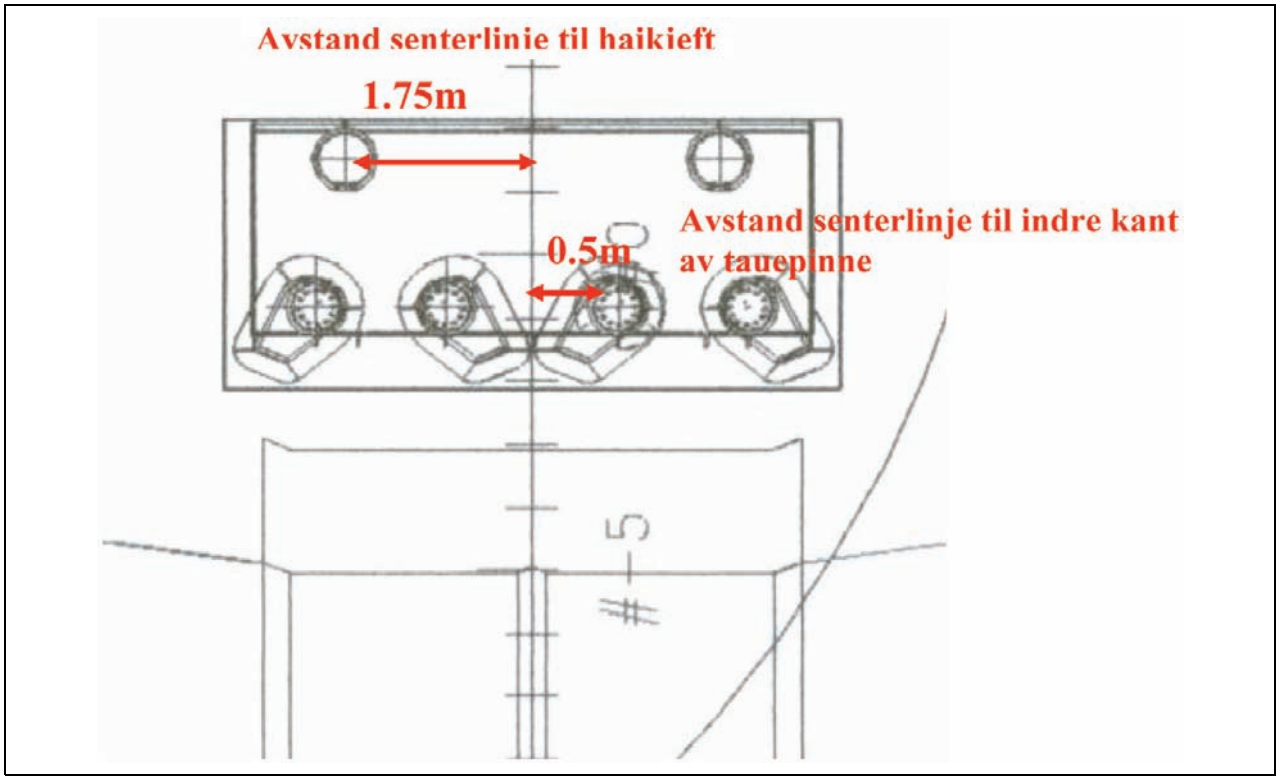


Figure 5.8 Dimensioned sketch of shark-jaws and towing-pins

Figure 5.9 Photograph of shark-jaws and towing-pins

On delivery from the shipyard the following wire lengths were installed:

AH winch	1,700m x 77mm
Towing winch	1,500m x 77mm
Secondary winch	0

On the after deck, at the edge by the stern roller, two shark-jaws were installed 1.75 metres from the centreline. Each shark-jaw has a couple of towing-pins, one outer and one inner, which are fitted closer to the stern roller than the shark-jaws. It is 0.5 metres between the centreline and the inner edge of the inner towing-pin, see Figure 5.8. The inner towing-pins are closer to the vessel's centreline than are the shark-jaws. The shark-jaw can only be used when the chain or wire is resting against the outer towing-pin, see Figure 5.9. Diameter of the shark-jaw is 500 mm and that of the towing-pin 450 mm. When the towing-pins are raised, the connection is closed, in that the flanges are turned towards one another. When the towing-pins are depressed, a brake valve is opened so as to reduce the hydraulic pressure in the system.

The hydraulic system functions in such a way that if the vessel rolls over and remains upside down, in consequence of their own weight the towing-pins and shark-jaw will slide out. The brake valves will hold the shark-jaw and towing-pins in raised position even if the vessel should later return to an upright position, see Annex 1, Section 1.11, for a description from Karmøy Winch.

The power resources for the anchor-handling equipment came from between one and four hydraulic pumps that delivered a maximum oil pressure of 60 bar. This could give lifting capacity on the first wire layer, with a drum diameter of 1,300 mm, of about 400 tonnes. With more wire on the drums lifting capacity is reduced.

Maximum brake capacity is 550 tonnes with the same quantity of wire. All the winches were equipped with tension control, which is governed by adjustment of the hydraulic motor's working pressure. A control panel gave the winch operator information about the power resources, the connections, the status of brakes and the tension. See Figure 5.6.

The winch package has a function for emergency release, confer Annex 1, Section 1.7. The main principle of this winch is to achieve a controlled release, where the tension determines at what speed it will go. In the event of a power cut, the accumulators will see to sufficient power resources to ensure the functionality of the system.

At the time of the incident, the wire from the anchor-handling winch had been slacked off, in that the emergency release button had been activated. The winch's operational status was consequently that connections were in, but the brakes

released. According to the manufacturer, the system would then reduce the torque to a minimum and the drum would increase speed on the basis of external stress from the wire or chain (tension) up to a speed of about 40m/min (half-full drum). First Officer Syversen observed about 12m/min.

At the time of the incident the following wire lengths were installed:

AH winch	2,300m x 84mm
Towing winch	1,500m x 77mm
Secondary winch	1,700m x 77mm

DNV has tested and certified the winches, including the emergency release, by delegation from the Norwegian Maritime Directorate and in accordance with the Directorate's regulatory system, confer Section 3.2. The requirement is emergency release within a maximum of 10 seconds of activation. Tests were made for the anchor-handling winch (aft), with brake activated at 105 tonnes tension (4 seconds to release) and without brake activated 68 tonnes (1 second to release). Corresponding tests were done also for the towing winch (forward starboard) and the working winch (forward port).

5.7 Rescue equipment and rescue arrangement

The vessel had six inflatable rescue floats, three on each side. The vessel was also equipped with a Man Over Board boat (MOB boat) to pick up people in the water. The total number of survival suits was 39, and they were placed in cabins and dedicated workstations such as the bridge and engine control room. The total number of life-jackets was 40, which were placed in lockers on A Deck at mustering stations plus the bridge and control room. All rescue equipment was installed and approved in compliance with the regulations.

5.8 Navigation and communications equipment

The vessel was equipped with the following permanent navigation equipment:
- Radar 3cm
- Radar 10cm ARPA
- DGPS x 2
- GPS compass

Figure 5.10 Survival suit

- ECDIS
- Gyrocompass plus 4 x repeaters
- Magnetic compass
- Autopilot
- Sonar
- Anemometer

On board was also "Transocean" positioning equipment of type DGPS for use in anchor-handling. This means that the positions and movement of both the rig and the vessels could be monitored with a precision of +/- 2m (filed in a computer file). This equipment was centrally operated from the rig by the navigation operator. Registration from this system is shown in Figure 5.11.

The vessel was equipped with the following permanent communication equipment:
- VHF 2 permanently installed
- VHF DSC 2 permanently installed
- MF/HF
- MF/HF DSC
- MF/HF Telex
- Inmarsat C
- Satellite telephone
- AIS
- Navtex

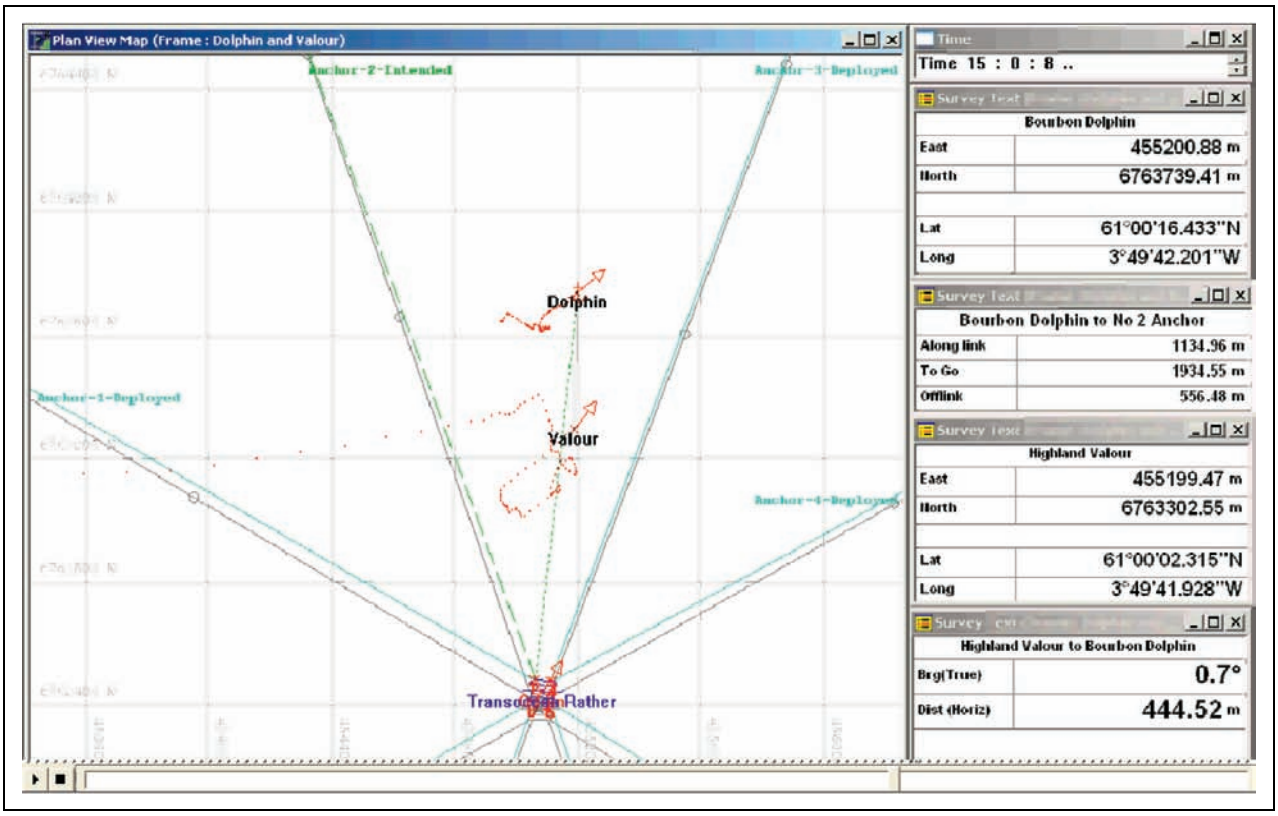


Figure 5.11 Image from Navpak during run-out of anchor no. 2

- Facsimile
- Portable VHF x 5
- SART x 2
- EPIRB x 2

With the exception of the five portable VHFs, the other equipment was located on the bridge. The EPIRB, which is a floating radio transponder, was mounted on the wheelhouse roof. As far as the Commission knows, no signals from the EPIRB were received after the capsizing, so it was probably not released during the accident.

All navigations and communication equipment was installed and approved in conformity with the regulatory system.

5.9 Manning

The "Bourbon Dolphin" had two shifts that were led by Captains Frank Reiersen and Hugo Hansen. Under the Norwegian Maritime Directorate's manning schedule, there was to have been safety manning of in all ten persons on each shift, so as to meet the certificate requirements of the Qualification Requirements, confer Section 3.4. This requirement was fulfilled at the time of the accident. For further discussion of the crews, see Section 4.2.

5.10 Operating history from October 2006 until the end of March 2007

The "Bourbon Dolphin" had completed 16 work assignments offshore prior to her loss. The vessel had participated in nine rig moves with anchor-handling in The North Sea area on charter from both Norwegian and foreign operators. The "Bourbon Dolphin" had also performed supply and subsea support assignments. Several of the assignments were so lengthy that both crew shifts were involved.

In the period from 4 October to 7 November the vessel was manned by Shift 1 (with Captain Frank Reiersen). From and including assignment no. 5, towing of a rig for Conoco Phillips, Shift 1 and Shift 2 (with Captain Hugo Hansen) alternated.

According to information from the company, the "Bourbon Dolphin" functioned well and lived up to the expectations the owners had of the vessel. Both Captain Frank Reiersen and Captain Hugo Hansen testified that the vessel was an all-

rounder and effective. Both, however, had some questions related to cargo capacities and the vessel's stability, as described in Section 12.3.2.

As the Commission has understood the explanations on this point, the masters attributed this to the fact that the vessel was new, and they needed to gain experience with the vessel's sailing characteristics under various conditions.

5.11 Evaluation

5.11.1 Contracting and construction

The figures that can be related to changes made to the A102 design of the "Bourbon Dolphin" point in the direction of heavier equipment being placed over the main deck. This is in line with information that the Commission has received through witness questioning. The changes were of a design nature and affected the gross tonnage.

The Commission had, through its questioning, not received the impression that the vessel's stability characteristics had been subjected to any particular evaluation in the light of the changes implemented. It is clear that these characteristics would be affected and thus meant that the vessel's stability could be more demanding to deal with during operations.

5.11.2 The vessel's arrangement

The vessel is arranged with many tanks, to be used for both ballast and cargo. This may be cargo of the type brine, barite, bentonite, mud etc. Use of such tanks for seawater means a need to clean them before use for cargo, which involves a cost and use of time. This may represent a threshold for use of the tanks for seawater, which is unfortunate. It ought not to be the case that economics and safety are opposed to one another in the operational assessments made by the crew. Conversations with the vessel's crew confirms that such thresholds existed and that they were reluctant to fill these tanks with seawater.

In the Commission's opinion, ballast tanks that it is necessary to use in order to safeguard the vessel's stability in anchor-handling operations, should not be of the combined type.

5.11.3 Stability

The vessel's stability book contains a chapter called "Instructions for Master". The contents of this chapter are standardised and provide no direct information about important matters related to the vessel's stability in various operations. This is an unfortunate practice that the Norwegian Maritime Directorate ought to have pointed out during its approval of the stability book.

The company had not prepared instructions for use of the roll reduction tanks as required by the Building Regulations Section 15. It was thereby not communicated that the tanks of the "Bourbon Dolphin" ought to be empty during anchor-handling operations.

The Commission has also noted that the book's load conditions for anchor-handling do not follow the standard for set-up of conditions that the shipyard had used for other vessels and also confirmed under questioning. Use of winch power and appurtenant point of attack for this (against the inner towing-pin) is not compatible with the vessel's maximum winch power and the use of the shark-jaw. The Commission would note that there are no concrete requirements for the content of such load conditions, but considers that the circumstances around this ought to a greater extent have been communicated in the stability book so as to make sure that the crew were aware of this and of the limitations it imposed.

The Technical Manager, Bjørn Bergsnes, had among other things a background from Ulstein Design. He was thus in a position to understand the vessel's technical characteristics, including those related to stability. This was also among his primary duties in the company. There was a dialogue between the company, including Frank Reiersen and the shipyard, about the vessel's load conditions. Frank Reiersen asked for the preparation of more, and more realistic, load conditions over and above what had been presented by the shipyard. As far as the Commission is aware, this dialogue ceased in September 2006 without further clarification. Given his expertise, Bergsnes ought to have followed this up and made sure that there was no doubt that the crew obtained knowledge of the vessel's stability characteristics and operational limitations.

For the "Bourbon Dolphin" the anchor-handling conditions were set up in such a way that bunkers had to be refilled after three or four days. Such a frequent bunkering will often be very difficult to achieve. The masters told the Commission that large quantities of bunkers were necessary to safeguard the vessel's stability. The anchor-handling conditions confirm this.

The Commission has noted weaknesses in Ulstein's quality assurance of the vessel's stability.

As the project progressed it was noted that the vessel became heavier and acquired a more unfavourable centre of gravity without this, according to information given to the Commission, having led to evaluation and non-conformance action on the part of the shipyard. The stability casework gives the impression that the same person had prepared calculations in the stability book without these having been checked or controlled by anyone else in Ulstein. That the stability book was subsequently approved by the Norwegian Maritime Directorate does not relieve Ulstein of responsibility for quality-assuring its work.

The "Bourbon Dolphin" was a combined PSV and AHT vessel, also described as an AHTS. Designing a combination vessel is more demanding than designing a PSV or an AHT. The main focus for a PSV is cargo capacity, whereas for an AHT there is more focus on propulsion system and deck layout.

Factors affecting stability are directly affected by the compromise resulting from different needs. Important factors for an AHT in this context are:

- Overall dimensions
- Buoyancy configuration, including design of hull and superstructure on deck
- Weight and centre of gravity
- The winch's pulling-power
- Capacity for leading of wire
- Bollard pull
- Ballast capacity

The vessels are as a rule designed with a large beam in relation to their draught, so that they have little or no buoyancy over the deck aft of the superstructure forward. Developed stability requirements have been developed for this type of vessel (IMO Resolution A.469 (XII)), which means that in order to have sufficient stability in various load conditions, particularly with large draught and little freeboard, there will be a need for a high GM.

For most load conditions a high GM yields disadvantageous sailing characteristics in relation to rolling. It is therefore normal for these vessels to have one or more roll reduction tanks in order to enhance comfort on board. Use of roll reduction tanks helps to reduce the vessels' static stability and can thus, for certain vessels in given operations, constitute a safety hazard.

In the light of the above, an AHTS vessel can be more demanding to operate in relation to stability. This is a challenge for the crews. It may therefore be more demanding to plan and control load conditions for these vessels than for others.

The Commission considers that in consequence of this there ought to be particular attention paid to the stability of these vessels, both in relation to scope and content of aids (stability book, load calculator) and qualification/training of crews.

Observations from the swing test, when a 17 º list was registered, point in the direction of the propulsion engine being over-dimensioned in relation to the vessel's hydrostatic characteristics.

The Commission is not aware that the company gave any training in the use of the load calculator. In March 2007, however, Chief Officer Bjarte Grimstad paid a visit to Ulstein Verft, allegedly in order to obtain information on the load of the vessel, including use of the load calculator and stability book.

5.11.4 Winches and other anchor-handling equipment

The winch package appears to be rather large in relation to the vessel's stability characteristics. No load conditions in the stability book show that the winch can be utilised with its full pulling-power and at the same time fulfil the stability requirements. In addition, the vessel was equipped with a big secondary winch that could accommodate large quantities of wire. This can mean that the vessel has highly-placed weight. When the vessel was lost, 1,700 metres of 77 mm wire was installed on this winch.

Previously the anchor-handling winches had a quick-release function that caused a rapid and uncontrolled release of the winch so that chain and wire rushed out. Even if it is apparent from the user manual that the emergency release system had been altered, it appears to have been a widespread perception that they still had a quick-release option. Even the officers on the "Bourbon Dolphin" shared this perception. The emergency release is more a support function for the winch than for the vessel as such. In the last phase of the situation that developed on 12 April, it is difficult to see that the emergency release would have had any preventive function.

5.11.5 The rescue equipment

When the vessel rolled over, only a single one of the rescue floats was automatically deployed. As mentioned above in Section 3.2, the Statutory

Regulations No. 1855 of 17 December 2004 (the Rescue Regulations) makes a functional requirement that an inflatable float shall be deployed automatically if the vessel should sink.

On 15 November 2007 Commission Member Dag Andreassen and Captain Frank Reiersen performed a test and review of a rescue float similar to those used on the "Bourbon Dolphin". It appears that the floats were installed in compliance with the regulatory system. There may be several reasons why they were not released when the vessel sank. The most probable is that, because the vessel was floating upside down for three days, the cradle design, deck design or loose objects prevented the floats from floating up to the surface. When the vessel subsequently sank, the rotation pattern probably prevented liberation of the floats from structures in the superstructure. As regards a later release of the floats, it is considered that the system was no longer intact because of the water pressure. Subsequent ROV files confirm that one of the floats on port side was squashed flat on the vessel. Since one float was observed near the casualty, it follows that four floats are unaccounted for.

The radar transponder was later found off Harstad in North Norway.

The Commission is of the opinion that the footgear of the survival suit provides little support and reduced mobility. This may result in delaying the donning of the suit as long as possible. In this incident it was not observed that the survival suit was used, although life-jackets were. That seven of fifteen survived wearing only a life-jacket is due mainly to nearby vessels having come quickly to the rescue.

Chapter 6
The planning of the rig move

6.1 Introduction

Drilling rigs can either be positioned on the field by the use of a mooring system or else with the aid of dynamic positioning or a combination of these. The majority of the rigs operating in the North Sea and adjacent areas are moored. Many of these rigs were not designed for deep water. The existing mooring lines must then be extended with chain/wire/polyester or a combination of these, and perhaps spring buoys, so that the rig can be anchored in deep water. Some of these rigs (this does not apply to the "Transocean Rather") will not be able to bear the weight of several hundred metres of extra chain and lighter mooring system employing wire or polyester must then be designed. For the same strength, wire weighs about one quarter as much as chain in water and polyester about 1/30th of chain's weight in water. In the last decade the use of polyester has become more common for drillrigs in deep water, but it is not widespread in the North Sea and is regarded as relatively new technology.

When a drillrig is to be moved from one location to another, it may be a question of anything from one nautical mile to movement over wide stretches of ocean. With the exception of rigs with dynamic positioning, all rigs must be assisted by towing vessels and anchor-handling vessels in order to moor themselves.

For mooring, either the rig's permanent system is used, where the mooring is run out from the rig, or else a pre-laid mooring system. In the first method the anchors and the mooring lines are run out and tautened from the rig. In a pre-laid system the anchors are first installed in the correct position and thereafter the mooring lines are stretched up towards the rig with the aid of an anchor-handling vessel. Use of pre-laid systems is not common in the North Sea but is employed to an increasing degree where found expedient. Using a pre-laid system can reduce the forces to which the vessels are exposed to a minimum during deployment of the anchors. During the deployment the forces are limited mostly to the weight of the mooring line between seabed and vessel. These forces are easy to control, as they are mainly vertical.

The Rosebank find was made in 2004. In April 2007 activity consisted in drilling of appraisal wells to evaluate the find.

In the rig move in question, it was the rig "Transocean Rather" that was to be moved two nautical miles from 213/26-1z Rosebank – Location "G" to Location "I". This chapter will provide a description of the involved parties on the operator side, of the rig and the key personnel during the operation, and will discuss the procedure that was prepared for the rig move.

6.2 Brief description of Chevron, Transocean and Trident

The oil company Chevron North Sea Limited (Chevron) is a part of Chevron Upstream Europe, the strategic business unit in Chevron Corporation. Chevron Corporation has its head office in San Ramon, California, and is one of the world's biggest integrated energy companies with operations in more than 180 countries all over the world, and involved in every sector of the oil and gas industry.

Chevron Upstream Europe has a number of exploration fields in the North Sea area, among other things in the UK Sector. There, Chevron has ownership interests in five production fields in which Chevron is the operator, one field in common operation and three fields operated by other companies.

Chevron has a comprehensive written manual for the implementation of marine operations, the "ChevronTexaco Marine Operations Manual", see Annex 1 Section 3.1. The manual also applies to Trident, which prepared the procedure. Chevron has also prepared "Guidance to Vessel Masters" for vessels hired for Chevron by TEAM Marine, confer Section 7.1 and Annex 1, Section 3.4.

Richard Macklin was Chevron Marine & HSE Specialist for the operation.

Transocean is the world's biggest offshore drilling contractor, and stands for the operation of around 82 mobile drilling units, which include drillships and various kinds of rig. Fourteen of the rigs are operating in the British and Norwegian sectors of Northern Europe. On a world basis Transocean has 30 rigs that can drill in waters deeper than 1,370 metres.

The company Transocean is registered in the Cayman Islands. Head office is in Houston, Texas. The business units for Europe and Africa are managed from offices in Aberdeen and Paris. Transocean has more than 12,500 employees.

For Transocean's operation a manual for marine operations has been prepared, the "Transocean Marine Operations Manual", which is general and is used for all Transocean's mobile drilling units.

For the "Transocean Rather" there was also prepared a separate Operation Management Plan (OMP) for the contract with Chevron, in conformity with the requirements of UK Step Change in Safety, Health and Safety Management System Interfacing. The Emergency Response portion of the OMP satisfied the special requirements of Regulation 4 of the Offshore Installations (Prevention of Fire and Explosion, and Emergency Responses) Regulations 1995, confer Section 6.6; see Annex 1 Section 3.5.

In the Transocean data card, confer Annex 1 Section 3.6, it is stated that the vessels shall operate in conformity with the NWEA guidelines.

Key personnel on the "Transocean Rather" during the operation are discussed in Section 6.4.

Trident is a British consultancy firm that offers maritime and technical services and has moving of rigs as its speciality. The company has been in operation since 1986 and performs more than 200 rig moves per year worldwide. Trident has performed moving of semi-submersible rigs in water depths from 59 to 1,650 metres.

Trident has a marine, a technical and a positioning division, who collaborate to create an integrated solution in which all the services are delivered by Trident. The marine division is responsible for marine superintendents and towmasters. Trident does not have any employees of its own to discharge the towmaster function, but hires self-employed individuals on an ad hoc basis. The technical division has employees with naval architect qualifications, whereas the positioning division contributes hydrographical surveyors and navigation engineers.

Sean Johnson of Trident was a marine superintendent for the rig move, whereas Martin Kobiela was technical manager. During the operation, inspector Martin Troup of Trident was stationed on board the rig as survey engineer.

6.3 The "Transocean Rather" - specifications

The oil rig "Transocean" Rather has the following specifications:

Name:	Transocean Rather
Type:	Column Stabilized unit
Gross Tonnage:	22,052
Class Notation:	DNV +1A1 HELDK, DRILL, CRANE, ICE-T
Construction site:	Daewoo Shipbuilding & Heavy Machinery Ltd, Okpo, South Korea
Construction year:	1987 – 12, upgraded in 1995
Previous Name:	Sonat Prat Rather 1988
	Sonat Rather 1997
Port of Registry:	Panama
Flag state:	Panama
Owner:	Transocean Offshore Deepwater Drilling Inc.
Operator:	Transocean Offshore (UK) Inc with company address
	Transocean House, Crawpeel Road, Altens, Aberdeen
Country:	The United Kingdom
Design:	GVA-4500
Accommodation section:	108 bunks + 2 Transocean offices, 2 customer offices, 1 sickbay
Helideck:	89ft x 89ft; Chinook 234 or Sikorsky S-61

Stationing:	Moored
Maximum drilling depth	7,620 m
Maximum water depth	1,372 m

Technical Data

Length:	99 m
Breadth:	87 m
Depth:	44 m
Operational draught:	25 m
Transit draught:	9 m

Mooring equipment:	
Winches:	8 Hepburn w/ GE 752s
Wire/Chain	8 x 6 000 ft x 3 ¾ in wire; 2,900ft x 84mm K4 chain
Anchors	8 x 18 tonne Bruce anchors

6.4 The "Transocean Rather" - personnel

Offshore Installation Manager (OIM)

The OIM has the supreme authority on board the rig. He is responsible for the rig's safety during both drilling and moving. Maritime operational authority during moving is delegated to the towmaster. The OIM has the responsibility for performing new risk assessments in the event of changes during the operation, confer Section 3.7.2.

The OIM on the "Transocean Rather" was Patrick O'Malley, who is trained as a drilling engineer. He has 22 years experience of drilling activities in the offshore industry, of which eight years as OIM. He is an employee of Transocean and reports to the rig manager onshore.

Figur 6.1 The "Transocean Rather"

It is stated in Section 1.5.1 of the RMP that:

> "nothing in this manual shall supersede applicable legislation covering the authority of the vessel master or Offshore Installation Manager (OIM)" *(original in English)*

Barge Supervisor

The Barge Supervisor is responsible for the rig's stability, including daily ballast, unloading and loading operations, plus monitoring of environmental factors. He is the day-to-day maritime manager on the rig. During rig moves his responsibility is restricted to ballasting operations and running of the winches. The Barge Supervisor has the technical operating responsibility for the winches.

The Barge Supervisor on the "Transocean Rather" during the operation was James A. Sutherland, who is a certified deck officer. Sutherland has 23 years experience in the offshore industry, of which twelve years in the same post and the last two years on the "Transocean Rather". He is employed by Transocean and reports to the OIM.

Transocean Towmaster /Chevron Marine Representative

The towmaster has delegated authority from the OIM to lead or monitor safety during the rig move operation. He shall, following instructions, inform the OIM and the marine representative of the op-

erator about all operational non-conformances. The towmaster shall keep a running log of duties and incidents during the operation and perform his tasks from the pilot house.

The towmasters during the rig move were Ross Watson, John G. Sapsford and Harvey Wilks. Ross Watson came on board on 26 March and left the rig on 9 April. John Sapsford came on board on 28 March. During the first phase of the operation, Watson and Wilks functioned as towmasters, while Sapsford had the role of Chevron Marine Representative, who was to safeguard the operator's interests during the operation. In addition to their function as towmasters, Wilks and Sapsford were the Chevron Marine Representative on board during the last phase of the operation.

The Commission has been informed by representatives of the operator, by the duty-holder and by the towmasters that this arrangement was common in the UK Sector and that it was not considered that the combination of the roles of Chevron Marine Representative and towmaster involved any safety limitations or loss of a safety barrier.

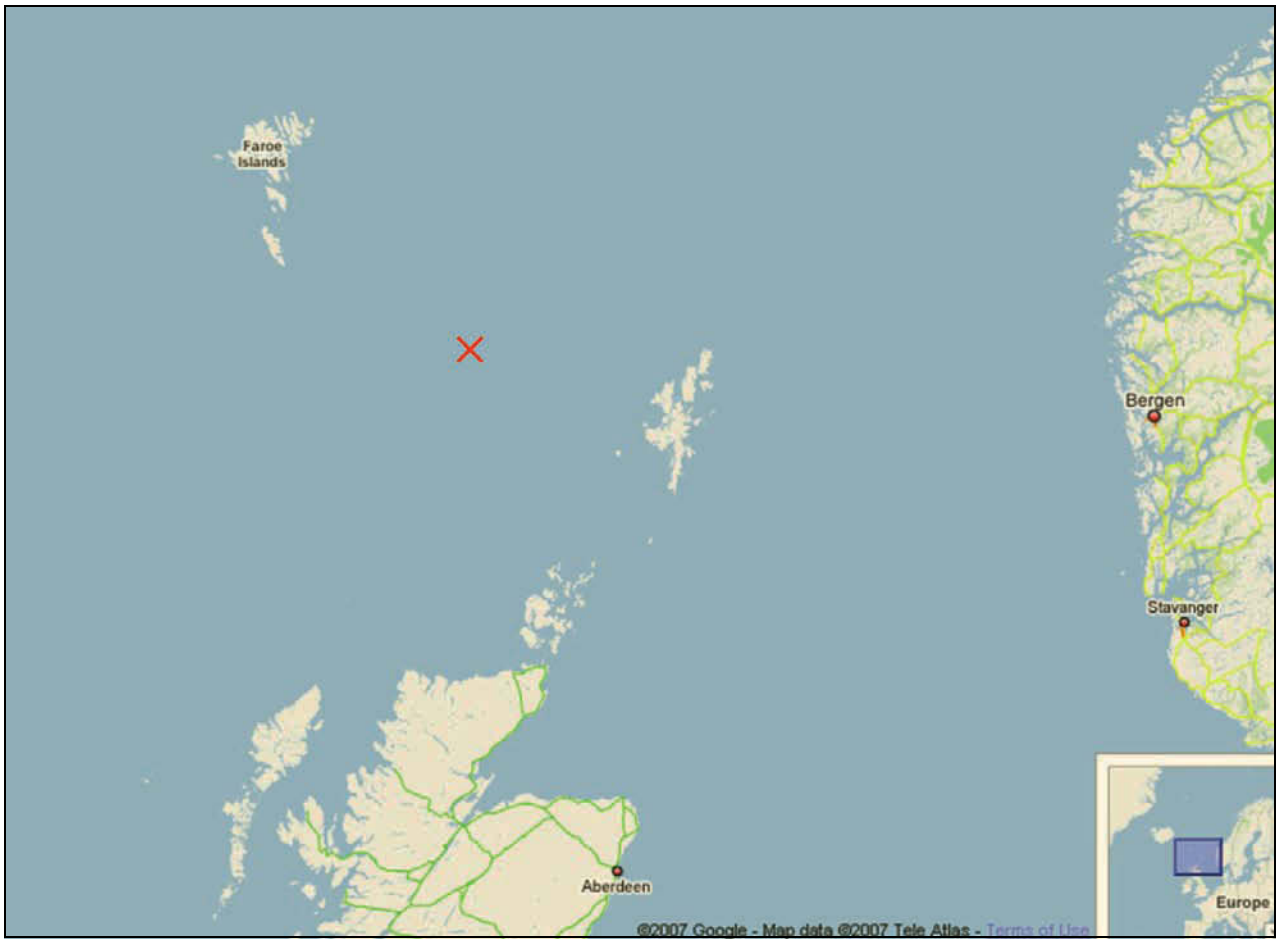
Harvey Wilks was certified as deck officer with 10 years' offshore experience in the position as control room officer and, in unspecified periods, as reserve OIM. He was serving as towmaster for the first time on the "Transocean Rather".

J. G. Sapsford is certified as a ship's master with an OIM certificate in addition. He has eleven years' practice as a barge supervisor and an OIM. From 2002 he has been marine representative in different offshore projects including rig moves.

Navigation Engineer

The navigation engineer handles the positioning equipment used during the rig move and assists the vessels with navigation-related questions. Martin Allan Troup, of Trident, was on duty when the accident occurred.

A more detailed description of work assignments and responsibilities during the rig move is provided in the RMP (Sections 2.3 and 2.4), see Annex 1, Section 3.7.



Figur 6.2 The Rosebank Field

6.5 The making of the contract between Chevron and Transocean

Chevron is the operator and one of the licensees on the Rosebank field west of Shetland. Chevron prepared the programme for drilling of appraisal wells. On 31 July 2005 Chevron and Transocean signed the contract for delivery of the rig in order to drill three appraisal wells in three different locations, which demanded three separate rig moves. Chevron's maritime specialist testified that they were originally to start drilling in March 2006 but that this was delayed because the rig was still working for another customer. The contract presupposed that the rig met Chevron's operational requirements.

Trident was hired by Chevron in order to provide the following maritime services in connection with the rig move:

- Mooring analyses
- Rig move procedures (RMP) and presentation of these on board the vessels
- Navigation equipment with personnel
- Chevron marine representative for the rig moves

Trident also acquired personnel to perform the towmaster functions.

6.6 Choice of mooring system and installation method

6.6.1 Provisional mooring analyses

According to provisional mooring analyses made on 10 May 2005, it was possible to moor the rig in March and April months with the rig's permanent mooring system as described in Section 6.3, modified with chains inserts and wire. This system satisfied the requirements of DNV POSMOOR 1996. At that point no analyses for year-round operations had been done. The analyses were based on the "Transocean Rather West of Shetland mooring and riser analyses environmental data" (Annex 1, Section 4.2). In a meeting between the parties on 6 June 2005, it was decided that the rig should be moored with chain inserts, which is the heaviest solution, but, according to the parties, the only solution that would meet POSMOOR design requirements for year-round operations on the Rosebank felt.

Chevron, Transocean and Trident have pointed out that a chain system ensured that sufficient anchor line would be lying on the bottom under all conditions, thereby preventing the anchors being lifted up.

Polyester was considered at an early date. According to Trident's representative, this proved unobtainable, nor could it – for technical reasons – be combined with the rig's mooring wires.

6.6.2 Final mooring analyses

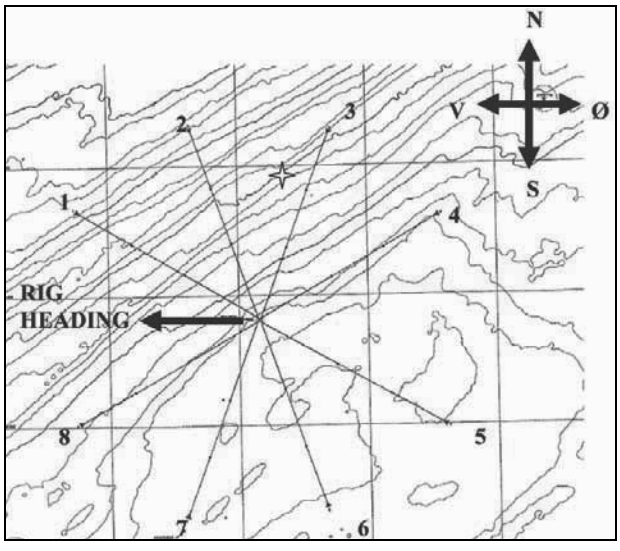
Trident prepared a new mooring analysis on 21 July 2005, see Annex 1 Section 3.2, which concluded that they needed:

- Water depth 1,189m
  - 915m 76mm chain inserts for mooring in the months December to February
  - 381m 76mm chain inserts for mooring in the months March to May
- Water depth 1,098m
  - 762m 76mm chain inserts or mooring in the months December to February
  - 302 m 76mm chain inserts for mooring in the months March to May

On the basis of Trident's specifications, Chevron hired eight lengths of about 914m 76mm chain from International Mooring Systems. The same mooring system was planned for all three locations.

6.6.3 Choice of installation method

Chevron chose a conventional mooring system in preference to the possibility of pre-laying the anchor and the mooring system. The reason for this



Figur 6.3 The mooring pattern of the "Transocean Rather"

choice was first and foremost negative experiences (loss of buoyancy buoys) with a pre-lay system for the rig at a location on the margin of the Atlantic.

6.7 The rig move to 213/26-1z Rosebank - Location "G"

The original plan was to move the rig from Shell's Benbecula field and moor it on the first Chevron field, Location G. Due, however, to technical problems with departure from the Shell field, in August 2006 it was decided to tow the rig to Invergordon in order to perform the necessary repairs. The first rig move for Chevron was therefore the towing of the rig from Invergordon to Location G, where it was moored on 25 October 2006. The rig move from Invergordon to Location G took 14 days 15 hours (Annex 1, Section 3.7). The vessels used during this move were the "Highland Valour", the "Highland Courage", the "Normand Neptun" and the "Mærsk Leader".

The procedures for this rig move were prepared by Trident.

6.8 The planning of the rig move to Location "I"

After the mooring at Location G commenced, the players began their preparations for the move to Location I. Trident's Sean Johnson testified before the Commission that they gained some experience from the move to Location G. Among other things the chasing system did not work, so that they had to use J-chasers, see Figure 6.4. Because of the forces and weight during deployment of the anchors at Location G, there were problems with the winches on the rig. The problems that arose were not with the tension, but with the winches' dynamic braking system, which was not dimensioned for the weight of the extra chain. On this rig move they burnt out a set of disc brakes while running out chain. More information on the winch problems during the rig move to Location G will be found in Annex 1, Section 3.7.

In order to reduce the winch loads on the rig, it was decided to use a two-boat solution to deploy each of the anchors. In addition five vessels were specified instead of four; one vessel was to be used as a pure towing and grappling vessel.

Figur 6.4 Lockable J-chaser

6.9 Rig Move Procedure for Location "I"

The latest revision of the rig move procedure (RMP) is dated 16 March 2007, see Annex 1 Section 3.10. Planned time for the rig move was five days eight hours.

6.9.1 The vessels

Page 5 of the RMP says that five anchor-handling vessels shall be available for the operation, four "primary" vessels plus one towing vessel.

Page 16 of the RMP shows the vessels nominated as follows;

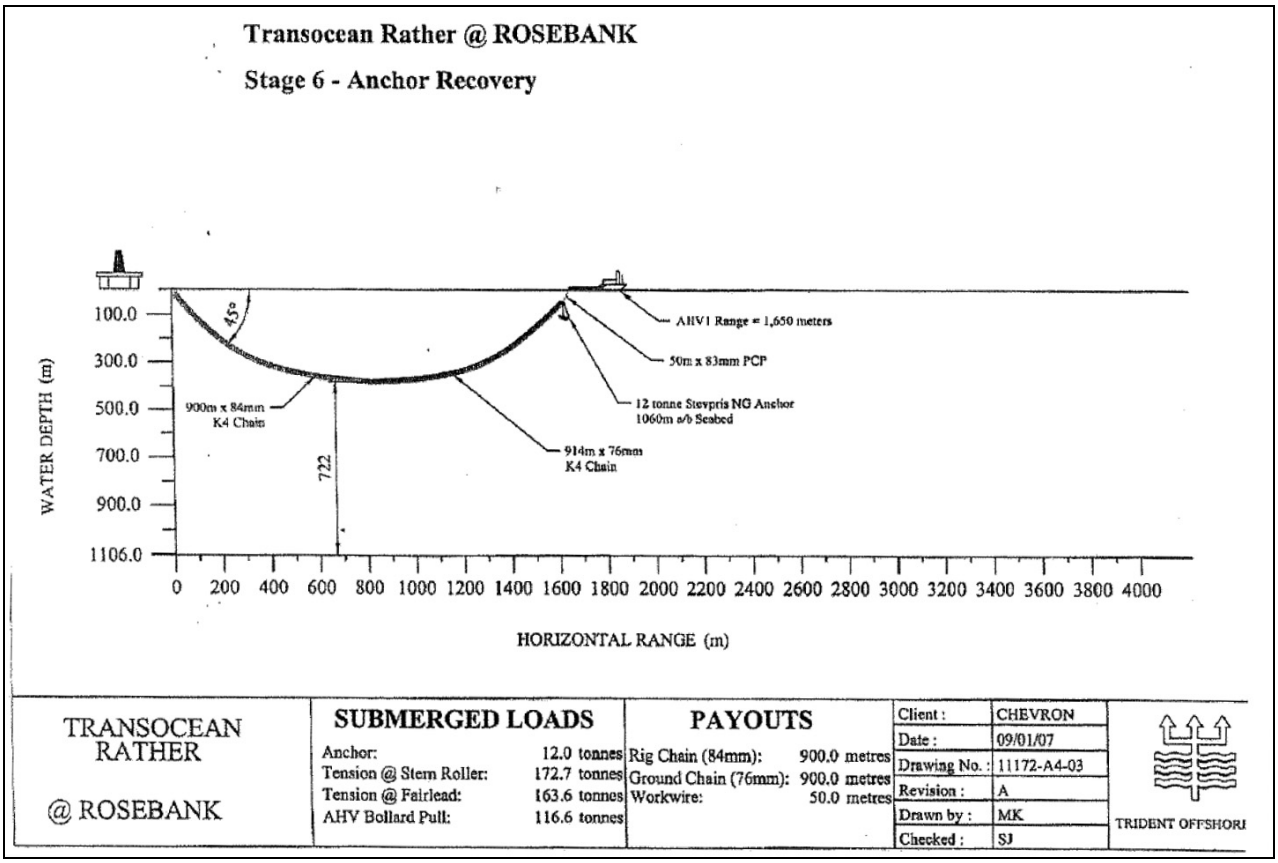
AHV A – Primary vessel
AHV B – Primary vessel
AHV C – Assist vessel
AHV D – Assist vessel
AHV E – Towing and grappling vessel

On page 17 of the RMP it is stated that all AHVs shall have a minimum bollard pull of 180 tonnes and the towing vessel one of 150 tonnes. In addition, it is here defined what kind of equipment each of the four anchor-handling vessels shall be able to take on board.

- All the vessels shall have gypsy for 76mm chain
- One AHV shall have gypsy for 84mm chain
- A J-chaser
- A grapnel

It is thereafter described that the primary vessels must take on board the following equipment:

- One 2300m 84mm work wire
- Capacity for three 914m 76mm chain inserts
- Chain gypsies for 76mm chain
- Capacity for 900m 84mm chain



Figur 6.5 Anchor recovery – Stage 6

It is thereafter described that the assist vessels must take on board the following equipment:

- One 2,300m 84mm work wire
- Capacity for a 914m 76mm chain inserts

It follows from this that also each of the assist vessels were to recover and deploy a primary anchor and chain inserts.

The RMP did not make any explicit requirements for the vessels' winch capacity.

6.9.2 Recovery of the secondary anchors (nos. 2, 3, 6 and 7)

Recovery of anchors is done by the anchor-handling vessel paying out work wire and going out to the anchor along the chain with the aid of a J-chaser, see Figure 6.4. The procedure states that one shall not operate with more than 150 tonnes tension on the AHV winch in "breaking" of anchors without the towmaster's permission.

The anchor is "broken" loose from the seabed with the aid of the vessel's winch. In cases where the chain has sunk into the seabed, the AHV lifts the chain loose from the seabed by using her winch. Thereafter the rig and the AHV winch in the wire at the same time as the AHV follows the chain until all the wire has been winched in. With the anchor under the stern roller there is only chain between the rig and the vessel, as shown in Figure 6.5.

In order to make a controlled decoupling of the chain inserts, an assistant anchor-handlings vessel is used to take the weight of the chain about 300m aft of the primary vessel with the aid of a grapnel, see Figure 6.6. This is to facilitate the anchor's placement over the stern roller for subse-

Figur 6.6 Grapnel

quent uncoupling from the chain. The chain inserts are then stored in the primary vessel's rig chain locker and the anchor remains lying on deck. The rig chain is thereafter winched in and the end transferred to the rig with the aid of the Permanent Chaser Pennant (PCP).

6.9.3 Recovery of primary anchors (nos. 1, 4, 5 and 8), towing to Location "G"

It was a requirement of the procedure that all the four primary anchors be broken loose at the same time. When all of the anchors have been broken loose from the seabed, but not lifted, the towing vessel shall connect herself to tow cables and assist in holding the rig in position. When the tow has been secured (i.e., the towing vessel connected to the rig), recovery of the anchors can begin. When the anchors are at the stern roller, see Figure 6.5, the tow can begin. When the rig is within 50 metres of its location, the towing vessels are uncoupled and made ready to assist as grappling vessels in the deployment of anchors.

6.9.4 Deployment of anchors

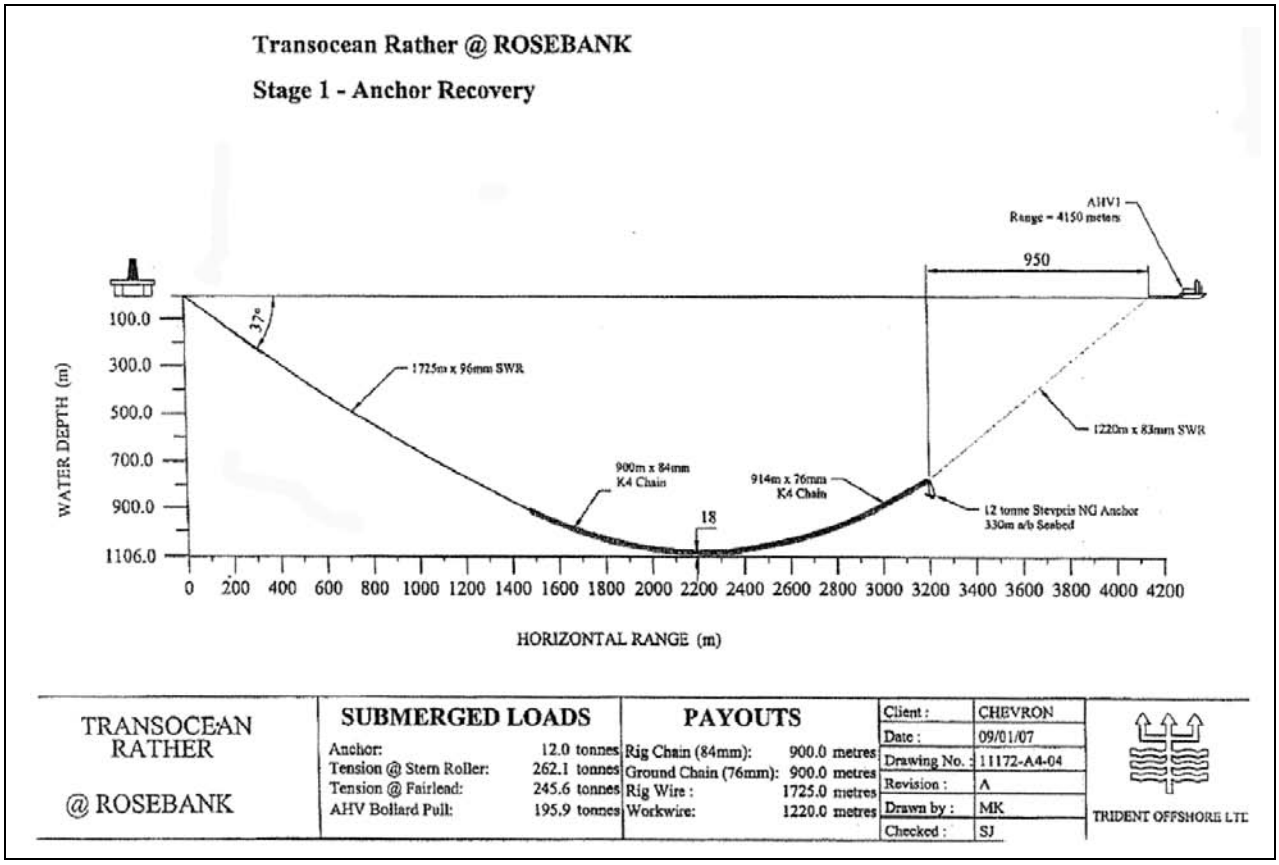
According to RMP, primary anchor no. 4 (see Figure 6.3) is the first anchor deployed. Deployment of the anchors is thereafter a pure reversal of the recovery process described above. The anchors are deployed in pairs and diagonally. During deployment of the anchors, grappling will proceed about 200 metres from the rig's winch. After the anchors have been run out, they are pre-tautened with the aid of the rig's winch. After all four primary anchors have been deployed, the rig is stabilised at the location.

6.9.5 Requirements for bollard pull

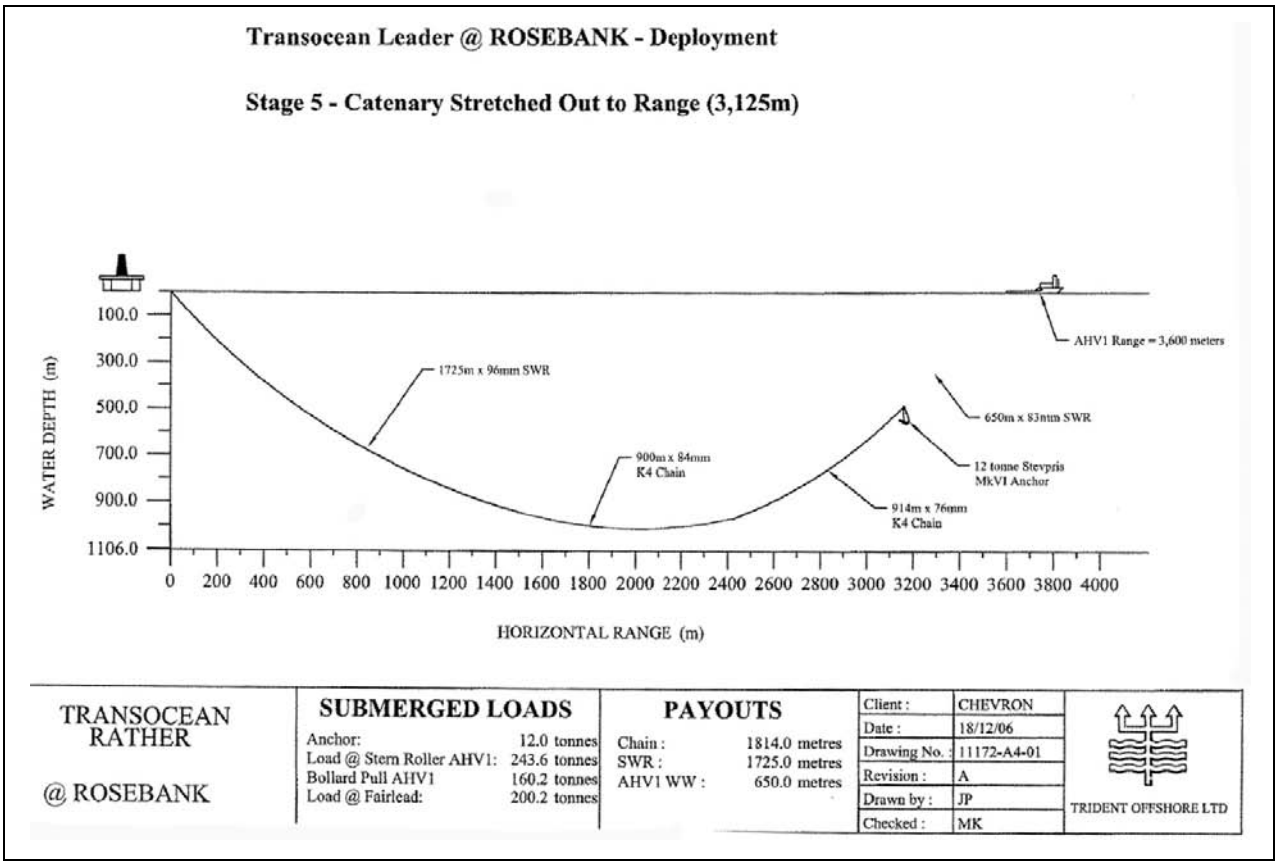
The calculations in the RMP focused on:

- Tension in mooring line and workwire
- Requirements for the anchor-handling vessel's bollard pull
- Vessel positions in relation to the rig
- Anchor positions over the seabed
- Mooring line's angles with the fairlead, and
- Necessary length of workwire.

In the analyses made for recovery and deployment of anchor, static forces due to the weight of chain and wire were calculated. Trident thereafter made simplified dynamic analyses exclusively in a head sea for the conditions that resulted in the



Figur 6.7 Anchor recovery – Stage 1



Figur 6.8 Anchor recovery – Stage 5

Source: copied direct from the RMP.

highest static forces. In these analyses the movements of a typical middle-sized anchor-handling vessel was calculated in a maximum wave of 4.0 metres (Hs approximately 2.2 metres), which resulted in a 2.0-metre heave movement, according to the RMP. This heave movement was modelled as a regular movement at the end of the mooring lines and the forces were then calculated. The effect of neither the pitch nor the surge was taken into account in these dynamic force calculations.

For the recovery analyses, stage 1 (see Figure 6.7) resulted in the greatest forces. Forces due to the weight of just the mooring lines were 262 tonnes at the vessel's stern, which resulted in a necessary bollard pull of 195.9 tonnes. In addition to these forces, calculated total external weather forces due to wind, current and wave drift were calculated at 10.9 tonnes in a head sea and 48.8 tonnes in a lateral sea. The static forces were calculated for maximum waves of 4.0m with a period of 8.5s, current speed of 1.0m/s and wind speed of 10m/s. Current against the mooring lines was not taken into account in these calculations, as confirmed in the Commission's questioning of Martin Kobiela. According to the simplified dynamic calculations, one would then see forces up towards 318 tonnes on the vessel's winch.

To quote from Sean Johnson's testimony before the Commission:

> "This is an alternative task that might be relevant, but that was not necessary. The information in the curves is set up for the sake of the towmasters. The weight of the vessels was therefore much lower in recovery of anchors, because the chain could lie on the seabed and not much bollard pull was required for recovery. The vessels did not, therefore, have any high requirement for bollard pull in this stage. It was of no significance that the chain was dragged along the seabed. Johnson also explained Stage 3 of the recovery of anchors, see p. 58 of the procedures, to Reiersen, where he (Johnson) thinks the load was 136 tonnes, which was the maximum bollard pull that Johnson expected during the mooring recovery method."

How this was communicated to Captain Frank Reiersen is discussed in more detail in Section 8.1.

For the deployment analyses, step 5 (see Figure 6.8) resulted in the greatest forces. Forces due to the weight of just the mooring lines were 243.6 tonnes at the vessel's stern, which resulted in a necessary bollard pull of 160.2 tonnes. In addition to these forces, total external weather forces due to wind, current and wave drift were calculated at 10.9 tonnes in a head sea and 48.8 tonnes in a lateral sea. The static forces were calculated for maximum waves at 4.0m with a period of 8.5s, current speed of 1.0m/s and wind speed of 10m/s. Current against the mooring lines was not included in these calculations.

According to the simplified dynamic calculations, in Stage 5 forces approaching 292 tonnes on the vessel's winch would then be seen.

6.9.6 Weather criteria

Under Section 6.5.3 of the NWEA guidelines for anchor-handling, the rig move procedures shall contain weather criteria (the worst weather in which the operation can be performed) and weather window (weather forecasts that indicate that the operation can be performed within a given period), so that applied analyses and the basis for these can be handled so as to secure a controlled operation.

Chevron's Marine Operations Manual applies to Trident, who prepared the procedure. The weather criteria in the manual were thus to be followed by Trident.

It appears from the manual's Section 9.5.1 (Mooring and anchoring patterns) that a rig move procedure shall include the following:

> "The maximum weather limits for working and stand by conditions including maximum expected anchor line tension where required." *(original in English)*

Section 4.6.3 of the manual (Vessel details) states further that:

> "Contractor shall as a minimum provide the following details of all vessels working in the spread when anchoring
>
> 1. The minimum bollard pull necessary to hold the vessel at all drafts against the worst anticipated tidal stream, 40knot wind, and a 6 meters sea all acting in the same direction. The maximum and minimum bollard pull required depending on the direction of the weather relative to the vessel.
> 2. Limiting environmental conditions for operating
> 3. Propulsion and positioning systems" *(original in English)*

With reference to Table 4 on page 23 of the RMP, Martin Kobiela testified before the Commission that the indicated values are used only in the mooring analysis, but merely as a "rough guide" for maximum criteria. There are thereby no specific weather criteria for the operation. The weather conditions referred to in the RMP's mooring analysis are:

- Maximum waves of 4.0m, with a wave period of 8.5s
- Current speed 1.0 m/s (1.94 knots)
- Wind speed 10 m/s (19.4 knots)

Kobiela also testified that those performing the operation must continuously consider whether the weather conditions are satisfactory. This is evaluated there and then by the participants. There is no assessment in the RMP of how much downtime due to the weather conditions was expected during the operation.

6.9.7 Risk assessments and plans for alternative situations (contingency planning)

As described in detail in Section 3.7.2, the NWEA guidelines for anchor-handling demand that risk assessments be performed for the operation.

Section 1.2.2 (Responsibility) of Chevron's Marine Operations Manual lays down the following regarding plans for alternative situations (contingency planning) and risk handling;

> "ChevronTexaco has a duty of care to ensure that all work is carried out with minimum risk to all personnel and facilities. To that end, operational procedures shall be submitted early so that prior to approval, all parties can be consulted and as necessary a risk assessment can be undertaken to identify potential major hazards and demonstrate that adequate procedures and safe guards are in place to mitigate against potential hazards and their consequences prior to mobilisation. This shall also ensure that ChevronTexaco and the Marine Contractor Safety Management Systems complement each other" *(original in English)*

It is further stated in Section 1.2.3 (Clarification):

> "To make clear the ChevronTexaco policy and attitude to standards and responsibilities re-

garding the way in which marine operations are planned and carried out at any of the ChevronTexaco sites". *(original in English)*

Section 4.6.5 (Contingency plans) states that:

"The offshore unit/vessel operator shall submit a step by step contingency plan. Actions and listing showing the responsibilities in the event of an emergency which shall include but not be limited to the following: […] sudden deterioration in weather" *(original in English)*

Section 4.12.1.6 (Information required) has the following to say:

"The Contractor will be required to submit the following information to ChevronTexaco for review:- […] HAZOP documentation and safety plan" *(original in English)*

Identified scenarios that according to the RMP can demand planning of alternative situations are:

- Problems reaching the anchor by use of J-chaser
- PCP fracture near the rig
- Fracture of PCP during deployment of anchor wire.

The risk assessments in the RMP cover only handling of technical problems that can be expected to arise during recovery and deployment of anchors. Risk assessments related to the safety of the rigs and the vessels are not discussed.

6.10 Evaluation

In the Commission's opinion, there exist several weaknesses in the planning of the rig move. Key elements are composition of the maritime manning on the rig, choice of mooring system and installation method, method of calculating necessary bollard pull and winch capacity plus lack of concordance between estimated and actual weather. The biggest and most serious weakness in the RMP is nevertheless the fundamental lack of risk analyses and identification (HAZID) and the handling of unforeseen events (contingency planning).

6.10.1 Maritime manning on the "Transocean Rather"

Section 6.1 of the NWEA demands that rig personnel must know the participant vessels' operational limitations. The OIM's formal and practical expertise in maritime operations was limited, which is why the follow-up operational authority was delegated to the towmaster hired for the rig move. The towmaster is without affiliation with the participant organisations.

The barge supervisor was the member of the permanent rig crew with the greatest maritime expertise and during the rig move provides peripheral maritime assessment support to the OIM. During the rig move he had the primary responsibility for winch and ballast operations. Overall responsibility for handling safety is vested in the OIM. The towmaster, who in practice led the maritime operation on behalf of the OIM, had not participated in the preparation of the RMP including risk assessments. This helped to remove or weaken necessary safety barriers of a human character. To the extent that the maritime expertise is not located on the highest level of command, it is essential that there be close and good communication between the possessor of that maritime expertise and the person in supreme command on board the rig throughout the rig move. In the planning phase, a high level of maritime expertise is required to handle safety.

O'Malley claimed to the Commission that he was not informed about important non-conformances during the operation – the drift from the run-out line for anchor nos. 6 and 2, grappling outside the RMP and the near-miss between the "Bourbon Dolphin" and the "Highland Valour". The Commission cannot see that a system was established or implemented that secured an adequate flow of information. It is the duty of the OIM at all times to be informed about all matters of significance for the operation being performable in conformity with the RMP and in such a way that the safety of all involved parties is addressed.

Chevron's Marine Representative is charged with addressing the level of operational safety enshrined in Chevron's Marine Manual.

In addition, the doubling-up of the roles of towmaster and Chevron's Marine Representative removed an important safety barrier for the operation.

6.10.2 Choice of mooring system and installation method

In the planning phase no qualitative analyses of alternative mooring technology (wire/polyester/spring buoys) and alternative installation methods (prelaying of anchors) were performed. Use of al-

ternatives could have secured a more robust installation methodology, and less vulnerability to weather risk. In operational areas with great challenges as regards both weather and depths such as the area west of Shetland, it will always be a material contribution to safety management to make a thorough evaluation of all alternatives with regard to choice of materials and deployment methods.

6.10.3 The rig move procedure

6.10.3.1 Requirements for bollard pull

The RMP identifies requirements for bollard pull due to the weight of the mooring lines alone as 160.2 tonnes during deployment of anchor. In addition to this, the RMP estimates 10.9 tonnes in static forces on the vessel in a head sea and 48.8 tonnes in a lateral sea with 4m max waves, 1 m/s current and 10 m/s wind.

During deployment of the anchors there will be a probability that some of the vessels will have to deploy the mooring line in a lateral sea and/or a head sea. In the case of the "Bourbon Dolphin", we have heard testimony that the use of full side thrust reduces the bollard pull to 125 tonnes (see Section 5.5 for a more detailed explanation). This reduction will vary from vessel to vessel, but such a reduction is not unusual for a medium-sized anchor-handling vessels. In addition to this, the bollard pull will be highly reduced due to the vessel's movement in the waves, the reduction of the bollard pull will naturally increase with deteriorating weather.

The RMP refers to the fact that the static forces on the vessel are calculated to take account of for the reduction in bollard pull. The Commission cannot see how this is taken account of in the RMP and has made repeated requests for a detailed explanation. After the hearing the Commission received two reports from Martin Kobiela. He was not successful in justifying the requirement for 180 tonnes bollard pull; see Annex 1, Sections 3.14 and 3.15.

In calculating the expected static forces in a lateral sea, the RMP does not include forces acting on the vessel due to current against the mooring lines. In a 1.0 m/s uniform current for deployment of anchor stage 5, forces acting on the AHV due to current forces against the lines have been calculated as up to 20 tonnes. Such a load means that the RMP has underestimated the static forces by around 35%. Increasing wind, waves and current will yield markedly increasing static forces (wind and current forces are proportional to the square of the speed). The weather criteria employed in the above analyses are not reflected in the RMP as operational limitations and are consequently not a reference-point for safe operations.

Given the navigational data, the Commission is able to note that the "Bourbon Dolphin" was drifting before the weather from 13:45, which indicates that she did not have sufficient thruster capacity to keep herself along the deployment line. The probable cause of the drifting around this time is thought to be increasing current forces across the mooring lines due to increasing chain lengths plus a general deterioration in the weather situation.

The Commission also finds it relevant to refer to calculations of necessary bollard pull in a head sea shown in the RMP. As mentioned above, the static forces from the weight of chain and wire alone come to 160.2 tonnes. In addition, account must be taken of 10.9 tonnes in static forces plus current forces against the mooring lines, which the Commission estimates at 3 tonnes. Exclusively static forces will thereby demand a minimum of 174 tonnes in continuous bollard pull. The static forces are calculated in a weather situation that was considerably milder than the real one at the time of the accident. As mentioned above, in addition the effective bollard pull is severely weakened due to the vessel's movements. The 180 tonnes bollard pull standard is therefore too low.

The Commission also finds weaknesses in the calculations of tension to be found in the RMP. As mentioned above in Section 6.9.5, only simplified dynamic calculations were made. The Commission has performed its own calculations that confirm the static loads on the mooring line in the RMP. A maximum winch tension of 292 tonnes was calculated for deployment of anchors in the RMP. These analyses have been calculated with a 4m max wave (significant wave height, Hs, approx 2.15m). If we take account of the vessel's real movement, these forces will increase by an estimated 10-15%, depending on the vessel's movement characteristics. As Kobiela mentions in his report to the Commission (Annex 1 Section 3.15), it is normal to set Hs from 3.5 to 4.0m for anchor-handling. Corresponding analyses in a 4.0m Hs would have given an estimated increase of 25%. In normal practice for addressing safety factors one would have used a design criterion of Hs 5.0m for an operational criterion of 4.0m Hs (explained in greater detail in Section 3.8). Corresponding analyses with Hs 5.0m would have yielded an estimated increase of 30%.

Such an underestimate of forces could have caused an overload of the vessel's winch capacity.

6.10.3.2 Weather criteria

In the opinion of the Commission, it merits criticism that the RMP was not in conformity with the requirements of NWEA plus internal Chevron requirements (40 knots wind and 6 metre waves) as regards weather criteria. This is described in greater detail in Sections 3.7 and 6.9.6. Clear weather criteria shall be established in an RMP. It is expected that weather criteria are unambiguously communicated in the RMP as an important safety barrier. The forces appearing in the analyses were incomplete and defective and unsuited to visualising the forces one could expect to encounter during the operation. This had significance for both requirements for bollard pull and for winch forces.

It appeared from the RMP that, before the operation was implemented, weather forecasts would be obtained and a weather window identified in order to execute the operation in a safe manner. The Commission would question whether it is possible to identify such a weather window while lacking clear requirements for weather criteria. Both Chevron's and Trident's representatives have told the Commission that clear weather criteria can be unfortunate and counter-productive. Chevron's marine manual, however, makes unambiguous requirements for clear weather criteria.

The Commission is of the opinion that maximum weather criteria can hardly be an obstacle to safe operation but on the contrary a material element of the risk analyses. The weather criteria can be handled as a reference for suspension of the operation in an unfortunate combination of waves, wind and current. All RMPs ought to define that the stated weather criterion is an upper limit for safe operation and be continuously evaluated by the person responsible for the operation.

6.10.3.3 Risk assessments and plans for alternative operations (contingency planning).

Chevron lays down in its system of procedures that their operations are to be planned and executed with minimal risk. The operator has argued that the RMP is a coherent risk analysis in which the risks are continuously handled for all stages.

In the Commission's opinion the procedure lacks an integrated and comprehensive risk analysis for the operation as a whole, despite such a requirement being enshrined in Chevron's and Transocean's operational manuals. In addition, the NWEA guidelines contain provisions about this. The RMP lacks formal HAZIDs and HAZOPs, and by and large lacks solutions for alternative operations (contingency planning).

As described in Section 3.6.2, it is the Commission's opinion that under British acts and regulations the employer has the responsibility for preventing people other than his employees being exposed to risk, as long as this is "reasonably practicable".

Witnesses from the operator and rig testified before the Commission that they did not regard it as foreseeable that an anchor-handling vessel could roll over, and consequently that no risk measures for such a scenario were prepared. Given that capsizing has for many years been a frequent cause of accidents at sea, the Commission can by no means concur in such reasoning. That there has been only a single capsize of an anchor-handling vessel does not mean that we can deduce that such vessels are incapable of capsizing. In the Commission's opinion, therefore, "reasonably practicable" measures could in a simple manner been taken to minimise the risk, by for example an attention zone around anchor run-out lines, see Section 13.9.3.

Moreover, witnesses from the operator and rig have argued that it is the vessels themselves that must address their own safety. To this the Commission would remark that even if the vessels ought to have prepared adequate risk assessments, this does not relieve the operator of his paramount responsibility for addressing the safety of all involved parties.

It follows from Chevron's marine manual and the NWEA guidelines that the operator must ensure that risk analyses concerning the participating vessels are prepared before the operation starts. Neither during the start-up meeting onshore or on arrival on the field did the rig ask for the vessels' internal risk analyses. This was confirmed by Captains Reiersen and Bergtun during questioning. Reiersen also testified that normally the vessels send their risk assessments to the rig. From what the Commission has been given to understand, it is not usual for the vessels to send the risk analyses to the company.

There has been a failure to consider what might go wrong between vessel and rig and between participant vessels. In order to reduce the tension on the rig, it was decided to use a two-boat solution in the anchor-handling operation. Use of

two vessels near to one another increases the risk for the involved parties. Handling of great forces between two vessels may unleash uncontrolled forces against the one vessel in the event of unforeseen events such a wire breaking or a grapnel being lost. It may also cause uncontrolled near-miss situations, as was experienced shortly before the accident. That the vessels were operating in a tough weather and current environment with great mooring weights increased the risk picture further. If, instead, a lighter mooring system or presetting of anchors had been considered, the risk could have been reduced considerably.

Transocean's system of procedures demands that special risk analyses (HAZOP) be undertaken in multi-vessel operations. The Commission perceives this as applicable to rig moves. Such a multi-vessel risk analysis is totally absent from the RMP.

Nor had the RMP performed risk analyses for the case that a vessel did not follow the run-out line as shown on the navigation plot. At such depths and such heavy-weather areas to which the RMP applied, the risk analysis should also include the consequences of an anchor being deployed in the wrong position.

In addition the Commission notes the insufficient alternative operational solutions (contingency planning). Chevron's marine manual contains comprehensive requirements for contingency planning. Over and above the three concrete cases discussed in Section 6.9.7, contingency planning is absent from the RMP. Requirements in the operating systems of the participant operators were not reflected in the RMP. Even if Trident had prepared a RMP, it was Chevron Marine HE&S, Richard Macklin, who was supposed to ensure that the operational requirements in the Chevron marine operations manual were conformed to in the planning and execution of the operation.

Chapter 7
The vessels

7.1 The chartering of the anchor-handling vessels

Under the contract between Chevron and the "Transocean Rather", Chevron was responsible for acquiring sufficient vessels to move and moor the rig. The vessels were hired from the spot market before the operation was to start. Spot contracts for vessels are normal: the shipbroker prepares and transmits lists of available vessels that meet the operator's vessel specifications. On the basis of the shipbroker's list of vessel specifications and price offers, the vessels are chosen – often shortly before the rig move is to begin.

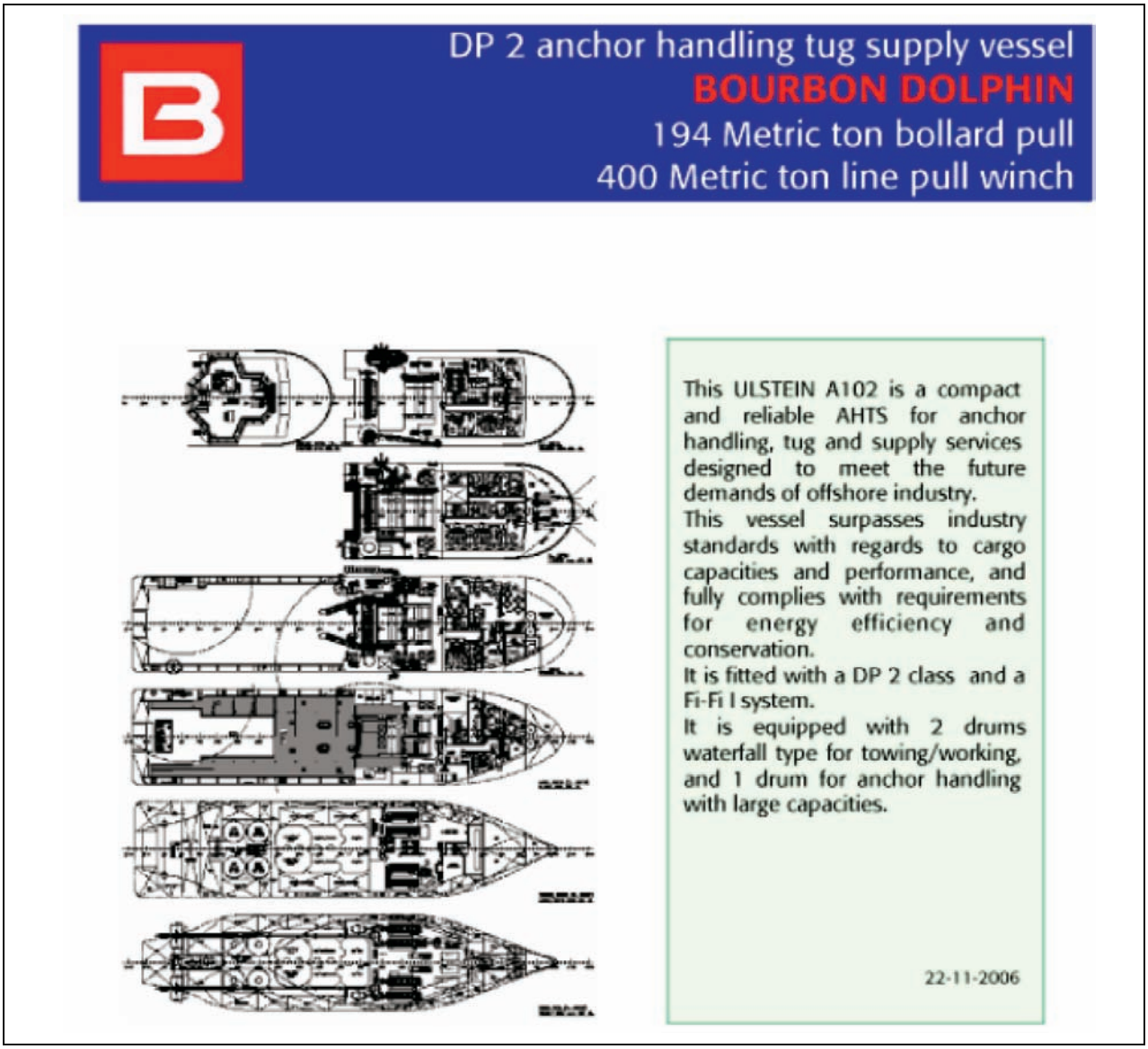


Figure 7.1 The "Bourbon Dolphin" specifications

On the basis of expected loads, chain weights and lengths of workwire etc., Trident had prepared vessel specifications for Chevron. A minimum bollard pull of 180 tonnes and winch capacity of 400 tonnes was recommended. In preparatory meetings, in which also TEAM Marine and the shipbrokers, the Stewart Group, participated, the involved parties reviewed the vessel specifications.

TEAM Marine is a logistics organisation that, under the coordination agreement between Chevron and other oil companies, operates to achieve coordination and efficiency in the hire market and use of offshore supply and service vessels in the North Sea area. TEAM Marine is not a separate legal entity, does not have employees of its own and does not sign contracts in its own name.

TEAM Marine collaborates closely with the Stewart Group, whose mission is to find available vessels that meet the requirements from TEAM Marine's members, and to broker contracts with the companies. The Stewart Group operated on the basis of a shortlist of available vessels that met requirements for winch capacity, brake capacity, rig chain locker capacity and bollard pull for this concrete rig move.

In the sales prospectus the "Bourbon Dolphin" was described as a DP anchor handling tug supply vessel, 194 tonne bollard pull, 400 tonne line pull winch, see Figure 7.1, and was marketed by the company as a deep-water anchor-handling vessel. In the Ulstein Group's website of February 2007, the vessel was described as designed to handle anchors and mooring lines in deep water. On 26 March the "Bourbon Dolphin" was inspected by the Stewart Group's maritime inspectors in Aberdeen and accepted. At the same time the "Olympic Hercules" was chartered for the assignment. Because of winch repairs on the rig there was no need for four vessels from the outset.

The contract between Chevron and Bourbon Ships was signed on 26 March 2007. The hire period was stated as "Day by day hire for the Transocean Rather rig move" with a rate of GBP 50,000 per day excluding fuel. In connection with the chartering the vessel was visited by Sean Johnson of Trident, who on behalf of Chevron introduced the RMP on board, see Section 8.1. In the Transmittal Form (Trident Offshore Limited) signed by Captain Frank Reiersen, the vessel was designated "AHV C", see Annex 1, Section 3.11.

A week later the "Highland Valour" and the "Vidar Viking" were chartered for the assignment.

7.2 Overview table with key data

The table below shows the five vessels involved in the operation of moving the "Transocean Rather". Sections 7.3 to 7.5 provide a more detailed description of the vessels. The towing vessel "Sea Lynx", which in the Rig Move Procedure was assigned the role of Vessel E (tug), had a peripheral role in the accident and is not described further.

Table 7.1 Overview table of involved vessels

	Bourbon Dolphin	Highland Valour	Olympic Hercules	Vidar Viking	Sea Lynx
Gross Tonnage (t)	2,974	3,160	4,477	3,382	2,556
BP continuous (t)	180	180	250	205	173
LOA (m)	75.2	80	82.1	83.7	73.5
B (m)	17	18	20	18	16.4
Winch pulling-power (mt)	400	500	500	400	300

7.3 The "Highland Valour"

The anchor-handling vessel "Highland Valour" has the following specifications;

Name:	Highland Valour
Type:	630 – Supply Vessel/Tug
Gross Tonnage:	3,160
Class Notation:	ICE-C Tug Supply Vessel SF E0 CLEAN DK(+) HL(2.8)
Constructed at:	Aker Tuleca SA
Outfitting Yard:	Søviknes Shipyard AS
Construction year:	2003 - 07
Port of Registry:	London
Flag state:	The United Kingdom
Owner:	Gulf Offshore (NS) Ltd
Operator:	Gulf Offshore (NS) Ltd
Address:	184-192 Market Street, Aberdeen
Country:	United Kingdom

Technical Data	
Bollard Pull cont.:	180 tonnes
Winch pulling-power:	500 tonnes
Length overall:	80 m
Beam:	18 m
Depth:	8 m
Draught:	6.6 m
Net weight:	1,187 tonnes
Deadweight:	2,989 tonnes

Figure 7.2 The "Highland Valour"

The master of the "Highland Valour" was Gordon Keith Williams, who has almost 30 years' experience of anchor-handling. Chief Officer John Hugh Dunlop has over 20 years experience at sea, of which the last twelve from anchor-handling. Chief Engineer Richard Stuart Ogley has 25 years experience at sea, first and foremost from various offshore vessels. First Officer Sean Mark Alexander Dickson has two years experience of anchor-handling. All these were questioned by the Commission.

7.4 The "Olympic Hercules"

The anchor-handling vessel "Olympic Hercules" has the following specifications;

Name:	Olympic Hercules
Type:	630 – Supply Vessel/Tug
Gross Tonnage:	4,477
Class Notation:	ICE-C Tug Supply Vessel OILREC SF E0 DYNPOS-AUTR DK(+) HL(2.5)
Constructed at:	Ulstein Verft AS
Outfitting Yard:	Ulstein Verft AS
Construction year:	2002 - 01
Port of Registry:	Ålesund
Flag state:	Norway
Owner:	Olympic Ship AS
Operator:	Olympic Shipping AS
Address:	P.O. Box 234, Fosnavåg
Country:	Norway
Technical Data	
Bollard Pull cont.:	250 tonnes
Winch pulling-power:	500 tonnes
Length overall:	82.1 m
Beam:	20 m
Depth:	9.6 m
Draught:	7.5 m
Net weight:	1,343 tonnes
Deadweight:	3,750 tonnes

The master of the "Olympic Hercules" was Grim Are Bergtun. He has eight years experience of anchor-handling, of which inter alia 1 ¾ years as master and 3 ½ years as Chief Officer. Bergtun testified before the Commission.

Figure 7.3 The "Olympic Hercules"

7.5 The "Vidar Viking"

The anchor-handling vessel "Vidar Viking" has the following specifications;

Name:	Vidar Viking
Type:	630 – Supply Vessel/Tug
Gross Tonnage:	3,382
Class Notation:	ICE-10 Icebreaker Tug Supply Vessel SF HELDK-SH E0 DYNPOS-AUTR NAUT-OC DK(+) HL(2.8)
Constructed at:	Havyard Leirvik A.S
Outfitting Yard:	Havyard Leirvik A.S
Construction year:	2001 - 02
Port of Registry:	Skärhamn
Flag state:	Sweden
Owner:	Transviking Icebreaking & Offshore AS
Operator:	Company AB Transatlantic
Address:	Box 32
Country:	Sweden
Technical Data	
Bollard Pull cont.:	205 tonnes
Winch pulling-power:	400 tonnes
Length overall:	83.7 m
Beam:	18 m
Depth:	8.6 m
Draught:	7.2 m
Net weight:	1,145 tonnes
Deadweight:	2,600 tonnes

The master of the "Vidar Viking" was Halvor Magnus Enoksen. He has five years experience in anchor-handling as master. Enoksen testified before the Commission.

Figure 7.4 The "Vidar Viking"

7.6 Evaluation of vessel inspection

National and international requirements include technical vessel specifications, crew qualifications, operational routines and system management.

In the light of the complexity of the operation in question and safety sensitivity, vessel requirements must be verified through, in varying degrees, submitted documentation and local vessel review (inspection). Direct contact with the owner may in certain cases be required in order to verify implementation of operating systems. This applies for example to owner qualification requirements and routines.

Inspection revealed a lack of vessel information to verify factors such as:

- Available bollard pull with full use of thrusters
- Maximum manageable lateral current under given conditions
- Crew qualifications
- System implementation (risk analyses)
- Basic operational procedures (anchor-handling)
- Hydrostatic characteristics.

Chapter 8
Execution of the rig move

8.1 The briefing meeting

As mentioned above in Section 3.7.2, the NWEA guidelines lay down that the rig owner is responsible for the rig move procedures being reviewed with participant vessels and key personnel, the information being understood and the risk assessment being performed.

Before the assignment commenced, all the vessels had individual briefings in Aberdeen with Sean Johnson of Trident. At the briefing the vessels received the RMP, handed over by Johnson personally. They were also given Chevron's Guidance to Vessel Masters, confer Annex 1 Section 3.4. Present at the briefing on the "Bourbon Dolphin" were Johnson, Captain Frank Reiersen, the Chief Officer, and the First Officer. The meeting lasted about one hour, which several witnesses testified is a normal time in the UK Sector. According to Captain Bergtun, on the "Olympic Hercules" the briefing lasted about 20 minutes.

At the briefing the RMP was gone through. It was not reviewed in detail, but they went through the introduction and general elements. According to Johnson, they discussed the drawings in the procedure and looked more closely at the mooring system, the rig system, wire etc. They also reviewed the seabed conditions, obstacles and what the procedure meant for the vessels. Reiersen testified that before the briefing he was not aware at what depths they would be operating, but he did know that the operation was to proceed west of Shetland.

Reiersen and Johnson have given divergent testimony about what was said at the briefing with regard to what role the "Bourbon Dolphin" was to play in the operation. According to Reiersen, it was said that expected forces could come up to 194 tonnes during anchor recovery. Reiersen claims to have objected at that point that the "Dolphin" did not have the capacity for that, given its bollard pull of 180 tonnes. In the light of the information from Johnson, Reiersen understood that the "Bourbon Dolphin" was only to be an assist vessel. By that Reiersen meant that the "Dolphin" should only grapple.

For his part, Johnson testified that it was always the plan that the "Dolphin" should recover and deploy a single primary anchor and that Reiersen was also expressly made aware that changes could be made along the way, which was also the reason why Johnson went so carefully through both the recovery and deployment of the anchors. Johnson's testimony on this is reproduced under Section 6.9.5. According to Johnson, there was no objection from Reiersen to the briefing.

After the briefing with Sean Johnson, Captain Reiersen summoned the bridge and deck crew on the "Bourbon Dolphin" for a review of the operation. Reiersen testified before the Commission that the engineers were not called in, because meetings are most concerned with the details of the use of the anchor-handling equipment.

At the briefings with the officers on the "Highland Valour", the "Olympic Hercules" and the "Vidar Viking", they were told that they would have to expect changes along the way, without it being clarified what these changes might involve. Chief Officer Dunlop of the "Highland Valour" testified that they were told to "expect the unexpected". According to Richard Macklin (Chevron), it was stated at the meetings with the "Valour" and the "Viking" that the vessels' roles could be changed along the way.

8.2 The crew change

On 30 March 2007 there was a crew change in Scalloway, Shetland, whereby Captain Frank Reiersen and his crew were relieved by Captain Oddne Remøy. Remøy was not the regular master on board, but had exchanged tours with Captain Hugo Hansen. The rest belonged to the ordinary crew of the "Bourbon Dolphin". Able Seaman Øystein Sjursen had come on board with Captain Frank Reiersen's shift, but stayed on because the mustering crew were a man short.

Captain Reiersen informed the Commission that the crew change should originally take place on 29 March, but that it had been delayed because a winch on the rig was to be repaired. Reiersen also testified that if the rig move had gone according to plan without delays, they would have waited to implement the crew change until his shift was finished with the rig move. He had, however, envisaged that they could have changed crews already in Aberdeen before the operation commenced.

In a crew change it is normal practice to conduct a so-called handover, during which the relieving shift, together with the new shift, reviews the condition of the vessel and equipment, assignments and any special circumstances about which the new shift ought to know. Bourbon Offshore has its written procedures for handover between masters, chief/first officers and chief engineers, plus cooks, see Annex 1 Section 2.3. The able seamen have no handovers at crew change. After the handover has been performed, the forms are signed. As mentioned above in Section 4.5, the internal audit of 9 March gave a non-conformance because these forms were not always signed. According to Steven Rooney, however, the handover was always done. The handover forms were stored on board and are consequently not available.

There are no company guidelines for how long a handover ought to last. In this case it lasted about one and a half hours, from about 04:00 to 05:30. The vessel then undocked and set a course towards the "Transocean Rather", which was 135 nautical miles from Scalloway. They arrived at 15:00 local time on 30 March. For Captain Remøy and First Officer Syversen, who were both new on board, familiarisation with the vessel was given simultaneously with the handover. For more discussion of familiarisation, see Section 4.7.1.

Captain Reiersen testified that he undertook a quick review of the RMP with Captain Remøy and informed him how the operation had gone so far. Reiersen also communicated to Remøy that Johnson had allegedly confirmed that the "Dolphin" was too small to be primary vessel and that it had been indicated that they were to play the role of assist vessel. He had underlined in the RMP on board that they were to be assist vessel. Reiersen also reported that Johnson had explained that there could be changes along the way, among other things because they had not obtained all the vessels envisaged at that point in time. Remøy had not commented on this.

Together with the masters' handover, the chief/first officers held a handover with the relieving shift. First Officer Syversen testified that they received information that there was some damaged equipment on the rig that was causing delays, but that nothing definite was said about what assignments the vessel was to have. The RMP was not reviewed at the first officers' handover; he obtained information about the rig move through his own study of the procedure.

First Engineering Officer Morten Reite, who was on Reiersen's shift, informed the Commission that he went through a handover procedure with the engineers. In addition there was a checklist that the chief engineers went through.

Captain Hugo Hansen testified that it was normal on the "Bourbon Dolphin" for the handover to take between one and two hours, which Bjørn Idar Remøy in his testimony confirmed was normal practice in the company. Both Hansen and Syversen have testified that on other vessels on which they were new, they had had a combined handover/familiarisation of around five hours.

It appears from daily reports up to 3 April that the date for "Next crew change" was "03.04.2007". In the daily report up to and including 4 April, the date of the crew change was changed to "03.05.2007".

First Officer Syversen testified that he was not called in to any internal briefing during the period he served on the "Bourbon Dolphin".

8.3 Brief description of the operation up to 12 April

8.3.1 Introduction

The implementation of the procedures for recovery and deployment of anchors demanded that a number of jobs related to connection of chain, wires, hooks, chasers etc. be performed on deck. In order to hold the chain and/or wire during these work operations, the vessels used their cranes, shark-jaws and towing-pins, see Figures 5.8 and 5.9. A more detailed description of the "Bourbon Dolphin" equipment is given in Chapter 5.

Every morning the vessel reported to the company – "daily reports" – about her activities over the last 24 hours. The reports were made at 24:00 and sent to a separate defined mail-address. They stated also consumption over the last 24 hours and stocks of fuel and lubricant, meteorological observations and data for calculation of consumption. Over and above designating the activity as "AH operation" no further description was given. For certain days the vessel had been "St-by

w/o/w" (Stand-by, waiting on weather). The Commission has obtained daily reports from the company. The last, which was sent on the morning of 12 April, concerned 11 April 2007. The company did not receive a report for 12 April, nor was one created.

The daily reports form the basis for modelling of the vessel's load condition at the time of the accidents, see Table 9.2.

8.3.2 The implementation

The "Bourbon Dolphin" and the "Olympic Hercules" arrived on the field on 27 March 2007 and began the work of recovering the secondary anchors. With the "Olympic Hercules" as primary vessel and the "Bourbon Dolphin" as assist vessel, anchor nos. 6 and 2 were recovered. The "Bourbon Dolphin" left the field on the evening of 29 March for the crew change. On 30 March the "Bourbon Dolphin" was back and recovered anchor no. 3 with the "Olympic Hercules" as assist vessel.

On 31 March the "Bourbon Dolphin" began the work of breaking loose anchor no. 7, but was not by herself able to loosen this from the seabed. The "Olympic Hercules" had therefore to be called in, and with the aid of a J-chaser they tried to get the anchor loose. The anchor came up, but both the J-chaser and other mooring equipment was damaged.

On 2 April the two anchor-handling vessels and the tug "Sea Lynx" arrived on the field. All the anchor-handling vessels participated in the work of loosening and recovering the four primary anchors. Transcripts of the rig's logs show that in the period from 2 to 4 April they had various problems getting the anchors loose, among other things they broke several J-chasers. Recovery of anchor no. 8 was extremely difficult, equipment was damaged and tension on the rig's anchor winch reached 360 tonnes.

During this part of the operation they were also hampered by poor weather. Not until 8 April were all the anchors up, and did the weather conditions allow the rig to be towed to and moored at a new location. Recovery of the primary anchors was not done in conformity with the RMP, but in accordance with a formal revision made on 30 March and the towmaster's adjustments made on 7 April 2007. For deployment of the primary anchors two vessels had to be used, among other things to relieve the weight on the rig's winches. From 9 to 11 April there was also a break in the operation due to the weather. All primary anchors had then been deployed.

In his Vessel Performance Assessment towmaster Ross Watson, who was on the rig up to 9 April, awarded all the vessels the grade VG (very good). In the report (Section A – Semi-submersible Marine report) Watson wrote the following:

> "Olympic Hercules and Vidar Viking good vessels and crew but – the previous extremely sharp edge of operations in the past is no longer there.
>
> Bourbon Dolphin is not sufficiently experienced for this type of work. The duty persons on the bridge have to be instructed from the rig pilot house and from other vessels in tasks such as how to work chaser collars and how to get a grapnel off the chain. In the latter case, at no. 4, the anchor chain had to be hauled to the deck for the grapnel to be removed. That was after 3 hours of attempts to free it and simply should not have happen with at ballasted grapnel.
>
> Highland Valour is not necessarily the fastest in operations but is positive and successful. Also, the vessel is not DP equipped yet turns in a job as good as if not better than the others on this operation.
>
> Sea Lynx absolutely outstanding reconnecting the secondary towing bridle following the break of the primary bridle." *(original in English)*

The report stated further that during recovery of the anchors equipment was damaged, among other things several J-chasers, swivels and pear links. Anchor no. 4 disappeared on the seabed.

When he testified before the Commission, Ross Watson clarified his description of the lack of experience of the "Bourbon Dolphin" as applicable to the use of chasers and other equipment in a deepwater operation.

8.3.3 Written division of labour for deployment of secondary anchors

While they were waiting for better weather, the "Highland Valour", the "Bourbon Dolphin" and the "Vidar Viking" were sent to Lerwick in order to supplement damaged equipment, redistribute anchors and fetch other equipment. The "Bourbon Dolphin" then took on board two 18-tonne Bruce anchors (secondary anchors).

First Officer Geir Tore Syversen testified – both in the maritime inquiry and subsequently before the Commission – that the "Bourbon

Dolphin" had a GM of 0.26 when she left Lerwick. He said he had entered this in the vessel's deck log. The Commission has considered this information in Section 9.10.2. On 10 April towmaster John Sapsford prepared a written procedure that specified the vessels' assignments and the sequence for running out the four secondary anchors, which still remained. This was sent by e-mail to Chevron, Trident and Transocean and to the vessels. The procedure was approved by Chevron. There were no changes.

On the morning of 11 April the "Bourbon Dolphin" began the deployment of anchor no. 3 and gradually developed problems with the chain. In the rig move logsheet is entered for 11:44:

> "Too much weight on Bourbon Dolphin gypsy whilst paying out chain from locker, request Vidar Viking grapple chain to take weight". *(original in English)*

According to the procedure, the "Vidar Viking" was to grapple chain 300 metres behind the stern of the "Bourbon Dolphin" so as to relieve the weight. The "Bourbon Dolphin" was then to overboard the anchors over her stern, after which the "Vidar Viking" was to loosen her grappling hook and thereafter to grapple anew, 300 metres from the rig's fairlead.

It appears that the "Vidar Viking" grappled the chain at 12:05. Not until 20:52 was the anchor deployed on the seabed. All together, the work on the mooring of no. 3 took over 23 hours up to 08:13 on 12 April. The time can partly be attributed to the fact that they had to go on stand-by in expectation of the deployment of anchor no. 7.

At the same time, the "Highland Valour" and the "Olympic Hercules" were busy with the deployment of anchor no. 7. The "Highland Valour" also had too much load on the chain, as shown by the log and the fact that at 13:20 the "Olympic Hercules" had to use a J-chaser to relieve the weight. It appears from the testimony from Captain Williams and Chief Engineer Ogley of the "Highland Valour", however, that they did not register any extraordinary weights. Ogley thought that the tension on the vessel's winch was around 120 tonnes. Problems also arose with the rig's no. 7 winch, which at one point had to be stopped because of overheating. Not until 03:00 on 12 April was anchor no. 7 on the seabed.

On 12 April there remained deployment of anchors nos. 6 and 2. According to the plan from the towmaster, the "Olympic Hercules" was then to deploy no. 6 with the "Highland Valour" as grappling vessel, whereas the "Bourbon Dolphin" was to deploy no. 2 with the "Vidar Viking" as grappling vessel.

At 05:35 the same morning, however, the "Highland Valour" reported a leak in a fuel line and asked for 1½ hours to repair it. They reported the completion of the repair at 06:56.

The "Olympic Hercules" had commenced the work on anchor no. 6 at 02:40. Since at 06:00 they had reached the stage in the process when grappling should be initiated, the "Vidar Viking" was asked to assist.

Recovery of anchors:

28 March	anchor no. 6	Bourbon Dolphin assisted Olympic Hercules
30 March	anchor no. 2	Bourbon Dolphin assisted Olympic Hercules
31 March	anchor no. 3	Bourbon Dolphin recovered anchor with Olympic Hercules as assist vessel
1 April	anchor no. 7	Bourbon Dolphin recovered anchor with Olympic Hercules as assist vessel
6 April	anchor no. 8	Bourbon Dolphin assisted Vidar Viking
7 April	anchor no. 4	Bourbon Dolphin assisted Olympic Hercules
7 April	anchor no. 1	Bourbon Dolphin assisted Highland Valour
8 April	anchor no. 5	Olympic Hercules assisted Vidar Viking

Deployment of anchors:

8 April	anchor no. 5	Olympic Hercules assisted Vidar Viking
8 April	anchor no. 1	Bourbon Dolphin assisted Highland Valour
9 April	anchor no. 4	Bourbon Dolphin assisted Olympic Hercules
9 April	anchor no. 8	Vidar Viking assisted Olympic Hercules
11 April	anchor no. 3	Bourbon Dolphin deployed anchor with Vidar Viking as assist vessel
12 April	anchor no. 7	Olympic Hercules assisted Highland Valour
12 April	anchor no. 6	Vidar Viking assisted Olympic Hercules
12 April	anchor no. 2	Valour as assist vessel

The "Bourbon Dolphin" began the work on anchor no. 2 at 09:17. The "Vidar Viking" was already at that time involved in the work on anchor no. 6. It was therefore the "Highland Valour" that was eventually given the assignment of assisting the "Bourbon Dolphin".

8.3.4 The role of the "Bourbon Dolphin" up to 12 April

Under the requirement specifications in the RMP, the vessels should have capacity to take 914 metres of 76 mm chain inserts. The procedure presupposed that all the four anchor-handling vessels should recover and deploy one primary anchor each. All the chain inserts were of the same length, regardless of whether they were for the primary or secondary anchors.

The "Bourbon Dolphin" was involved in recovery and deployment of all the four secondary anchors, both as primary vessel and as assist vessel. That the vessel was designated as "Vessel C" in the charter does not mean any restrictions on the assignments the vessel was given during the operation. Nor did the reservations expressed by Ross Watson in his assessment lead to any changes in the work assigned to the "Bourbon Dolphin".

As far as the Commission knows, no objections were made by the "Bourbon Dolphin" to the assignments the vessel was given to perform during the operation.

8.4 Evaluation

8.4.1 The briefing meeting

The time earmarked for the briefing (about 1 hour) is, from what the Commission has been given to understand, normal in the UK Sector. The operation in question was, however, complex and demanding, and therefore occasioned a more thorough review than otherwise, particularly in the light of the risks and challenges the vessels were to handle. Johnson had had a role in the planning phase and was aware of the procedure's more critical elements, but had no operational responsibility for the implementation.

Frank Reiersen and Sean Johnson had different perceptions of what was said at the meeting with regard to the duties of the "Bourbon Dolphin" and what changes in the procedure might involve. The ambiguities in the RMP with regard to the vessels' concrete assignments (confer Section 6.9), were thereby not clarified via the briefing. There is reason to believe that the misunderstandings were due partly to the fact that the procedure was not circulated prior to the briefing and partly that the time allocated was insufficient. As far as the Commission is aware, no minutes were kept.

There was no joint planning meeting between the operator, the rig and involved vessels before the operation commenced. Such a meeting would have been useful and provided a better understanding of the operation. They were to proceed with a complicated operation in deep water, which inter alia involved tandem operations with the vessels. A review of hazard factors, experiences from the previous rig move, weather and current conditions and coordination of technical challenges related to the operation, would have been natural items on the agenda of such a meeting.

Under the NWEA guidelines, prior to the operation a start-up meeting should be held. The guidelines do not say anything more about who is to be present. In 61 A of the Norwegian OLF guidelines, however, it is recommended that operational personnel from the rig, the operator and the vessels should meet, but this is nevertheless a practice that is not always followed on the Norwegian Shelf.

8.4.2 The crew change

As regards the crew change, questions may be raised about the expediency of the change happening just after the operation had begun, rather than before the operation commenced. At the same time, it may be difficult to alter dates for crew changes, which follow shift plans and are planned well in advance, at short notice. The time allocated to the crew change was in line with company practice. Seen in relation to the complexity of the operation, more time should probably have been allocated to the handover alone. The greatest objection is nevertheless that the time allocated was used for both handover and familiarisation at the same time (as regards Remøy and Syversen). For more discussion of this see Section 4.7.1.

Due to the time of the crew change (in the middle of the night) it was hard to hold an internal briefing with the crew before departure.

Chapter 9
The accident

9.1 Introduction

The rig was moved to Location "I" and the four primary anchors deployed in the period 8 to 9 April 2007. When the primary anchors have been deployed, the rig is safely moored. Deployment of the secondary anchors, which the vessels have on board, is then done diagonally and in pairs, so as to avoid one-sided stress on the rig's mooring, as shown in the mooring pattern, see Figure 6.3. The vessels proceed in a line as straight as possible from the rig to the deployment position, along so-called "anchor tracks", and so that the deployment is coordinated in time. Diagonal deployment also makes the mooring sufficiently taut. See the general account in Chapter 6.

This chapter will first present the deployment of anchor no. 6 and thereafter a coherent presentation of the events on board the "Bourbon Dolphin" in chronological sequence. As a part of this course of events, the grappling attempt and the near-miss situation with the "Highland Valour" will also be described.

The presentation is based on the testimony of the officers and crews of the vessels, and the towmaster and personnel on the "Transocean Rather". The testimonies are incorporated in a special annex to the report, (see Annex 2). Written logs, rig plots and weather data are also used.

In Section 9.10 the load conditions/stability challenges of the "Bourbon Dolphin" up to the capsizing are discussed specially.

9.2 Anchor no. 6

At 02:42 the "Olympic Hercules" fetched PCP from the rig and began the work of running out the rig chain towards the position of anchor no. 6. The heading was 160 degrees, but the current was running in the direction nor-nor-east to north-easterly and it was necessary to bear up so as to keep position. At 06:55 the "Olympic Hercules" had connected the anchor to the wire and overboarded it over her stern roller. The plot from the rig shows that at that point in time the "Olympic Hercules" had drifted east of mooring line 6.

Captain Grim Bergtun's testimony on this to the Commission was as follows:

> "They noticed during the running-out of chain that there was strong current and had to bear up a lot in order to hold the line. When the anchor was connected the vessel had to correct its course relative to the anchor to get the anchor over the stern roller. The vessel then immediately drifted to port and ended up 400 metres off course before the anchor was over the roller. They came increasingly out of course and at maximum had drifted 600-650 metres. They then used all their thruster capacity, but it was not sufficient to hold their bows into the weather."

The work of running out rig chain and the vessels' chain inserts proceeded until 06:00. The "Vidar Viking", which was free, was then instructed by the rig to assist the "Olympic Hercules" in grappling the chain, as the anchor was launched. According to the rig's log, the "Vidar Viking" got hold of the chain at 07:44.

The "Olympic Hercules" did not manage to get back on track using her thrusters and rudder/propeller alone. At the worst, the "Olympic Hercules" had drifted about 730 metres east of line no. 6. According to Captain Grim Bergtun, the current was normally 2.5 knots, but that day was stronger.

The rig first asked the "Olympic Hercules" to wait, while the "Bourbon Dolphin" deployed anchor no. 2 together with the "Highland Valour". The "Olympic Hercules" used her lateral thrusters on full (80 %), but was still drifting off, and so Captain Bergtun did not want to heave to and wait. Bergtun asked the rig to pay out its wire so as to give the "Olympic Hercules" speed for manoeuvring. The towmaster at first refused, but later granted the request, and wire was paid out from the rig's winch.

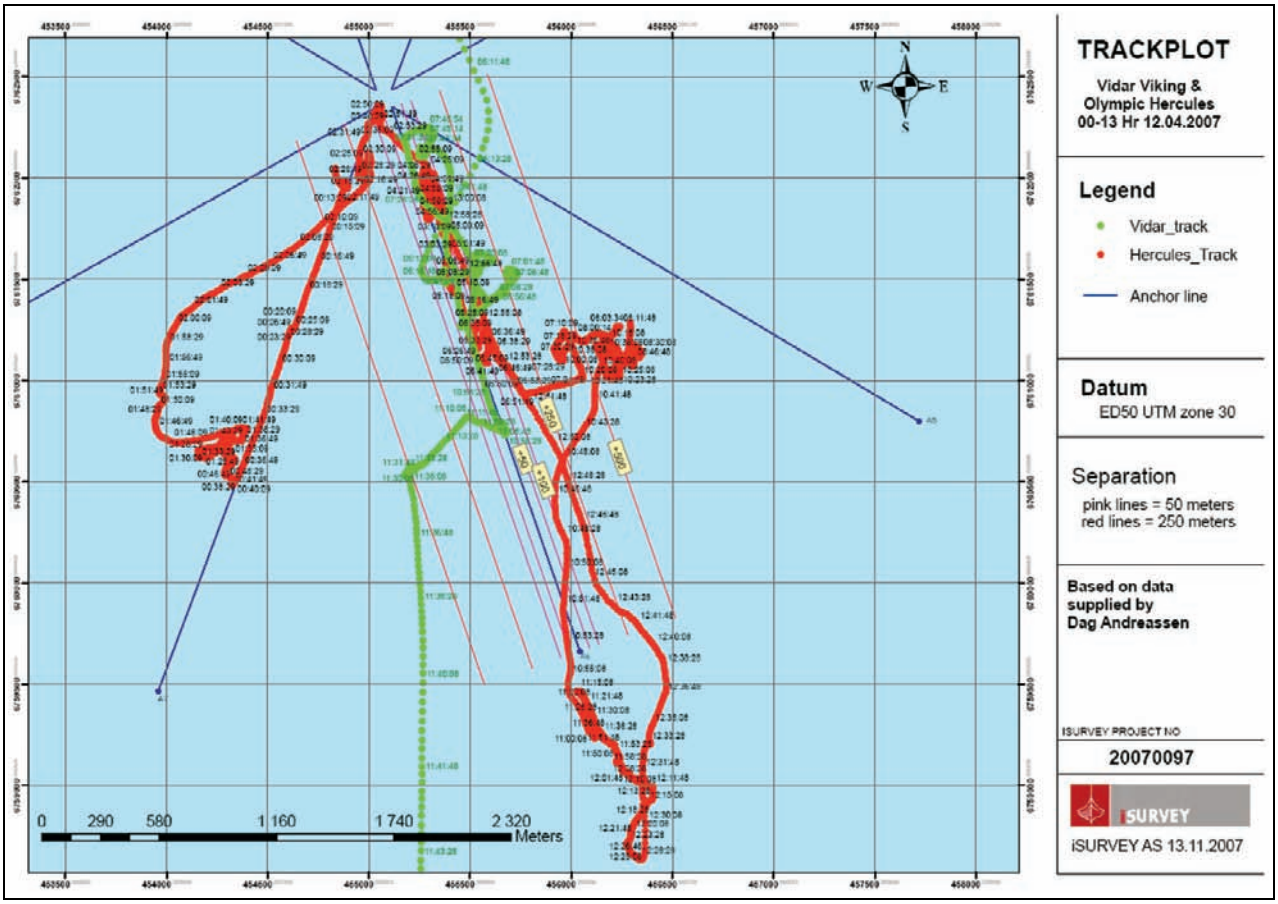


Figure 9.1 Trackplot for deployment of anchor no. 6

James Sutherland, bargemaster on the rig, testified before the Commission that running out wire from the rig's winch without the chain having been grappled involves a danger of damaging the wire and the rig's bolster.

When the rig slacked off the wire, the vessel obtained propulsion in the water and could make use of her rudder. By giving starboard rudder and full speed ahead and use lateral thrusters, Bergtun managed to manoeuvre the "Olympic Hercules" back against the current and up to the line. He testified that the vessel, due to the weight of the chain and the manoeuvring, then listed up to 12 degrees to starboard. According to the testimony the chain shifted between the outer towing-pins.

The "Vidar Viking" went off the chain at 11:19. At 12:30 anchor no. 6 was deployed on the seabed in the correct position. The "Vidar Viking" was then allowed to leave the field.

9.3 Anchor no. 2

The "Bourbon Dolphin" had been primary vessel in the deployment of secondary anchor no. 3. On 12 April there remained the deployment of the last secondary anchor, anchor no. 2. This was a 18-tonne Bruce anchor, which the "Bourbon Dolphin" had taken on board in Lerwick on 9 April. The anchor was on deck, lashed to the cargo rail on port side, as shown in Figure 9.3.

In the towmaster's plan the last phase of the operation described as follows:

> "When pennant returned from no.6, rig transfer crane pump from Port to Stbd. Bourbon Dolphin to no.2, receive pennant from rig and roller chaser complete with thrash chain. Rig pay out 920 m rig chain then change over to wire. Bourbon Dolphin connect lockered 76 mm insert chain and deploy 914 m of chain and install new roller chaser collar on chain and connect anchor to chain. 250t Shackle on chaser collar to be secured with stainless steel locking pins. Thrash chain to be secured to 250t shackle with no 7 Pear Link. 75m pennant to be secured to thrash chain with kenter or no. 7 Pear link and second new 75m pennant to be secured to first pennant with CCL, kenter or Pear link. Vidar Viking to grapple chain 300m from stern of Bourbon Dolphin and take weight of chain. Bourbon Dolphin to overboard

anchor. Vidar Viking to disengage grapple and grapple chain 300m from fairlead. Run anchor." *(original in English)*

9.4 The morning shift

On Thursday 12 April 2007 Captain Oddne Remøy went on watch at 06:00. Together with him on the bridge was First Officer Kjetil Rune Våge. Chief Engineer Frank Nygaard was on watch in the engine-room. Also on watch were Able Seamen Sandø and Vike. Electrician Søren Kroer, cook Ånje Nilsen and the engineering trainees Thomas Arnesen and Kim Henrik Brandal began their watches at 08:00.

Våge had the responsibility for preparing daily reports and sending these electronically to the company every morning. The Commission has obtained the reports from the company. There is no report for 12 April; the reason for this is that the daily report concerned the preceding 24 hours. The report that was sent in the morning of 12 April thus concerned 11 April, from 00:00 to 24:00.

9.5 Weather, wind and current conditions on 12 April 2007

The "Transocean Rather" received and retransmitted to the vessels continuous weather forecasts from two different forecasting institutions, Wilkens and Weathernews.

At 06:00 on Thursday 12 April the forecast was for increasing wind from the south-west, with a 28-knot mean speed and gusting up to 35 knots (10m height) until 21:00. Wave height was given as 3.4m significant, max 5.9m, according to the forecast from Wilkens, who also expected an increase to 4.0m significant, max 7.1m from 12:00 to 21:00, confer Annex 4.4.

Weathernews had a rather milder weather forecast in which the max wave on 12 April was predicted at 6.3m, with lesser wind speeds up to 25 knots (10m), see Annex 4.5.

The Commission has received an expert assessment from the Norwegian Meteorological Institute (DNMI) regarding the weather conditions on the day of the accident. DNMI's wave model calculated a significant wave height of 4.0m at 15:00 for the site of the accident (60:59'20"N, 003:49'20"W). A wave buoy, lying about 27 nautical miles in a south-westerly direction from the site of the accident (60:42'02"N, 004:30'00"W) measured significant wave heights of 3.0m at 15:00, of 3.6m at 17:00, 4.7m at 19:00 and 4.2m at 21:00. DNMI's model calculated a rather greater significant wave height for the measurement location. On this basis, DNMI estimated the wave height as between 3 – 3.5m at 15:00, a little over 3.5m at 17:00 and 4.0 m at 20:00. DNMI explains that the current in these areas can reach speeds of up to 3 knots, confer Annex 4.3. All times are stated as Coordinated Universal Time (UTC).

Captain Grim Bergtun of the "Olympic Hercules" testified that the wind was around 30 knots. The current was normally 2.5 knots but stronger that day, the current direction north-easterly, after a while in a more easterly direction. Bergtun estimated significant wave height as 3 – 3.5m in the period the "Olympic Hercules" was working with anchor no. 6.

Captain Halvor Enoksen on the "Vidar Viking" testified that the current was running in a north-easterly direction and struck the vessels on their starboard sides while they were working with anchor no. 6. The wind increased in the course of the day, 12 April, but the weather and current conditions were acceptable. Enoksen estimated the current as 1 – 2 knots or 0.5 – 1.0 m/s and between 2-3 metres significant wave height

Geir Tore Syversen testified it was blowing at 32 knots from the south-west. He thought significant wave height was given as 2.9 metres in the weather forecast they received from the rig. He thought that the current was possibly 2 knots (1 m/s) but had no measurement to refer to.

Able Seaman Egil Hafsås, who was on watch from 12:00, has in both the maritime inquiry and in his testimony before the Commission described the weather conditions as "borderline" in relation to what was defensible for work on deck.

Able Seaman Øystein Sjursen testified that the working conditions were acceptable on 12 April. Able Seaman Per Jan Vike testified before the Commission that he went off watch at 12:00 but did not register anything abnormal. The weather was good when they took the chain on the boat, and they were told that the weather was deteriorating, but this turned out not to be the case. There was no sea over the stern.

The Daily Marine Report sent by the "Transocean Rather" (confer Annex 4.6), for 12 April reports a wind speed of 37 knots at 15:00, max waves of 5.0m at 04:00 and of 3.5 m at 15:00. The rig only had instruments for measuring the wind.

In October 2007 Aerospace prepared a report showing that current speed was 0.60 knots at 17:00 UTC. Wind was estimated at 26-28 knots (10m height) at 210 degrees. Significant wave height is estimated at 3-3.5m with a 7-8 second period at 15:00 UTC. Max wave is calculated at twice the significant wave height. These are estimated weather conditions at 17:00, see Annex 1 Section 4.9.

On board the "Highland Valour" they estimated a wind speed of 35 knots at 15:00, the wave height was characterised as "moderate" to "moderate/rough" on the day of the accident. Captain Williams confirmed that, even though the conditions were beginning to be marginal, they thought it was possible to perform the operation. No one on board was saying that the operation should be suspended.

On board the standby vessel "Viking Victory" they estimated a wind speed of 35 knots at 16:00 and a significant wave height of 2.5m at 08:00, which was reduced to 2.0m at 16:00.

Given this information about the weather situation, the Commission finds that mean wind strength was 30-35 knots, and significant wave height was about 3.5 m (max wave around 7 m) at the time of the accident. The weather observations are relatively consistent on this. On the other hand, there is strong disagreement about the current speed, nobody had a current meter but estimates varied from 0.6 knots (0.3 m/s) up to 3 knots (1.5 m/s). On 12 April it was cloudy, stable weather with good visibility, as shown also by the pictures.

9.6 Running of chain for anchor no. 2

The distance from the rig to the anchor location was about 3,000 metres as the crow flies.

The intention was to run out anchor nos. 6 and 2 more or less simultaneously. Diagonal tension load on the rig via chain/rig winch on no. 2 was also necessary in order to get a sufficiently taut mooring of no. 6, which was being run out.

The "Bourbon Dolphin" commenced the work at 09:16/09:20, when the vessel got PCP from the rig. The "Bourbon Dolphin" connected the rig chain to her own winch on board. The rig then ran out anchor chain from its winch, at the same time as the "Bourbon Dolphin" was running out along the line in a northerly/north-westerly direction. The "Bourbon Dolphin" had anchors on deck, lashed to the cargo-rail on the port side. As will be seen below, the Commission finds that the chain end from the rig went in over the stern roller aft between the outer and inner starboard towing-pins. The rig's chain was run out at 100 metres per minute from the rig winch.

At 12:00 there was a change of watch on the "Bourbon Dolphin". Captain Remøy was relieved by Chief Officer Bjarte Grimstad. First Officer Geir Tore Syversen relieved First Officer Kjetil Rune Våge. According to Syversen, the watch change on the bridge took 10-15 minutes. The incoming crews were given information about how much chain had been run from the rig, about weather status and which vessel was to grapple the chain in connection with the anchor deployment. Able Seamen Hafsås and Sjursen relieved Sandø and Vike. The trainees had a break pause from 12:00 to 13:00.

It appears from the rig's log that the "Bourbon Dolphin" had had some minor deviations in both directions from the mooring line in the first period of the run-out.

By 12:15 the rig's chain – 914 metres of 84 mm chain – had been run out. On board the "Bourbon Dolphin" the rig's chain was connected to 76 mm chain inserts from the vessel's starboard rig chain locker and continued to run the chain about 12:53. Plot from the rig shows that at that point in time the "Bourbon Dolphin" had no appreciable drift. The chain was run out at 20-25 metres per minute. The "Bourbon Dolphin" was maintaining a speed of about 0.25 knots, as towmaster John Sapsford testified.

Deviations from the line could be read off from the navigation screen on the bridge, as described in Section 5.8.

From data obtained from the rig's navigation system it appears that the "Bourbon Dolphin" was not holding on track. At 13:45 it was registered that the "Bourbon Dolphin", which was then 1,000 metres from the rig, had drifted east of the mooring line. At 14:00 the "Bourbon Dolphin" was 1,116.9 metres from the rig and 84.2 metres off track. At 14:17 the distance from the rig had increased to 1,200 metres and the drift had increased to 185 metres from the line.

In the maritime inquiry Syversen had stated that when the "Bourbon Dolphin" had run out about 3-400 metres of chain inserts, they were told to take a break "in order to correct in relation to the rig". Syversen also testified that they waited for 2-3 minutes. It has not been possible to verify this through other witness testimony. According to testimony from towmaster and from the officer

of the watch on the "Highland Valour" it is found that the "Bourbon Dolphin" reported that, at this point in time, 14:30, they were having problems getting back to the run-out line and asked the towmaster for assistance from the "Highland Valour".

The propulsion engines, steering power and capacity of the "Bourbon Dolphin" are described in greater detail in Section 5.5, and in the expert witnesses' report from Ship & Offshore Surveyors AS, confer Annex 1 Part 8.

On 12 April the lateral thrusters were run at full power. In the engine-room they were afraid of overheating. According to testimony from engineering trainee Kim Henrik Brandal, the Chief Engineer stayed in the engine-room after the end of his watch at 12:00. Around 13:00 Brandal was told that the lateral thruster had overheated. Both the engineers were then in the engine-room. A short time before the accident Brandal was again in the engine-room and saw that First Engineering Officer Emblem was trying to cool down the thruster with a high-pressure gun.

First Officer Syversen registered very intense use of thrusters as early as when he came on watch at 12:00. Current and wind were then coming from the same direction. According to Syversen, around 15:00 a telephone came from the First Engineering Officer asking for thruster capacity to be reduced, but the Chief Officer refused this. At the same time the "Bourbon Dolphin" asked the rig for assistance from the "Highland Valour".

Thomas Arnesen testified that at one point he overheard communication between the engine-room and the bridge. The Chief Engineer was, according to Arnesen, irritated that the bridge would not ease off on the thrusters. The Commission finds that this was in the period after 13:00, probably the same occasion as mentioned in Syversen's testimony.

The information about the engine use of the "Bourbon Dolphin" was not communicated on to the rig.

According to the rig's log, at 14:45 the "Bourbon Dolphin" reported that all chain was out (1,817 metres). Given the registered data, therefore, it must be found that the "Bourbon Dolphin" had continued running out chain also in the period from 13:50 to 14:45 with the exception of the brief pause mentioned above.

The loose end of the vessel's chain had been connected to the workwire on board. The time of this operation, which was performed on deck, has not been unambiguously determined. Able Seaman Egil Hafsås did not give any time for this, but most probably it was done before 14:30 as Able Seaman Øystein Sjursen testified. This point in time is compatible with the fact that the rig's log for 14:45 says the following: "Bourbon Dolphin complete paying out chain". *(all log entries originally in English)*

According to Syversen's testimony, all the chain had not been run out until 16:30. This time is not compatible with the assertion that at that point in time they had failed both to grapple the chain and to get the vessel back to the mooring line. Underwater photographs taken of the "Bourbon Dolphin" after the accident show that the vessel had around 220 metres of wire connected to the chain, paid out. This wire length may, however, have run out after the capsizing, before water penetration stopped the machinery. This is because the technical design permits run-out of wire after a black-out.

9.7 The attempt of the "Highland Valour" to get hold of the chain

In the rig's log for 14:30 is written: "Highland Valour to grapple No 2 Chain". At this point in time the "Bourbon Dolphin" was 1,184 metres from the rig and 337 metres off the run-out line. The "Bourbon Dolphin" had then warned the rig that the vessel wanted assistance due to manoeuvring problems. Measured in a straight line the distance between the "Bourbon Dolphin" and the anchor position was 1,968 metres.

Grappling of chain at this stage is not dealt with in the RMP. Nor is it in conformity with the procedure for deployment of anchor no. 2 that the towmaster indicated in his e-mail of 10 April.

When the request for assistance was granted by the rig, the object, according to the towmaster, was that the "Highland Valour" should relieve the "Bourbon Dolphin" of the weight of the chain, so that the "Bourbon Dolphin" could get herself back to the line for anchor no. 2.

Towmaster John Sapsford testified that grappling was done in order to help the "Bourbon Dolphin" get back to the line. Grappling is routine during a rig move. The crew of the "Highland Valour" were experienced, and the measure was considered to be in conformity with the procedures followed to get the anchor deployed in the correct position. The "Bourbon Dolphin" had all chain out and it remained only to connect the anchor and overboard it over the stern roller. At this stage, the "Highland Valour" was to have assisted

with the grapnel regardless. The towmaster complied with the vessel's wish and assumed that the vessel herself had evaluated the situation.

The Commission would remark that at this point in time anchor no. 6 was on the seabed and the rig thereby moored by 7 of the 8 anchors.

At 15:00 the "Highland Valour" was right over the mooring line and ready to grapple. The "Bourbon Dolphin" was then 559 metres off the run-out line and her distance from the anchor deployment position had increased to 2,016 metes.

The "Highland Valour" succeeded at her second grappling attempt. According to testimony from Richard Ogley, who was running the winch, the "Highland Valour" went in from the east, astern of the "Bourbon Dolphin", and first tried with 1,000 metres of wire on the hook, but did not achieve contact. Captain Williams and Chief Officer Dunlop have testified that the rig asked them to start grappling at 900 metres, but that they chose 1,000 metres to be on the safe side. They then sank the hook to 700 metres and tried again. The "Highland Valour" then achieved contact with the chain and managed to fasten the hook. Chief Officer Dunlop, who told the Commission that he had had long experience with grappling operations in deep water, but not with the object of helping another vessel to recover its position.

The rig had registered that the "Bourbon Dolphin" had at this point in time run out all her chain. In addition they were aware of the distance between the "Bourbon Dolphin" and the rig. The rig could thereby have calculated the chain arc and the chain tension, and directed the grapple operation. The Commission is uncertain whether the rig had at this point any definite opinion about the chain's angle of attack and how sharply the chain went into the deep after the "Bourbon Dolphin".

The "Bourbon Dolphin" continued to drift further and further off-line, at the same time as she was making little headway. From 15:30 to 16:00 the distance from the rig had increased by a little over 30 metres, whereas her drifting had increased from 650 metres to 730 metres, that is, an additional 80 metres from the line.

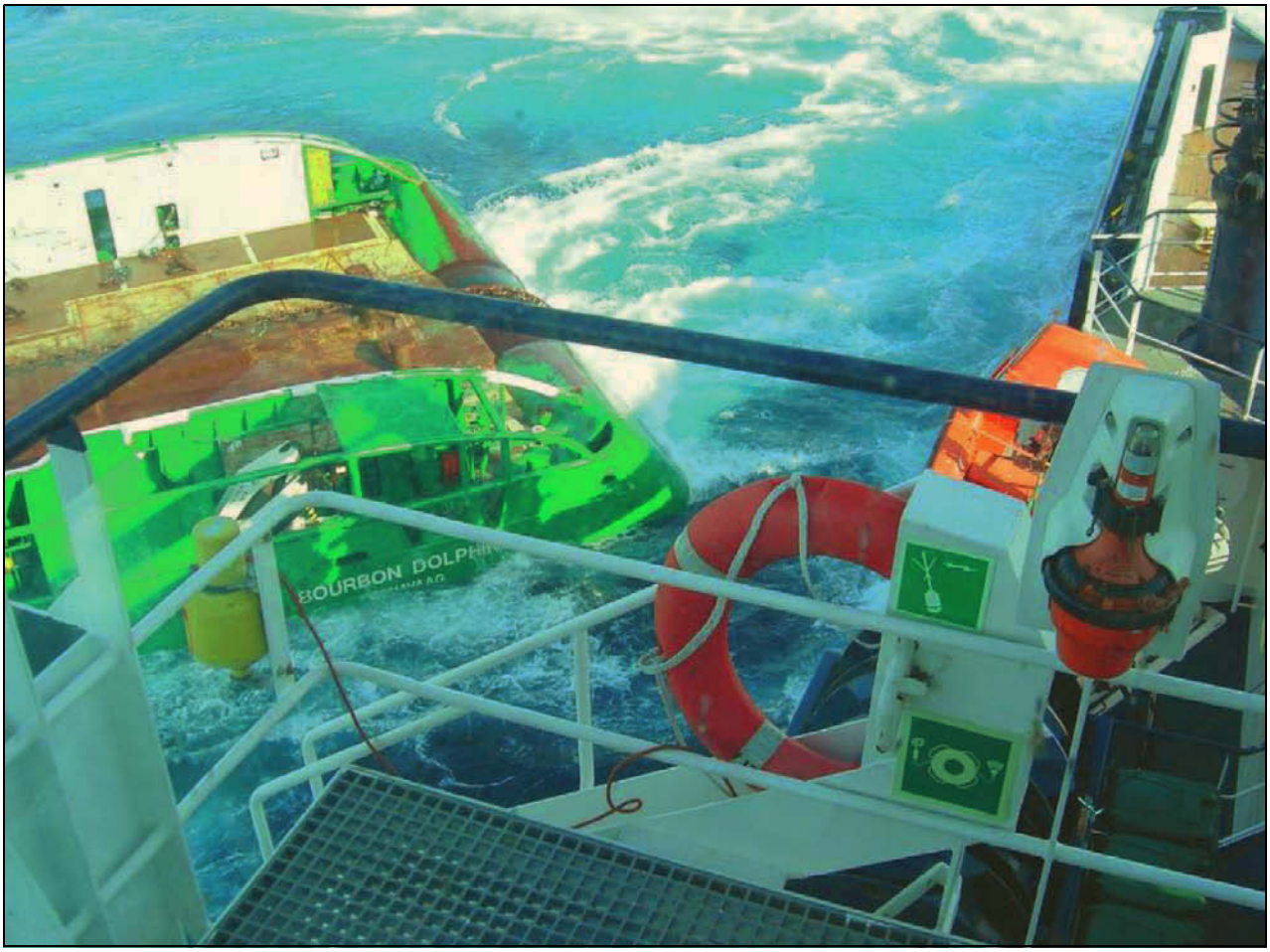


Figure 9.2 The near-miss

Photo: Sean Dickson

At 16:10 the "Highland Valour" reported that they had succeeded in grappling the chain. The "Highland Valour" experienced powerful tension on her winch, at the same time as the "Bourbon Dolphin" registered a fall in tension. At 16:20 the following was entered in the towmaster's log: "Both AHV's unable to hold station." At that point in time the "Bourbon Dolphin" was 840 metres off-line and the distance from the anchor deployment position had increased to 1,970 metres.

9.8 The near-miss between the "Bourbon Dolphin" and the "Highland Valour"

The grappling operation was not successful. Even if the "Highland Valour" had hold of the chain about 240 m aft of the "Bourbon Dolphin", the operation to get the "Bourbon" Dolphin back into the right position was a failure. The vessels were eventually lying almost sideways-on with their sterns closest. The crews of the "Highland Valour" and the "Bourbon Dolphin" have given detailed testimony about the near-miss that occurred at 16:26. Eyewitnesses estimated the distance between the vessels as a mere few metres, as shown by photographs taken from on board the "Highland Valour", see Figure 9.2.

First Officer Syversen, who was on the bridge of the "Bourbon Dolphin" with a view astern, said in the maritime inquiry that the "Highland Valour", when she lost hold of the chain, drifted at high speed towards the "Bourbon Dolphin", and that a collision appeared unavoidable. In his subsequent testimony before the Commission, he amended this and said that it was probably the "Bourbon Dolphin" that drifted astern when the "Highland Valour" lost the chain.

Chief Officer John Hugh Dunlop and Captain Gordon Keith Williams, who were both on the bridge of the "Highland Valour", have testified that the "Bourbon Dolphin" drifted towards the "Highland Valour" stern-first. At that point, according to the witnesses, the "Highland Valour" still had hold of the chain. It was not, therefore, the sudden weight of the chain that caused the speed of the "Bourbon Dolphins" astern. They think that they lost their grip on the chain at a rather later point in time. These witnesses supposed that the "Bourbon Dolphin" had lost propulsion at some point. They testified before the Commission that it was not until after their evasive manoeuvre that the "Highland Valour" lost her grip on the chain.

Figure 9.3 The "Bourbon Dolphin" at 16:31

Photo: Sean Dickson

On the basis of plots of the vessels' manoeuvring it is not possible to be sure of when the "Highland Valour" lost hold of the chain. According to the Rig Log Sheet, the "Highland Valour" reported "Grapple is off No 2 chain" at 16:35. Syversen testified that the sternwards drift came as a direct result of the "Highland Valour" having lost hold of the chain. It is clear that both vessels moved astern and that one point they were lying more or less side by side. The distance between their sterns was so small that, according to eyewitnesses, "the crews could almost have shaken hands".

Thanks to quick thinking on both vessels, the collision was averted. The "Highland Valour" manoeuvred away, while the "Bourbon Dolphin" succeeded in going full ahead.

The question from the "Highland Valour" as to whether they should make further attempts to grapple was answered by the rig in the negative. The "Bourbon Dolphin" had drifted so far that further attempts to grapple involved, according to the towmaster's testimony, a risk of contacting the mooring line for anchor no. 3. For 16:40 the log reads: "Both vessels instructed to move West – away from No 3". The "Highland Valour" thereafter proceeded westwards and away from line 2,

and lay about 500 metres off in expectation of further instructions.

The near-miss was not reported to the rig by any of the vessels and was therefore not logged, neither by the towmaster nor in other logs on the rig. Towmaster Sapsford testified that, from his position in the pilot house, he had been unable to see how close the vessels had been.

It has been stated that neither the commanding officer on the rig, OIM Patrick O'Malley, nor Bargemaster James Sutherland were informed that two anchor-handling vessels had almost collided.

Representatives of Chevron, the "Transocean Rather" shore management and Trident were not informed of this incident until after the capsizing. Nor had the "Highland Valour" entered the incident in her deck log. When the attempt to grapple began at 15:00, the "Bourbon Dolphin" had drifted 559 metres off the anchor line and was 2,016 metres from the anchor deployment station. At 16:40 the drift had increased to 948 metres from the line, and the distance to the anchor station had increased to 2,119 metres.

9.9 The period up to the capsizing

The picture taken from the "Highland Valour" at 16:31 shows that the "Bourbon Dolphin" had the chain between the starboard towing-pins. The port inner towing-pin was down, whereas the outer port towing-pin was up.

Testimony about the subsequent course of events is afflicted by uncertainty as regards both the facts, times, sequence, divergent opinions and processing of visual and other emotional impressions. The survivors of the "Bourbon Dolphin" are clearly affected by the drama they have undergone. The other players have, as far as they could, attempted to recapitulate their experiences and impressions. Neither the crew of the "Olympic Hercules" nor those in the pilot house on the rig were close enough to get visual impressions of what happened next.

The "Highland Valour" proceeded westwards and hove to in a standby position from the "Bourbon Dolphin", as shown in Figure 9.4. Chief Officer Dunlop testified that he registered that the "Bourbon Dolphin" had moved slowly west. Dunlop also testified that at one point, after the "Highland Valour" had gone standby, he heard the towmaster proposing that the "Bourbon Dolphin" connect workwire to her chain.

At 16:30 the "Olympic Hercules" asked to leave the field, and was held back by the towmaster with reference to the fact that the "Bourbon Dolphin" was suffering drift and might need assistance.

Communication between the rig and the vessels was over an VHF channel. The vessels, too, communicated among themselves on this channel during the operations. No sound recovery of this communication exists, and accounts of what was said are in part conflicting. The Commission has therefore been obliged to consider the individual statements according to their apparent probability.

Both the "Highland Valour" and the "Olympic Hercules" were now aware of the manoeuvring problems of the "Bourbon Dolphin". Captain Bergtun testified that he heard the "Bourbon Dolphin" saying over the VHF that the thrusters were running at full power. It has been proven by testimony from the crew of the "Highland Valour" and from Captain Bergtun that the suggestion that the rig pay out wire was refused. The towmaster confirmed that he received such an enquiry, but he did not consider it a good solution, because he was afraid that the situation of the "Bourbon Dolphin" could be further aggravated. The towmaster explained this in terms of the "Bourbon Dolphin" not being in the same situation as the "Olympic Hercules", which had the anchor in her wire and therefore could not pay out wire herself. The towmaster therefore proposed that the "Bourbon Dolphin" should pay out her wire.

The towmaster stated that neither the OIM nor the bargemaster was informed about the situation, despite the fact that he was afraid that the mooring of anchor no. 3 could be affected.

At 16:47 the "Bourbon Dolphin" had drifted 1,019 metres away from the line. This is the biggest registered deviation prior to the accident. By 16:55 the drift had been reduced to 936 metres.

Syversen testified that after the near-miss Captain Oddne Remøy had come onto the bridge and that he took command at 16:50. According to Syversen, Remøy and Chief Officer Bjarte Grimstad discussed the situation. The Chief Engineer, who now had overheating in the engine-room, called the bridge and asked for reduced use of thrusters. At this point in time the "Bourbon Dolphin" had a slight and persistent list to port – Able Seaman Hafsås estimated it at less than five degrees. Observations from the "Highland Valour", including photographs, have confirmed this.

Shortly before the accident Hafsås visited the bridge. He felt that the atmosphere was rather strange. The Chief Officer seemed somewhat anx-

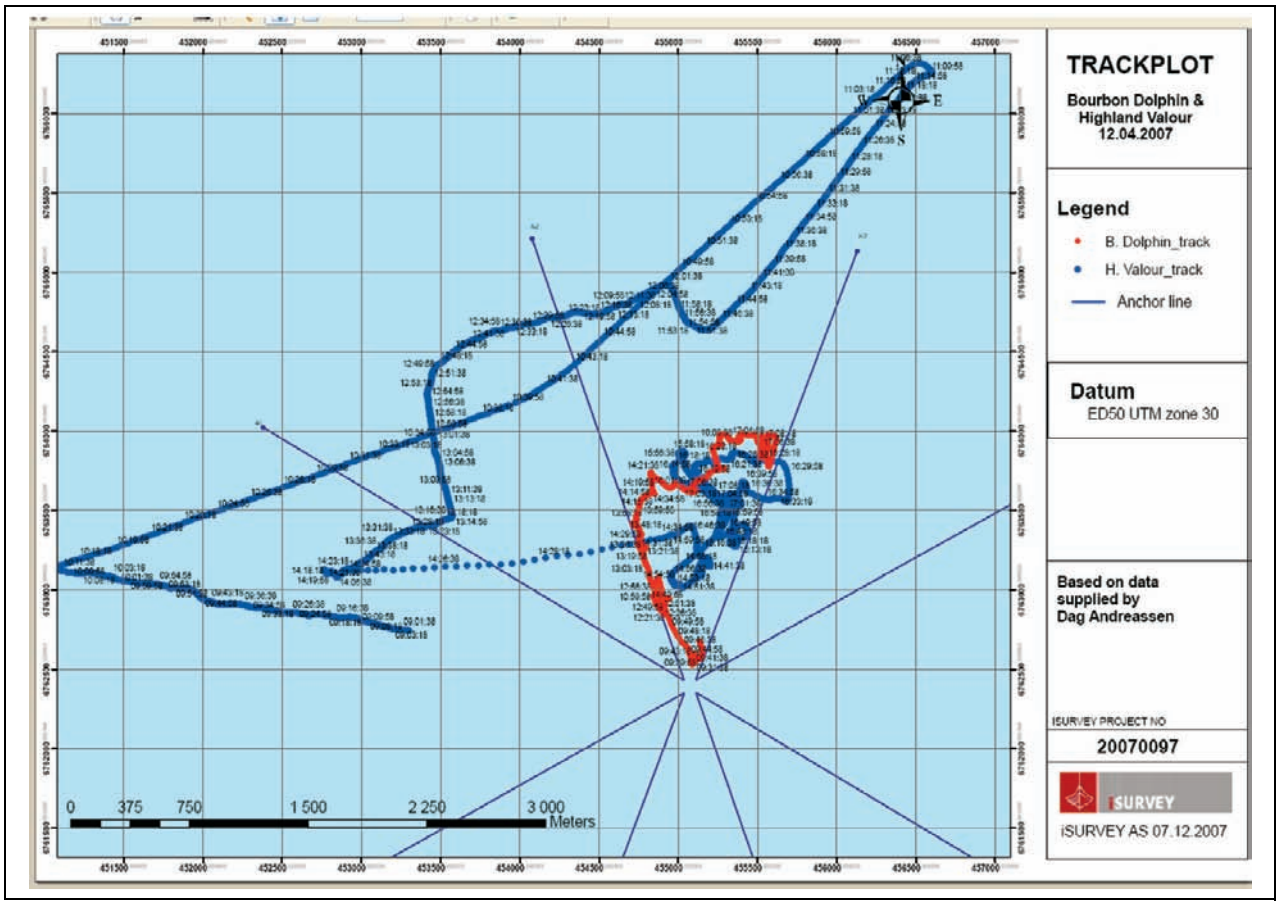


Figure 9.4 Trackplot for the "Bourbon Dolphin" and the "Highland Valour" 12 April

ious, whereas Captain Oddne Remøy appeared more relaxed.

Able Seaman Per Jan Vike testified that he visited the bridge briefly at two minutes to 17. Captain Remøy and First Officer Syversen were then sitting in their seats, whereas the Chief Officer was standing behind them. Sandø, who was off duty, was sitting at the window station beside them. According to Vike there was a normal, good atmosphere on the bridge and he does not remember anything in particular being spoken about.

Listing less than five degrees is noticeable, and on board the "Bourbon Dolphin" they had transferred ballast from the port tank (Tk 37 WB PS) to the starboard tank (Tk 33 WB SB) in an attempt to trim the vessel.

On the rig's part, the towmaster had proposed that the "Bourbon Dolphin" connect chain to workwire and run the wire between the towing-pins, so as – according to the towmaster's testimony – to give them better manoeuvrability. Both the "Highland Valour" and the "Olympic Hercules" heard this over the VHF.

The towmaster testified that he issued no orders, but made a suggestion that might give the "Bourbon Dolphin" greater ability to manoeuvre herself away from mooring line 3.

Captain Bergtun on the "Olympic Hercules" thinks he heard the towmaster suggesting that the "Bourbon Dolphin" should depress the inner towing-pin so as to improve the manoeuvring capabilities of the vessel. None of the witnesses on the "Highland Valour" overheard any such suggestion from the towmaster.

Geir Tore Syversen testified that the towmaster proposed that the "Bourbon Dolphin" run down the inner starboard towing-pin, but that Captain Remøy and Chief Officer Grimstad were at first unwilling to do so. Captain Bergtun testified that he subsequently heard from an able seaman on the "Olympic Hercules" that Captain Remøy got back on the radio and said that they would nevertheless try to depress the towing-pin. According to Syversen, who was on the bridge, but not involved in the discussion, both the master and the chief officer were worried by the towmaster's suggestion. They also thought that the anchor that was lying on the port side of the deck was in the way.

The towmaster has categorically denied having given any orders or concrete suggestions to

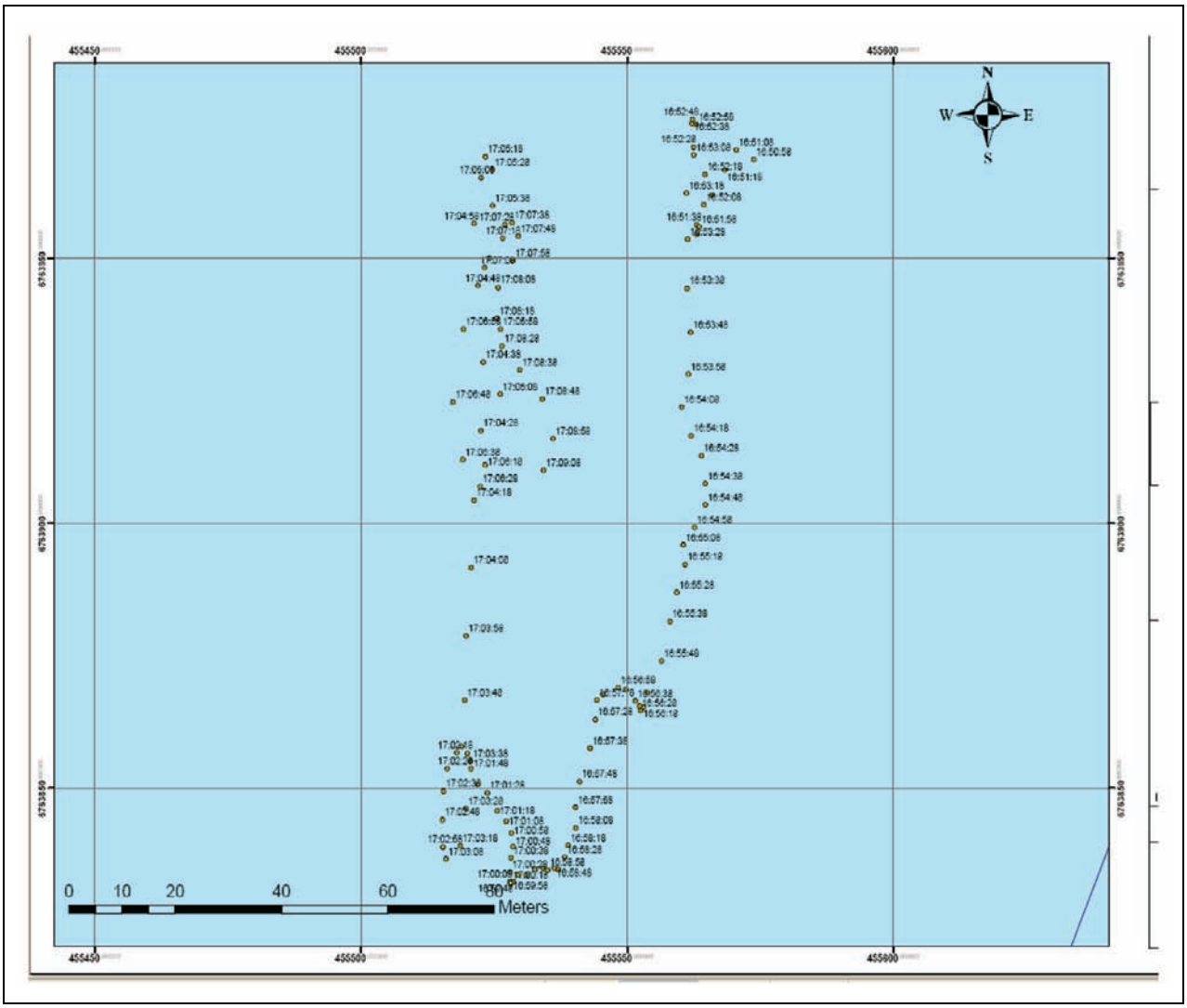


Figure 9.5 Trackplot for the "Bourbon Dolphin" from 16:50 until the capsizing

depress any towing-pin. From his station in the rig's pilot house he could not see the deck of the "Bourbon Dolphin" or any device on board and therefore had no idea which towing-pins were in use. He could not, therefore, have given any concrete instruction as to which towing-pins should be used or not.

Communication on the VHF channel was not recorded and cannot be retrieved.

It is not possible, therefore, to have any definite opinion about what was said. As the Commission sees it, the alternative of depressing the inner starboard towing-pin must have appeared as a possibility for the crew of the "Bourbon Dolphin", since shortly afterwards it was in fact depressed.

The weight of the chain lay against the inner starboard towing-pin, but the vessel was manoeuvred to reduce the load against the pin, so that it was possible to depress it.

This meant that the chain immediately whipped over onto the outer port towing-pin. Both Geir Tore Syversen and Egil Hafsås testified that they saw the chain smack over against the port outer towing-pin and that they heard a loud bang.

It is 2.7 metres between the centre of the inner starboard pins and the centre of the outer port pins, see Figure 5.8. Shortly afterwards the "Bourbon Dolphin" listed dramatically, according to several witnesses by as much as 30 degrees to port. This lasted about 15 seconds before the vessel righted herself again. The Chief Engineer thereafter warned the bridge that the starboard main engine had stopped. There was also a brief blackout and the "Highland Valour observed black smoke from the "Bourbon Dolphin".

Syversen had registered that the tension on the winch before the towing-pin was depressed was 295 tonnes and that it first fell, but then in-

creased suddenly to 330 tonnes just before the ship rolled over. Data from rig winch no. 2 shows that tension on the winch was not more than 180 tonnes at the time of the accident, see Annex 1 Section 3.13. The Commission would like to remark that lack of calibration of winches can lead to great uncertainty in the reading-off of forces.

Shortly afterwards the "Bourbon Dolphin" listed for the second time. The deck crews and the cook had managed to climb up onto the side of the ship. Syversen left the bridge at the same time as activating the winch's emergency release. At 17:08 the "Bourbon Dolphin" rolled over.

In the period from 16:40 to the time of the accident, nothing was entered in the log kept by the towmaster. In the Rig Move Log sheet, kept by Offshore Navigation Engineer Martin Troup of Trident, the time of the accident is given as 17:08 (see further discussion in Section 10.1). Troup also noted the following:

> "Dolphin had no 2 PCP, paid out all chain (rig + vessel), rig wire on winch, Valour grappled chain behind Dolphin, both vessels drifting toward no.3 chain, 100 m west of line, Valour lost grappnel, Dolphin tried heading back toward no. 2 line - struggling against wind and current and couldn't turn to 270° as chain on deck, Dolphin began tacking (zigzag) and was making slow progress to the west, tipped a few times to almost 45°, Valour issued warning to release chain, moments later Dolphin capsized (anticlockwise), had one anchor on deck." *(original in English)*

Troup, who came on watch at 14:00, had not entered anything in his log in the period between his coming on watch and the accident.

ROV pictures of the "Bourbon Dolphin" floating upside down have shown that the chain/wire has a strike-point aft of the winch (crucifix). When the ship rolled over, all the towing-pins sank down of their own weight, as described in Section 5.6, see Annex 1 Section 1.11. From the pictures, therefore, it is not possible to draw any conclusions about which towing-pins were up or down immediately prior to the capsizing.

9.10 Forces affecting the vessel during the accident

9.10.1 Introduction

The vessel was affected by various forces that all together culminated in the vessel rolling over.

The forces may be divided into the following:

- Liquid cargo on board (fuel oil, fresh water, ballast etc.)
- Individual cargoes on board (wire on drums, anchor on deck etc.)
- Tension from the anchor chain with appurtenant angle of attack.
- Water on deck
- Forces from thrusters and main propellers
- Wave, wind and current forces (environmental forces)
- Buoyancy

Some of these forces are static and some are dynamic. The vessel's inertia will be of significance for the dynamic forces.

Liquid and individual cargoes, with the exception of any liquid in the roll reduction tanks, may be regarded as static forces.

Tension from the anchor chain will dynamically affect the vessel. The chain's angle of attack is critical and this can vary.

Water on deck, forces from thrusters and propellers plus wave and wind forces will be dynamic.

Figure 9.6 Picture taken at 16:31.

Photo: Sean Dickson

Figure 9.7 Picture taken at 16:02.

Photo: Sean Dickson

The following information has formed the basis for an evaluation of the forces and variation therein:

- Daily Report from the vessel with information about different liquid quantities, confer Table 9.2.
- Lerwick Port Authority Report on departure Shetland on 10 April 2007, confer Section 9.10.2.
- Information from Captain Frank Reiersen regarding individual cargoes on board given to London Offshore Consultants and used in their stability analyses.
- Information from Captain Hugo Hansen about how his crew used the various tanks. See minutes of stability meeting, Annex 1 Section 1.10.
- Data from stability meeting regarding weights of wire, chain and various deck cargoes.
- Film taken from the rig on a mobile phone at the moment of the capsizing (see Figure 9.11).
- Pictures taken of the vessel from the "Highland Valour" just before the capsizing, see Figures 9.6 and 9.7.
- Witness testimony about the course of the accident and the load condition.
- Line loads.

The Commission has employed hydrostatic calculations in order to explain why the vessel rolled over. In these calculations the following of the above-mentioned forces are included in the vessel's load condition:

- Liquid cargoes on board (fuel oil, fresh water, ballast etc.)
- Individual cargoes on board (wire on drums, anchor on deck etc.)
- Tension from the anchor chain with appurtenant angle of attack (direction of the chain measured as an angle between this and the vessel's longitudinal axis).

The remaining above-mentioned forces will of course have an effect, but the Commission considered that they are of minor significance in explaining the course of events.

It may be seen from the pictures, and was confirmed in witness questioning, that, prior to the capsizing, the vessel regularly had some seawater on deck. The pictures show it running off the deck and not being shipped; and so it does not need to have had an effect in the capsizing of the vessel.

The vessel was affected by wind on her port side. This will contribute to giving the vessel a small list to starboard. Calculations using the IMO's wind and roll criterion give the vessel a list angle of less than 1°. This will be operationally compensated by use of the ballast tanks and has therefore not been used further in the calculations; it is more or less negligible.

Table 9.1 Overview of load conditions

No.	Load condition	Roll reduction tank	Mean chain tension	Variable chain tension	Variation in angle of attack of line	GM (m)	Stability	Transcript in Annex 1 Section 1.12, Pages
1.1	Departure	X	-	-	-	0.89	OK	1-5
1.2	Lerwick	-	-	-	-	1.13	OK	-
2.1	Condition	X	X	-	X	0.95	Not OK	6-10a)
2.2	before towing-pin depressed	-	X	-	X	1.12	Not OK	–
3.1	Condition after towing-pin depressed	X	X	-	X	0.95	Not OK	11-15[b)] 16-20[c)]
3.2		-	X	X	X	1.12	Not OK	20-24[c)] 21-25[c)]

a) Angle of attack = 25%
b) Angle of attack = 40%, 126 tonne mooring line tension
c) Angle of attack = 60%, 180 tonne mooring line tension

Forces from thrusters and main propellers contribute to some extent to the vessel's list and trim. At the moment of the capsizing half of the engine power was out of action and this was therefore less capable of affecting the vessel's float status.

9.10.1.1 Choice of load conditions

The Commission has focussed on the following load conditions:

The Commission has emphasised the following in choice of conditions:

- Departure Lerwick is of interest for:
  - demonstrating some of the weights on board
  - (dis)confirming information emerging from witness questioning
- Condition before the towing-pin was depressed is of interest for:
  - demonstrating use of ballast tanks prior to the capsizing
  - (dis)confirming information emerging from witness questioning
- Condition after the towing-pin was depressed is of interest for:
  - demonstrating the direct cause of the capsizing
  - (dis)confirming information emerging from witness questioning

In its analysis the Commission has both corrected for free liquid surface by use of the traditional method of virtually raising the vessel's centre of gravity, depending on the inertia of the free liquid surfaces, plus a more precise method that means that the liquid's change in centre of gravity depending on the list angle is directly included in the calculations. We have chosen to utilise the more precise method for correction of free liquid surface in the roll reduction tank and the traditional method for the other tanks. The traditional method gives poor results for the roll reduction tank, with excessive values for the free liquid surface effect.

From the daily reports the Commission extracted the following figures that underlie the quantity of bunkers used in the load conditions (see Table 9.2):

9.10.1.2 Tension

The following points of attack for the chain tension are used when incorporated in the load conditions:

- Fore-and-aft:
  - 3.6 m from aft perpendicular (AP) (top of the stern roller)

Table 9.2 Excerpts from daily reports

Point in time	Fuel Oil (m^3)	Lube Oil (m^3)	Fresh Water (m^3)
11 April 2007	464	32.831	147
10 April 2007	488	32.831	150
9 April 2007	507	33.131	153

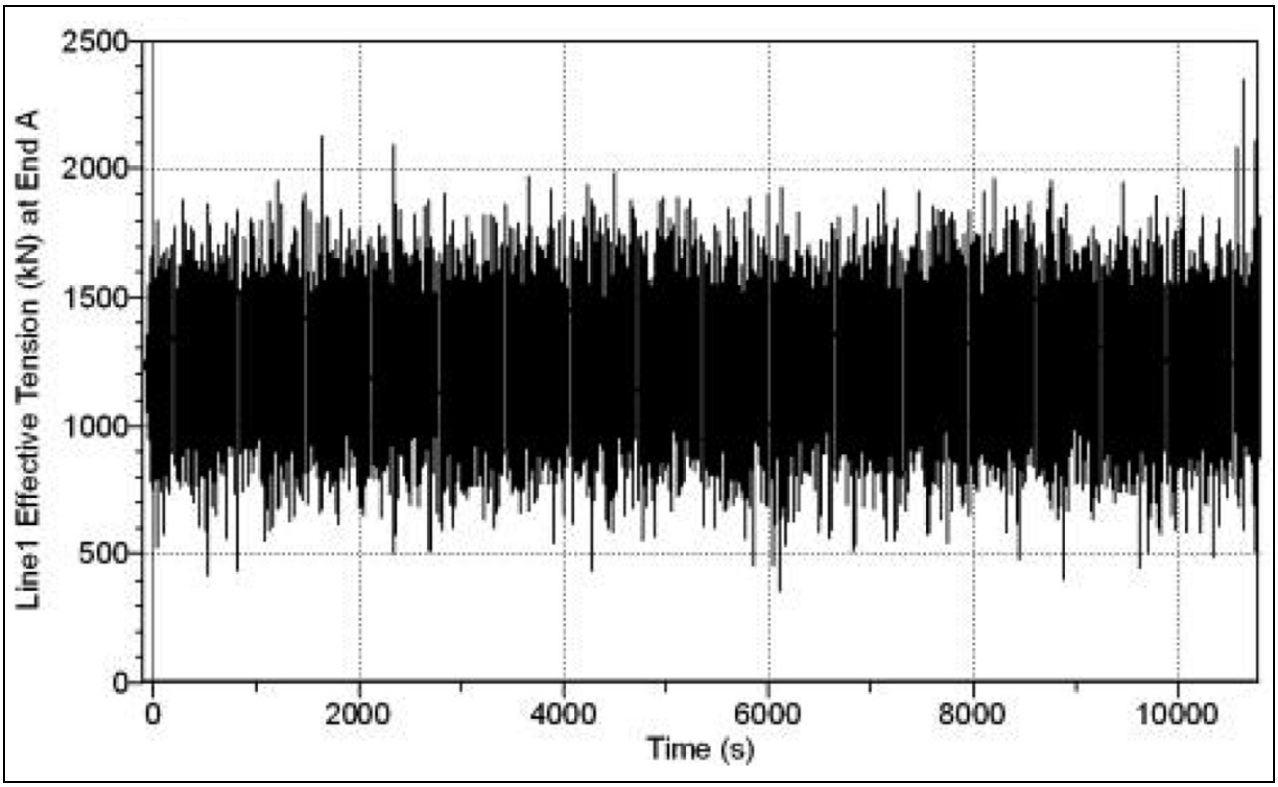


Figure 9.8 Line loads

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-------------------------------------------------------------------------

          HYDROSTATIC DATA for given waterline
           ---------------------------------------
          Draught, midship .... (m) :       6.000
          Trim, + = aft ....... (m) :       0.000
          List, + = stb. ...... (°) :       0.000
          Sea density ..(tonnes/m3) :     1.02500
          Plating ... (mult.factor) :       1.004
          ---------------------------------------
          Displacement ....... (m3) :    4663.736  (moulded)
                       ... (tonnes) :    4800.885
          LCB, rel. to midship  (m) :      -2.073
            ........ rel. to AP (m) :      31.427
          TCB..................... (m) :       0.003
          VCB..................... (m) :       3.331
          Wetted surface ..... (m2) :    1646.730

          Waterplane area .... (m2) :    1022.510
          Tonnes / CM   (tonnes/cm) :      10.481
          Trim moment  (tonn.*m/cm) :      54.857
          LCF, rel. to midship  (m) :      -6.546
               ... rel. to AP   (m) :      26.954
          Length in waterline   (m) :      70.482
          CW (Lwl) ............ (-) :       0.853
          KMT ................. (m) :       8.099
          KML ................. (m) :      80.218
```

Figure 9.9 Hydrostatic calculations

- Vertical:
  - 8.17 m over the vessel's baseline (top of the stern roller)
- Transversely:
  - 0.6 m to starboard when the chain is between the starboard towing-pins. In this situation the chain has an angle of attack to port and may easily be seen in figure 9.6. The centre of gravity has been calculated on the basis of this figure.
  - 2.5 m to port (end of the stern roller). This will be the situation when the chain is lying against the outer port towing-pin and the vessel is listing. This is more than the distance from the centreline to the inner edge of the relevant towing-pin (1.75 m), but is

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Internal Arrangement

No.	Identification text	Net Volume (m3)	LCG (m)	TCG (m)	VCG (m)	Mom.Iner. (m4)
23	T1 WB Forepeak Tank	161.408	63.708	0.000	6.316	269.71
24	T12 WB Centre Tank 1	76.003	31.500	0.000	0.671	345.74
25	T18 Rig Chain Locker 1 PS	133.796	32.725	-1.832	4.659	32.28
26	T19 Rig Chain Locker 1 SB	126.194	32.427	2.166	4.670	22.29
27	T27 WB DB/Wing Tank PS	46.202	7.573	-4.455	4.736	56.43
28	T28 WB DB/Wing Tank SB	46.202	7.573	4.455	4.736	56.43
29	T31 WB Stab. Tank 2	148.301	4.512	0.000	6.477	1228.15
30	T32 WB Aft Peak Tank PS	105.597	-1.216	-4.626	6.034	79.70
31	T33 WB Aft Peak Tank SB	105.597	-1.216	4.626	6.034	79.70
32	T37 WB DB/Wing Tank PS	53.702	52.345	-3.850	3.079	31.36
33	T38 WB DB/Wing Tank SB	45.998	52.208	4.031	3.388	30.45
1	T4 FO DB Wing Tank PS	51.501	47.114	-6.568	4.678	7.86
2	T5 FO DB Wing Tank SB	62.801	46.272	6.809	4.699	6.52
3	T6 FO DB/Wing Tank 1 PS	31.401	37.615	-6.588	1.730	23.90
4	T7 FO DB/Wing Tank 1 SB	45.701	37.564	7.016	2.613	24.07
5	T8 FO DB/Wing Tank PS	99.905	31.200	-7.099	2.870	44.63
6	T9 FO DB/Wing Tank SB	99.905	31.200	7.099	2.870	44.63
7	T13 FO DB/Wing Tank PS	110.204	24.665	-7.013	3.142	35.17
8	T14 FO DB/Wing Tank SB	111.802	24.619	6.985	3.110	37.05
9	T17 FO Centre Tank 2	76.602	24.420	-0.109	0.672	376.95
10	T25 FO DB/Wing Tank PS	93.203	18.289	-5.336	3.130	84.66
11	T26 FO DB/Wing Tank SB	92.503	18.298	5.328	3.098	84.65
12	T34 FO Centre Tank	34.400	13.772	0.000	0.874	106.97
13	T35 FO DB/Wing Tank PS	86.098	13.216	-6.734	5.696	18.02
14	T36 FO DB/Wing Tank SB	86.995	13.176	6.729	5.721	18.02
15	T71 FO Settl. Tank 1 PS	23.500	38.137	-7.968	4.545	0.58
16	T73 FO Service Tank 1 PS	21.400	41.623	-7.912	4.819	0.32
17	T74 FO Service Tank 2 SB	30.600	40.887	7.928	4.745	0.44
18	T75 FO Drain Tank PS	10.399	44.445	-2.119	0.600	13.31
19	T77 FO Overflow Tank	35.800	37.025	0.000	0.562	197.08
20	T79 FO Em. Gen. Tank	0.900	43.750	-6.760	15.150	0.01
21	T2 FW DB/Wing Tank PS	142.900	57.484	-2.276	4.919	77.74
22	T3 FW DB/Wing Tank SB	142.105	57.443	2.286	4.891	73.53
36	T90 LO Store Tank PS	18.200	49.704	-5.984	5.138	2.84
37	T91 LO Tank Main Gear PS	9.301	50.751	-5.635	5.150	1.60
38	T92 LO Aux. Engine PS	9.400	51.450	-5.392	5.156	1.70
39	T97 LO Drain Tank SB	10.900	46.160	0.173	0.600	37.07
40	T99 LO Drop Tank SB	10.399	44.445	2.119	0.600	13.31
34	T66 HP HO Store Tank PS	12.600	44.128	-7.645	5.467	0.42
35	T67 HO Drop Tank	12.600	48.293	1.280	0.629	73.17
41	T52 Sewage Tank SB	36.801	50.413	5.747	5.145	6.57
42	T80 Bilge Water Tank SB	17.100	41.300	1.866	0.505	27.83
43	T83 Sludge Tank PS	17.100	41.300	-1.866	0.505	27.83

Figure 9.10 Tank calculations

regarded as relevant in that the point of attack will move towards port the more the vessel lists.

In the calculations tension is entered as follows:
- The vertical component of the load is entered as a static load with centre of gravity as stated above. The angle between the vertical plane and the line is about 38°.
- The heeling moment given by the horizontal component in the transverse direction is modelled by setting a force couple on the vessel that in total yields a heeling moment that falls off with the cosine of the heeling angle. The heeling moment's arm is calculated on the basis of the tension's point of attack vertically to the centre of the propulsion propeller. The horizontal component in the transverse direction depends on the anchor line's angle of attack vis-à-vis the vessel.

Tension used in the calculations is the result of our own analyses. The calculations were done with the programs Orcaflex and Riflex. Movement characteristics of the vessel were obtained from Ulstein Design, see Annex 1 Section 1.9.

The analyses show that there is a mean force of 126 tonnes with a standard deviation of 22 tonnes, see Figure 9.8. The vertical component of this force is 100 tonnes and the horizontal component 78 tonnes. The tensions in the simulation vary between 35 and 240 tonnes. As seen in Figure 9.8, the forces vary between 80 and 180 tonnes most of the time. The tension variation has a period corresponding to the waves, confer Section 9.5. This is in conformity with observations made by First Officer Syversen, who stated that he could read tension off the winch as 80 and 180 tonnes during the deployment of anchor no. 2.

9.10.1.3 Calculation basis

The Commission's hydrostatic calculations were performed with the aid of the program Shipshape, which is approved by the Norwegian Maritime Directorate for calculation of stability.

Figure 9.11 Bourbon Dolphin on arrival at Lerwick at 14:35 on 10 April

Photo downloaded from www.Shipspotting.com

In our modelling of the vessel's geometry, hull, tanks, buoyancy volumes etc. we have compared the results from Shipshape with what we find in the vessel's approved stability book.

It is important that the geometric model has the correct buoyancy configuration. When checking this, we have chosen to compare hydrostatic calculations with the stability book for a relatively great draught. This is done in order to check that important volumes inter alia in the stern area have been modelled correctly.

Calculation of hydrostatic data for a mean draught of 6.0 metres from the baseline yields the results given in Figure 9.9.

Compared with the stability book, the deviation for important quantities such as displacement is 3 tonnes (0.06 %), for the longitudinal centre of buoyancy (LCB) is 0.026 m (0.04 % of LPP) and for the metacentre height (KMt) 0.007 m (0.09 %). These differences are without any practical significance for the calculation results.

All tank volumes have been defined in line with geometry given by Ulstein Verft in the stability book.

A list of transcripts of calculated volumes etc. is provided in Figure 9.10.

Volume and centre of gravity for the tanks in the model deviate insignificantly from the stability book.

9.10.2 Load condition 1, on departure from Lerwick

The Commission has relatively good information about the vessel's load condition on departure from Lerwick. This includes the main quantity of weights, consisting of wire, anchors on deck and fuel oil and fresh water. What we do not have a good idea of is the quantity of water ballast, including the contents of the roll reduction tanks.

Draught for the vessel on departure from Lerwick has been given as 6.2 metres. This is the draught that was reported to the port authorities. The vessel has a navigational draught that is 0.40 m greater than the draught measured from the vessel's baseline, in that the skeg in the after end goes 0.40 m deeper than the baseline. Draught at the marks refers to the bottom of the skeg. The Commission supposes that the draught stated is navigational draught, and that the vessel on departure from Lerwick thus had a mean draught of 5.8 m (from the baseline).

The vessel was photographed on arrival at Lerwick (see Figure 9.11). From this picture it may be deduced that the vessel had a mean draught of between 5.8 and 5.9 m. This corresponds to a navigational draught of between 6.2 and 6.3 m. It can also be seen from the picture that the vessel has a forward trim of between 0.3 and 0.4 m.

The Commission finds that two anchors were exchanged in Lerwick (two 12-tonne anchors for two 18-tonne anchors) and that this meant an extra deck cargo for the vessel of 12 tonnes. This makes for an increase in the draught of about 12-13 mm. A reported navigational draught of 6.2 m on departure from Lerwick points in the direction of the vessel not having changed her use of water ballast on calling at Lerwick and the vessel thus having more or less unchanged draught and trim on departure.

In his testimony, First Officer Syversen has stated that mean draught on departure from Lerwick was 6.5 m, and that the vessel had a "very small" forward trim. The Commission assumes that this is the mean draught that refers to the draught marks and is thus mean navigational draught.

As both Figure 9.11 and the reported draught point in the direction of a mean draught of around 5.8 m, the Commission chooses to use this as a guideline for modelling of the load condition on departure from Lerwick.

In this condition fuel oil and fresh water are allocated in line with indications given by Captain Hansen in the stability meeting.

There will be uncertainty related to the quantity of liquid in some of the tanks such as Bilge, Sludge, Sewage etc. It has been chosen to fill all tanks of this type to about 30%.

With stated load, stated draught and statements that the vessel was trimmed slightly forward on departure, we find that the vessel must have had water ballast in the aft tanks. According to information given by Captain Hansen at the stability meeting, the Commission finds that the ballast tanks T32 and T33 (see Figure 5.3) were in use because weights as stated and distributed in the vessel would in principle have given a forward trim.

The Commission has also used ballast tanks T37 and T38 in its calculations, as these tanks were often in use.

9.10.2.1 Load condition 1.1 (Condition with roll reduction tank)

The roll reduction tank T31 could have been in use on departure from Lerwick. This tank was

normally filled only with fresh water. If it was filled with fresh water, it is assumed that this was stated in daily reports to the company (see Table 9.2) regarding bunkers on board. Captain Hansen used only this roll reduction tank and never tank T30. Hansen has stated that the roll reduction tank was normally in use when the vessel was transiting, but not during anchor-handling.

The load condition for departure from Lerwick with the use of roll reduction tank T31 is shown in Annex 1, Section 1.12 (pp. 1-4). It appears from this that the condition has a mean draught of 5.80 m with a forward trim of 0.20 m and a GM of 0.89 m. This condition does not fulfil the stability requirements.

9.10.2.2 Load condition 1.2 (Condition without roll reduction tank)

Alternatively it is possible that the roll reduction tanks were emptied and that the freshwater was transferred to tanks T2 and T3. In order to maintain trim it is then necessary to move ballast backwards in the vessel. Instead of using the ballast tanks T37 and T38, tanks T27 and T28 were filled completely. This gives the vessel a forward trim of 0.27 metres and a draught of 5.80 metres. GM is 1.13 and the stability requirements are met.

The Commission regards it as less probable that the vessel left Lerwick without using the roll reduction tank. Testimony from Syversen suggests that it was in use. It was also usual to utilise the tank in transit conditions.

Captain Hansen has also stated that the tanks T27 and T28 were normally not in use, as they were small relative to the ballast tanks located aft in the stern. The Commission finds it impossible to model a realistic condition that gives a GM of 0.26 m in line with Syversen's witness testimony. Even with use of roll reduction tank T30 in addition to T31 instead of the aft ballast tanks (T32 and T33), it is impossible to get anywhere near such a low GM. Other professional milieus who have considered this have also concluded that it is not possible to achieve such a low GM for the vessel. The Commission therefore finds that Syversen's statement must be due to erroneous observation.

9.10.3 Load condition 2, before the towing-pin was depressed

In relation to the vessel's load condition on departure from Lerwick two days previous, the main differences are that:

- the vessel had run out both the chains and deployed an anchor,
- some bunkers had been used up,
- the vessel acquired tension from the chain during the anchor-handling operation, and
- the vessel had changed ballasting.

The picture in Figure 9.7 indicates that draught is still under 6 m and that the vessel has a slight aft trim. In that all chain in this situation has been run out, it is natural to suppose that the rig chain lockers T18 and T19 have been filled with seawater. This is in line with practice on board, and without ballast in these tanks the vessel's draught would be smaller than the picture indicates.

In that the vessel now has a vertical force on the stern roller of about 100 tonnes, it is natural that some ballast has been moved from the tanks T32 and T33. 100 tonnes would be the vertical component of the mean line tension (126 tonnes) in use of a line angle in relation to the vertical plane of 38°. This angle is the result of the Commission's own calculation of tension load in the anchor line.

From questioning of Syversen it is known that the ballast tanks T37 and T33 were in use, in that the Chief Officer at a given point transferred ballast from the port to the starboard side. We assume that the tanks T32, T33, T37 and T38 have been in use to adjust for trim and heel during the anchor-handling operation. We have distributed ballast between these tanks so as to obtain a draught and trim for the vessel that are compatible with the observations from photographs.

9.10.3.1 Load condition 2.1 (Condition with roll reduction tank)

In questioning, First Officer Syversen stated that the roll reduction tank was in use during deployment of anchor no. 2.

In the calculations we have ballasted the vessel with use of tanks as shown above so that she has as little aft trim as possible.

The tension on the line is 126 tonnes. This is mean tension on the chain as found in the Commission's analyses. It will impose a vertical force on the vessel of 100 tonnes. The horizontal force in the tranvserse direction varies with an angle of attack on the anchor line as shown in Table 9.3.

Figure 9.6 [*sic*] shows that the angle of attack is perhaps 20-25 degrees. The calculations show that the vessel probably has a list angle of 2-3° even with small angles of attack. This is in line with statements from witnesses.

Table 9.3 List angles and horizontal force as function of angles of attack, Load condition 2.1

Mooring line's angle of attack (°)	Horizontal transverse force (tonnes)	Vessel's list angle (°)
20	26.3	2.3
25	32.5	2.9
30	38.5	3.4
35	44.1	3.8
40	49.5	4.3
45	54.4	4.7
50	59.0	5.1
55	63.0	5.5
60	66.6	5.8

The calculations for a righted ship (no listing) yield a draught of 5.82 m, an aft trim of about 0.31 m and a GM of 0.95 m. This condition does not fulfil all the stability requirements.

The results for the condition with an angle of attack of 25° are shown in Annex 1, Section 1.12 (pages 6-10). The correcting arm for this load condition is shown in Figure 9.12.

9.10.3.2 Load condition 2.2 (Condition without roll reduction tank)

For this load condition, too, it is relevant to consider the condition without the use of roll reduction tank T31. As for the condition above, the vessel is ballasted with use of tanks T32, T33, T37 and T38.

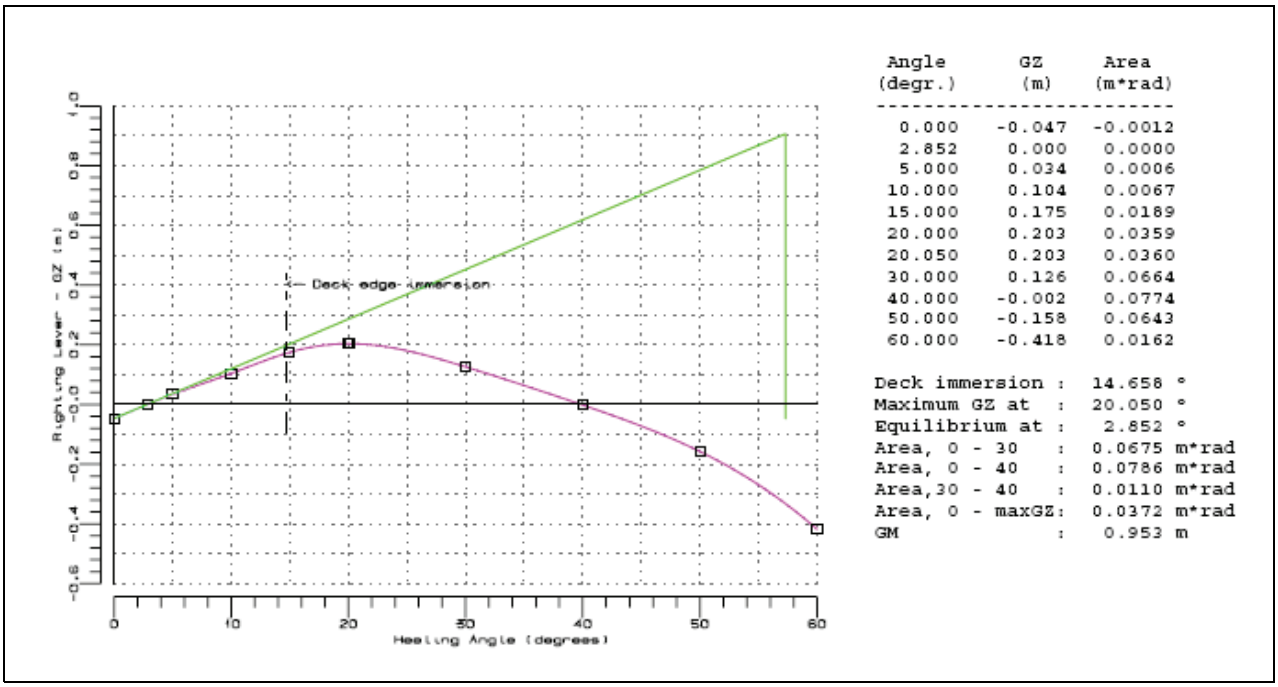
Calculations for the vessel's list angle for variation of the anchor line's angle of attack are shown in Table 9.4.

The calculations yield an upright draught of 5.80 m, an aft trim of about 0.05 m and a GM of 1.12 m. This condition does not fulfil the stability requirements, mostly in consequence of the aft trim. The negative margin is 0.08 m.

The calculations for load conditions 2.1 and 2.2 do not in themselves support conclusions on use of the roll reduction tank. Calculations for both cases are shown to be probable by witness testimony. Statements from Able Seaman Hafsås to the effect that the vessel had a persistent list angle of 5° provide no guidance for this assessment, as the differences are small.

9.10.4 Load condition 3, after the towing-pin was depressed

When the starboard inner towing-pin was depressed and the chain smacked over against the outer port pins, the list moment increased dramatically. Depending on the chain's angle of attack, the moment could increase further. A video clip taken on a mobile phone from the "Transocean Rather" just as the vessel was rolling over (see Figure 9.13) shows that the chain's angle of attack may have been very great – between 40 and 60°. This corresponds with



Angle (degr.)	GZ (m)	Area (m*rad)
0.000	-0.047	-0.0012
2.852	0.000	0.0000
5.000	0.034	0.0006
10.000	0.104	0.0067
15.000	0.175	0.0189
20.000	0.203	0.0359
20.050	0.203	0.0360
30.000	0.126	0.0664
40.000	-0.002	0.0774
50.000	-0.158	0.0643
60.000	-0.418	0.0162

Deck immersion : 14.658 °
Maximum GZ at : 20.050 °
Equilibrium at : 2.852 °
Area, 0 - 30 : 0.0675 m*rad
Area, 0 - 40 : 0.0786 m*rad
Area, 30 - 40 : 0.0110 m*rad
Area, 0 - maxGZ: 0.0372 m*rad
GM : 0.953 m

Figure 9.12 Correcting and heeling arms for load condition 2.1

Table 9.4 List angles and horizontal force as a function of angles of attack, Load condition 2.2

Mooring line's angle of attack (°)	Horizontal transverse force (tonnes)	Vessel's list angle (°)
20	26.3	2.0
25	32.5	2.4
30	38.5	2.8
35	44.1	3.2
40	49.5	3.6
45	54.4	4.0
50	59.0	4.3
55	63.0	4.6
60	66.6	4.9

a probable direction for the vessel in order to reach her anchor station, see Figure 9.4.

Lines have been inserted into Figure 9.13 that may make it easier to see the vessel's floating posture and direction as she capsizes.

9.10.4.1 Load condition 3.1 (Condition with roll reduction tank)

With the use of roll reduction tanks and the same chain tension as before the towing-pin was depressed (126 tonnes), we have calculated the list angle as a function of the anchor line's angle of attack. Table 9.5 shows this variation.

Table 9.5 List angles and horizontal force as a function of angles of attack, 126 tonnes chain tension, Load condition 3.1

Mooring line's angle of attack (°)	Horizontal transverse force (tonnes)	Vessel's list angle (°)
20	26.3	6.7
25	32.5	7.3
30	38.5	7.9
35	44.1	8.4
40	49.5	8.9
45	54.4	9.3
50	59.0	9.8
55	63.0	10.1
60	66.6	10.4

In this situation the vessel has some stability left with a positive reach of the GZ curve to 34°. This is in a situation in which the vessel is stressed with a mean tension. When the pin is depressed the vessel, in consequence of the dynamic conditions, may acquire a list angle of 15 to 20° before she rights herself and acquires a permanent list angle of 7-9°, depending on the anchor-line's angle of attack. For example an angle of attack of 40° gives a permanent list for this condition of about 9°. See Figure 9.14, also Annex 1, Section 1.12 (pages 10-15) for more details.

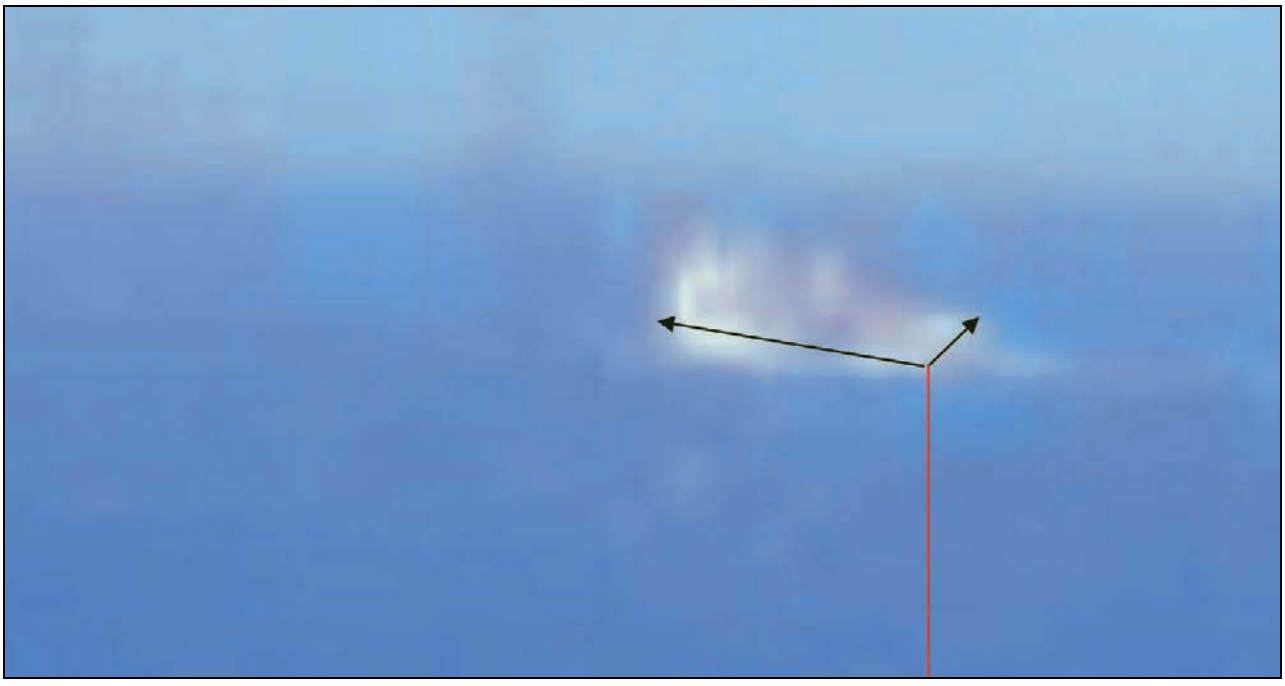


Figure 9.13 Still from a video taken from the rig with a mobile phone at the moment of the capsizing

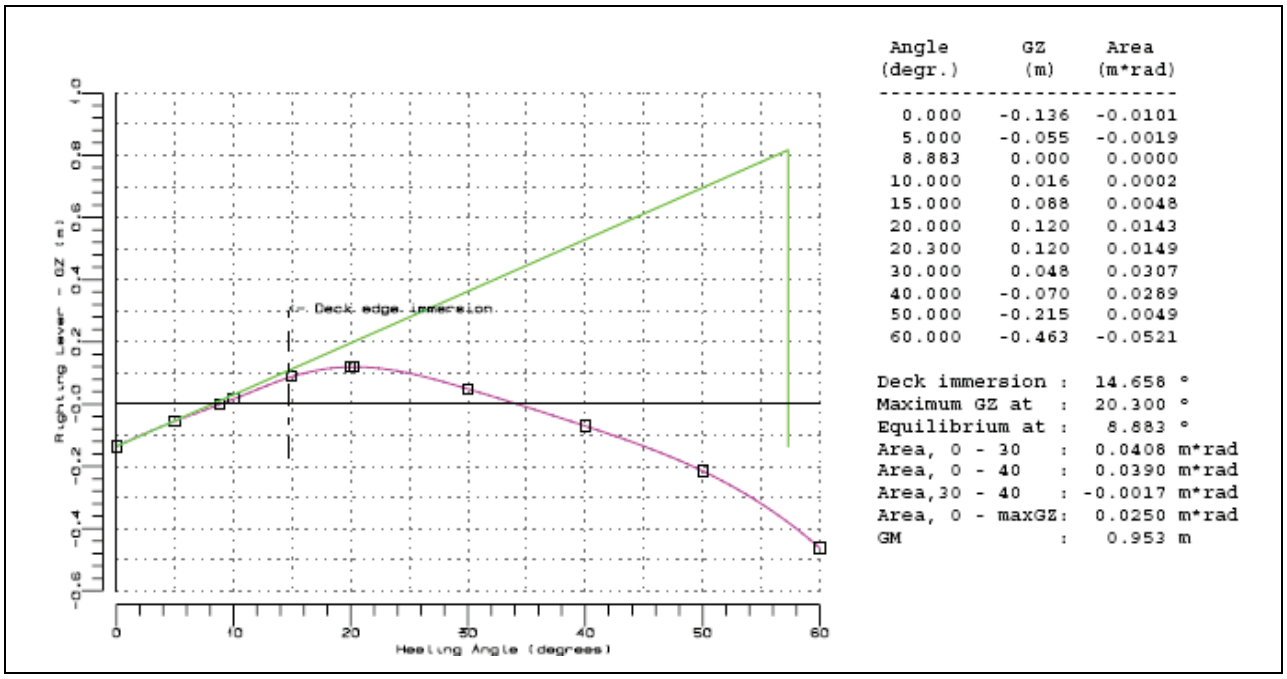


Figure 9.14 Correcting and heeling arms for load condition 3.1 after towing-pin is depressed. 40% angle of attack, 126 tonnes tension

According to witness observations, the vessel first acquired a powerful list to port, and thereafter quickly more or less righted herself again. The calculations for this load condition correspond to these observations. According to the calculations shown in Figure 9.14, the vessel has a positive GZ curve up to a list angle of about 34° and will therefore right herself from a relatively large list angle.

Only after two or three minutes did the vessel develop a powerful new list to port that resulted in the capsizing.

We have also made calculations for this condition for a line tension of 180 tonnes.

As previously explained, the tension in the chain varied most of the time from 80 to 180 tonnes (see Section 9.10.1). Table 9.6 shows how the list angle varies with the anchor-line's angle of attack.

In this situation the vessel has very poor stability. With an angle of attack of 60°, maximum GZ is as low as 0.035 m. In this situation, not much wave effect is needed to capsize the vessel. The GZ curve is shown in Figure 9.15, see also Annex 1, Section 1.12 (pages 16-20) for more details.

Calculations based on 200 tonnes chain tension and an angle of attack of 40° gives a corresponding GZ curve as shown in Figure 9.15.

9.10.4.2 Load condition 3.2 (Condition without roll reduction tank)

For load condition 3.2, we have focused on calculations for 180 tonnes line tension. This has been done in order to evaluate whether it can be demonstrated with a high degree of probability that the vessel would have capsized also without the use of roll reduction tank T31. Table 9.7 shows how list angles vary with the anchor line's angle of attack.

We see from the calculations that with an angle of attack of 60°, the list angle is 11.8°. The GZ cur-

Table 9.6 List angles and horizontal force as a function of angles of attack, 180 tonnes chain tension, Load condition 3.1

Mooring line's angle of attack (°)	Horizontal transverse force (tonnes)	Vessel's list angle (°)
20	37.9	8.9
25	46.8	9.7
30	55.4	10.5
35	63.6	11.1
40	71.2	11.7
45	78.4	12.3
50	84.9	12.9
55	90.8	13.4
60	96.0	13.9

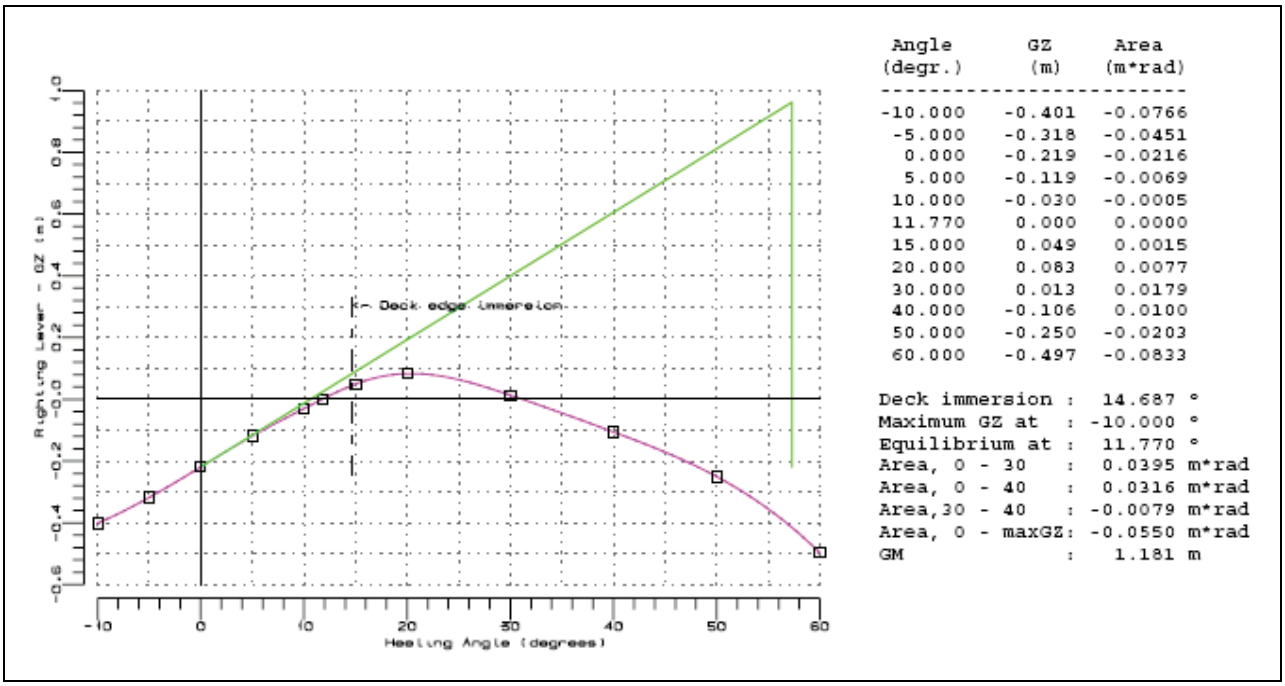


Figure 9.15 Correcting and heeling arms for load condition 3.1 after towing-pin is depressed, 60% angle of attack, 180 tonnes tension

ve for this situation is shown in Figure 9.16. See also Annex 1, Section 1.12 (pages 21-25). This GZ curve means that the vessel should have sufficient stability to tolerate the maximum tension of 180 tonnes even with an angle of attack of 60°, taking into account that the vessel is lying with a permanent list angle of 5-7° with mean chain tension.

On the basis of the calculations for load conditions 3.1 and 3.2, the Commission finds that the capsizing can be explained in terms of a probable load condition for the vessel and forces inflicted by the anchor line. The calculations also show that the roll reduction tank must have been in use during this part of the anchor-handling operation, in conformity with witness observations.

With an angle of attack of 60° and a tension of 180 tonnes, the vessel will acquire a list angle of almost 15°. The calculation in Annex 1 Section 1.12 (pp. 20-24) shows that the vessel's residual stability in this situation is very poor. The difference between the correcting and heeling arms is at maximum 12 mm. The situation is volatile and can end in a capsize at any time, see Figure 9.14.

9.10.5 Comments on the calculations

Even if the vessel had a negative stability margin in the capsizing situation and used roll reduction tank T31, it should be noted that in the modelled load conditions the vessel has a GM that can be regarded as sufficient to avoid casualty in most situations. It is not defective fulfilment of the stability requirements that is the proximate cause of the vessel capsizing. The proximate cause is the angle of attack that the mooring line gradually acquires in relation to the vessel and the tension in this line.

In a real situation a vessel would for a brief time have buoyancy from the bulwark in the side, until water ran onto the deck and this buoyancy effect disappeared. In the same way water can be

Table 9.7 List angles and horizontal force as a function of angles of attack, 180 tonnes chain tension, Load condition 3.2

Mooring line's angle of attack (°)	Horizontal transverse force (tonnes)	Vessel's list angle (°)
20	37.9	7.3
25	46.8	8.0
30	55.4	8.7
35	63.6	9.3
40	71.2	9.9
45	78.4	10.4
50	84.9	10.9
55	90.8	11.4
60	96.0	11.8

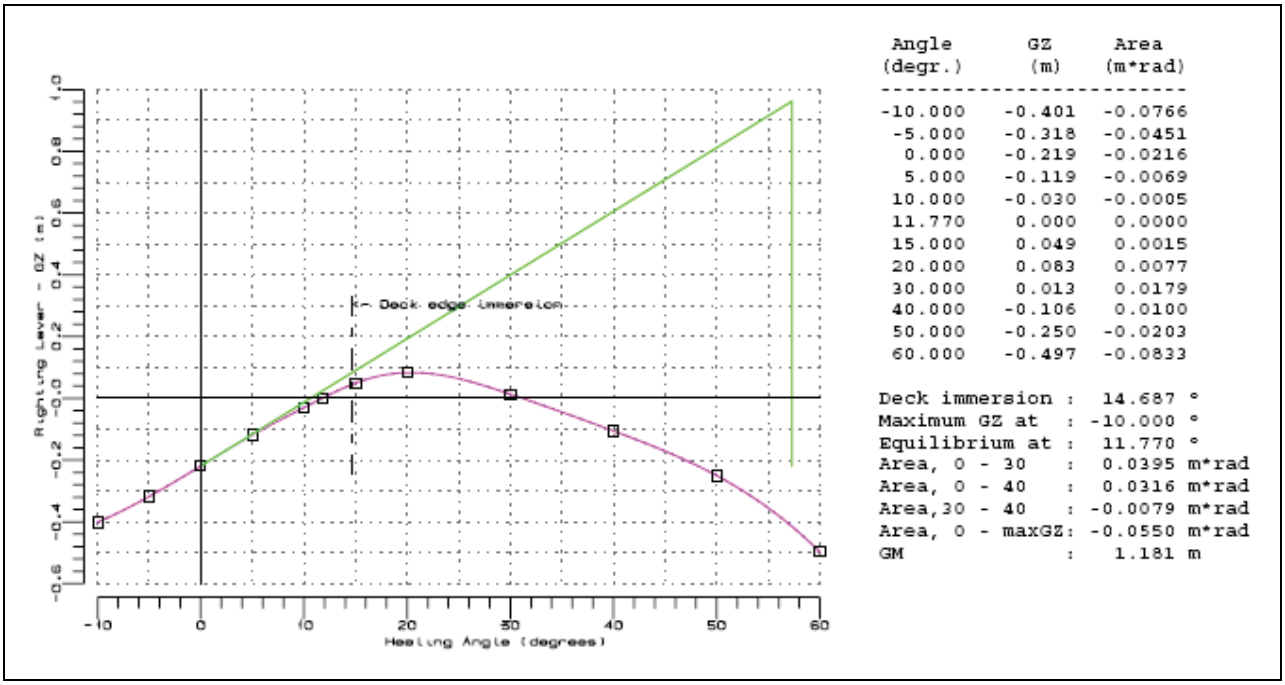


Figure 9.16 Correcting and heeling arms for load condition 3.2 after towing-pin is depressed, 60% angle of attack, 180 tonnes tension

"trapped" on deck for a short period and in a similar way compromise the vessel's stability.

It must in general be pointed out that even if a static calculation for this type of vessel were to show both some residual stability and a list angle of between 10 and 15°, in reality the vessel was dynamically affected by the waves. The residual stability enjoyed by the vessel in such a situation may be insufficient to avoid capsizing under the effect of the waves.

9.11 Evaluation

During deployment of the lines the tension came to 160 tonnes, due to the weight of the chain and wire. When the last line was deployed, the weather was side-on to the vessel. Her thrusters were running at full power, with full loading on the axle generator. Residual bollard pull was thereby reduced to 125 tonnes. The "Bourbon Dolphin" thus had no realistic possibility of reaching her anchor station. As shown in Section 8.3.4, the "Bourbon Dolphin" had been involved in the recovery and deployment of several of the anchors without problems. The reason why she was too weak for the deployment of the last anchor is that the operation began in a marginal weather situation with an unfavourable heading in relation to current, wind and waves.

Mooring lines 6 and 2 run diagonally out from the rig at the same angle as the prevailing north-easterly current (the Gulf Stream) in the area, confer Figure 6.3. The challenges of forcing a lateral current are thus direct comparable for the two mooring lines. Experience gained in deployment of anchor no. 6 will therefore be relevant to deployment of anchor no. 2.

With her continuous bollard pull of 250 tonnes, the "Olympic Hercules" was the biggest and most powerful of the anchor-handling vessels. The "Vidar Viking" is also bigger and more powerful than the "Bourbon Dolphin" and the "Highland Valour". It is clear that during the deployment of the anchor the "Olympic Hercules" developed a considerable drift that could not be corrected by the ordinary use of lateral thrusters and the vessel's propulsion engines.

In the light of the towmaster's testimony, no appreciable weight was laid on the fact that the "Olympic Hercules" drifted from the line. The towmaster maintained that deviations were normal and that it was up to the master and crew of the individual vessel to evaluate the situation, and if necessary suspend the job.

The Commission would remark that in this case they did not appear to have reflected that the problems encountered by the "Olympic Hercules" might result from the current being stronger than expected. This had a transfer value when deploy-

ment of anchor no. 2 was to be performed under the same current conditions.

The "Olympic Hercules" was primary vessel on anchor no. 6. The "Highland Valour" was to assist, but was delayed by a minor repair. The "Vidar Viking" was therefore instructed to assist on anchor no. 6. Despite the fact that this change in vessel composition meant that the two most powerful vessels were to work together on anchor no. 6, whereas the two smaller vessels became partners on anchor no. 2, it has not proved possible for the Commission to find that on the operator's part this led to a changed assessment of risk exposure, weather and current conditions, or a lowering of the threshold for suspending the operation.

As the Commission perceives it, those responsible on the rig laid decisive emphasis on the final result, namely that anchor no. 6 should be deployed in the correct position. It appears to have been without significance that along the way they experienced drifting, unexpected current forces and demanding and risky work on the part of the involved vessels' crews.

The towmaster and others in the rig's pilot house had current information on the vessels' location. In addition to direct observation with binoculars, there were computer monitors on which the vessel movements were continuously plotted. There was also a competent navigator present.

The operator and the rig have made it clear and explicit that they have no responsibility for maritime matters on the vessels, and that it will be up to the master on board to suspend an ongoing operation that he does not regard as defensible. The Commission has no doubt that a demand to suspend the operation would have been respected immediately, if the "Bourbon Dolphin" had made such a demand.

To the degree that tandem operations during deployment of anchors is dealt with in the RMP, this concerns lowering of anchors after chain has been run out and the anchor overboarded at the stern roller. The towmaster's written procedure for the last anchor does not involve any extended use of two vessels at an earlier stage.

Under the updated procedure of 10 April, the "Vidar Viking" was to assist the "Bourbon Dolphin". It also appeared that grappling was to be done in connection with the running out of anchors to take the weight of the anchor chain, that is, not before the vessel had come on station. The distance to the grappling vessel was stated to be 300 metres.

In the deployment of anchor no. 2 the updated procedure was departed from on five major points:

- grappling was done with a different purpose than described in the procedure, namely to assist a vessel that was drifting in an uncontrolled manner
- the "Bourbon Dolphin" was about 2,000 metres from her anchor station
- when grappling started the "Bourbon Dolphin" was about 430 metres from the "Highland Valour"
- the mooring line was not complete
- assistance was given by the "Highland Valour".

The grappling measure initiated by the "Highland Valour" seemed casual and not very expedient. Neither the "Bourbon Dolphin" nor the "Highland Valour" indicated having undertaken a special evaluation of the increased risk exposure that such a measure involved for both vessels. As for the rig, it restricted its responsibility to granting the request for assistance without looking more closely at possible consequences – both for the rig's mooring and for materiel and crew on the two vessels involved. Nor is it clear whether the towmaster thought that the "Highland Valour" and the "Bourbon Dolphin", had they succeeded, should pull the chain together, and if so on what pattern, whether they should get away from line 3 or whether the vessels should stay on stand-by and if so for how long and in expectation of what. Nor, for that matter, is a sideways operation of two vessels enshrined in the RMP.

There is no direct connection between the grappling attempt and the accident. The incidents show, however, that even at that point they were in a situation that was difficult to control and that had not proven susceptible to correction by verbal instructions or the measures attempted.

Neither the substantial drift, the unsuccessful grappling attempt or the near-miss with the "Highland Valour" had any direct significance for the negative development of the "Bourbon Dolphin" listing and later capsizing. Nevertheless, these incidents help to draw a picture of an anchor-handling operation that in its final phase was out of control.

The grappling attempt lasted from 15:00 to 16:40. Its purpose was to bring the "Bourbon Dolphin" back to the run-out line, but instead led to the drift increasing by about 400 metres and the distance to the station for anchor no. 2 growing by about 100 metres.

Even if the crew of the "Highland Valour" had been warned to "expect the unexpected", it is difficult for the Commission to conclude otherwise than that they had gone beyond the unexpected as well. Given that the representatives of the rig and the operator had witnessed such occurrences, it is difficult for the Commission to see why the totality of the operation was not reassessed and perhaps suspended by those with the ultimate responsibility. This must apply even if the paramount commander on the vessel had not demanded that the operation be suspended.

Through its investigations the Commission has discovered that the keeping of logs on board on the rig was incomplete. Even if there are no clear rules for log-keeping, the object is to secure continuous registration of important information and make this available to everyone who needs it.

The OIM did not have immediate responsibility for the maritime operations during the rig move. This was vested in the towmaster. As the person ultimately responsible for the rig, however, he had both the right and the duty to keep himself informed about progress and implementation, inter alia in order to assure himself that the rig was properly moored.

The "Transocean Rather" had chosen an arrangement whereby the functions of Chevron Marine Representative and Transocean Towmaster were merged and vested in one person, who was employed by neither Chevron nor Transocean. In his capacity of marine rep, the towmaster reported to Chevron's shore-based management. Reporting between the towmaster and the OIM was not formalised over and above regular morning meetings. During the day-to-day tasks there was informal contact between OIM and towmaster. From what the Commission has been given to understand, their respective offices were close, and the from time to time the OIM visited the pilot house.

In the opinion of the Commission it merits criticism that the towmaster did not keep the OIM continuously briefed about the situation that was developing. It is also incompatible with the OIM's duties that there were no fixed routines for non-conformance reporting on the rig. As early as 14:30 the "Bourbon Dolphin" had warned the rig of her manoeuvring problems in relation to the run-out line. The problems were not corrected. This was not a matter of a situation that arose suddenly and unexpectedly, but a situation that had been warned about and was gradually deteriorating.

The "Bourbon Dolphin" followed the instructions from the towmaster to proceed westwards, away from anchor line 3. It may appear that neither the towmaster nor the master was aware of the danger inherent in the chain acquiring an angle of attack that gradually increased as the vessel changed her heading to the west. The chain was directly affected by current, at the same time as the vessel's movements in the sea affected the drag from the chain.

The point of attack for the chain on the stern roller was dramatically changed when the inner starboard towing pin no longer secured the chain on the starboard side. The load against the outer port pin, in combination with the angle of attack of the mooring line in relation to the vessel, created the situation that ended in the loss of the vessel. The vessel's current load condition, the influence of current and waves and reduced manoeuvrability after the starboard main engine stopped, made it difficult for the vessel to extract herself from the situation.

The Commission finds that the depression of the inner starboard towing-pin was discussed on the "Bourbon Dolphin" in the critical period right before the capsize. The Commission would, however, remark that neither the officers of the "Bourbon Dolphin" nor the towmaster could have been aware of the stability challenges involved in the use of the outer towing-pins in the given situation.

The emergency release was not activated until Syversen left the bridge when the vessel heeled for the second time. It appears to have been the general perception on board that the emergency release function of the winch acted as a so-called "quick release" that caused spontaneous and full unspooling of wire or chain on the winch as soon as activated. In the Commission's opinion, this misunderstanding may help to explain why this emergency measure was not taken earlier.

As demonstrated, constant tension on the winch cannot have been as high as 330 tonnes. The Commission would not, however, rule out the possibility that tension at some point in time immediately before the capsize can have shown such a big load on the winch. In no circumstances had such a high tension been necessary to capsize the vessel. As shown in Section 9.10, the vessel can capsize with a line tension of 200 and 180 tonnes, with an angle of attack of 40° and 60° respectively.

No cost estimate for the operation has been submitted to the Commission. The five vessels were hired on fixed daily rates of a considerable size. There were no time-frames in these agreements.

Even if the operator has emphasised that the safety of the operation is always considered more important than rapid implementation, there is also reason to believe that the overall cost of the operation was also under continuous review.

In the Commission's opinion, the possibility cannot be ignored that a conscious or unconscious wish to get finished on the part of those involved may have led to an inadequate focus on safety in the concluding phase.

The RMP calculated the operation as taking five days and eight hours. From the start-up on 26 March, when the "Olympic Hercules" and the "Bourbon Dolphin" were hired, as the first two vessels, until 12 April, was more than 18 days. The operation was thus considerably delayed. It had been hampered by the weather and there had been other delays, inter alia equipment had to be repaired and replaced. Several people indicated that there had been a lot of waiting and that the operation had been fragmented and sometimes not very structured.

On 12 April the rig had been manned to start drilling.

It is particularly difficult to retain a fixed focus on the safety barriers even at the end of an operation. Experience shows that for one reason or another human attention will always be distracted. If an operation is perceived as routine, if everything has gone well previously, if the people involved are for various reasons impatient and want to finish up, it is crucial not to ease off on the safety requirements. In such a situation it is essential that no one is pressured or allows themselves to be pressured.

In this context the Commission would also point out that one of the anchor-handling vessels, the "Vidar Viking", had been given permission to leave the field before the operation had been completed. That was unfortunate, for reasons of safety and emergency response.

Chapter 10
The rescue operation

10.1 Introduction

The Commission will provide only a description of the rescue operation. It lies outside its terms of reference to evaluate how the operation was carried out. The H&SE (Health & Safety Executive) has stated that they are undertaking a investigation of the rescue operation in Scotland. The main focus is to look at potential for improvement, not to make anyone responsible for any errors and faults. The investigation is still in progress and had not been completed when this present report was submitted.

The following account will operate with precise times. The information has been obtained from various logs. Synchronised clocks were not employed, nor can we be sure that all information was logged immediately. Even if there may be small discrepancies with regard to accuracy, the precision is regarded as being of such a quality that we can refer to the times as stated in the logs. There exist several logs and the time stated for the same communication may vary somewhat from log to log. It is a matter of very small variations.

The information in this chapter is obtained from the following documents:

1. Towmaster's log, kept on the rig, see Annex 1 Section 5.1.
2. Ballast control room log, kept on the rig, see Annex 1 Section 5.4.
3. Transocean Emergency response log, see Annex 1 Section 5.3.
4. Chronological list of events at site, see Annex 1 Section 5.5.
5. Joint statement by Chevron / Trident / Transocean.
6. Maritime and Coastguard Agency
7. Main Rescue Centre Sola (HRS)
8. Operational log, Sunnmøre Police District (LRS)
9. Trident's navigation log, see Annex 1 Section 5.2.

These documents will also be referred to later in the chapter, by quoting solely the number of the log or document. For example, the emergency response log will be referred to as "(3)".

10.2 Raising the alarm – establishment of rescue leadership

OIM Patrick O'Malley was in the pilot house when the "Bourbon Dolphin" capsized. He immediately raised the alarm, and took command of the rescue work. The "Highland Valour" and the "Olympic Hercules" were at once requested to assist, as was the standby vessel "Viking Victory". According to the rig's towmaster log (1), the capsizing occurred at 17:10, while in Trident's navigation log it is given as 17:08 (9).

Transocean's shore-based management and the British coastguard were notified at 17:16 (4). A minute after that, the OIM activated the emergency alarm for the crew on the rig.

In his testimony to the Commission, Chevron's Peter Lee, MOE (Manager for Operational Excellence) stated that he was alerted at 17:15. Necessary personnel were called into Transocean's office in Aberdeen where an emergency response room was established. Transocean was assigned the main responsibility for the rescue work, with the OIM as on-scene leader. Chevron assisted with all the support necessary.

Chevron undertook responsibility for logistics and personnel questions, dealing with survivors, next of kin and evacuated personnel from the rig. Chevron established its own emergency management team, and in addition a crisis team. The latter was to relieve the emergency management team with regard to external communication so that the emergency management team could concentrate as much as possible on the operation itself. Chevron had no local representative in Shetland, and the first priority was to establish local representation. They got hold of a retired police officer with experience of both the oil and gas

industry and of crisis situations. Chevron was also in contact with Bourbon Offshore, which wanted assistance with accommodation and any other help they could give the survivors.

10.3 The survivors

First Officer Geir Tore Syversen had succeeded in getting off the bridge by climbing out through a door on the starboard side. At this point in time the list was so great that he had problems getting the door open. In addition to Syversen, Chief Officer Bjarte Grimstad and Able Seaman Tor Karl Sandø attempted to get through this door. The last observations that Syversen made of the situation on the bridge was that Captain Oddne Remøy, his son David Remøy and Sandø were slipping or falling down to the port side. Syversen has also testified that he saw Kjetil Rune Våge in the process of putting on a survival suit. After getting out, Syversen climbed up onto the railing on the starboard side. It was about at that moment the vessel rolled over.

Syversen was pulled under water when the vessel rolled over. When he came up to the surface, he was about half a metre from the vessel. He had not had time to don any survival gear. The vessel drifted away from Syversen. He spotted Able Seaman Per Jan Vike, who was lying in the water wearing a life-jacket. Syversen swam over to Vike, and clung onto him. After a short while they managed to climb aboard a float that drifted towards them. The float, which was partly full of water, was the only one of the vessel's rescue floats that had released.

Able Seaman Per Jan Vike was sitting in the TV room (the smokers' mess) when he noticed the vessel listing to port. The list was so powerful that he saw the sea just under the scuttle when he looked out. After donning a life-jacket he tried to climb after the vessel as she capsized. He jumped into the sea and managed to position himself after the above-mentioned float.

Able Seaman Øystein Sjursen was sitting in the lobby on main deck when he noticed the vessel listing to port. He went to the control room, where Chief Engineer Frank Nygård, engineer Ronny Emblem and electrician Søren Kroer were. There, on a screen, he could see the winches and the chains that ran through the towing-pins and out into the sea. He saw a lot of seawater coming on deck. He was worried, and returned to the lobby. Here he met trainees Kim Henrik Brandal and Thomas Arnesen and ran with them up to A Deck, where he met Able Seaman Egil Atle Hafsås. Hafsås opened the locker containing life-jackets. Sjursen understood that this was going to go badly. He climbed over the railing and up onto the vessel's side. At this point he heard the "abandon ship" alarm. When he understood that the vessel was not going to right herself again, he panicked and jumped into the sea.

Sjursen first tried to swim towards a container that had been on deck, but saw that there was a rescue float that was closer to him. When he reached the float he saw that Geir Tore Syversen and Per Jan Vike had already climbed into it.

Just after the inner starboard towing-pin was depressed, the vessel listed powerfully, about 30° on Hafsås' estimate. The vessel righted herself again, but Hafsås decided to put on a survival suit. On A Deck he managed to open the locker containing life-jackets. Here he met the trainees Arnesen and Brandal and gave them their jackets. When he went to fetch the survival suit the vessel had a black-out, but the power soon returned. The vessel listed and he went along the side of the ship and fell into the sea. As he was lying in the sea he saw a rescue float, but it was too far away for him to reach. He also saw a container that had come loose from the deck. The container drifted towards him and he managed to cling onto it, together with Brandal and Arnesen. They were drifting steadily further from the "Bourbon Dolphin".

The cook Ånje Nilsen was sitting with Able Seaman Per Jan Vike and watching TV when the vessel listed strongly to port. They went to the exit and got hold of life-jackets. Nilsen was standing on the port side of the ship and after a while the vessel listed so steeply that he fell into the sea. He began to swim away from the vessel as soon as he was in the water. He saw two of the crew coming up to a float, while three others were managing to hold onto to what he thought was a plastic barrel. He himself lay in the water until he was picked up by a rescue craft (25 minutes later, by his own estimate).

The "Highland Valour", which was the ship closest to the "Bourbon Dolphin", began immediately to proceed in the direction of the casualty. Skipper Gordon Keith Williams had observed the capsizing from the bridge and had triggered the main alarm. The "Highland Valour" took station east of the "Bourbon Dolphin". The crew could see survivors, in addition to flotsam from the casualty. It was also testified that a MOB boat was

launched at 17:30. The MOB boat went to the container to which Egil Atle Hafsås, Kim Henrik Brandal and Thomas Arnesen were clinging. The three of them were taken aboard the "Highland Valour", where they stayed until about 21:00, when they were flown to Tingwall.

At 17:17 (5) the "Viking Victory" deployed her first Fast Rescue Boat (FRV), and three minutes later her second rescue boat was launched. At 17:26 (4) the rig was informed that one of these rescue boats had picked up a survivor from the sea. This was the cook, Ånje Nilsen. He was the only one of the seven survivors who had not climbed onto a float or found something to cling onto. Nilsen was frozen and was given fresh clothes, and they tried to keep him warm. After being in the vessel's sickbay, at 20:34 (4) he was fetched by the helicopter and flown to a hospital in Shetland where he was examined by a doctor. He was in the hospital for 2-3 hours.

After Ånje Nilsen was taken on board the "Viking Victory", Syversen, Sjursen and Vike were picked up by that vessels' rescue boat and then taken on board the mother ship. They remained on board this vessel until they were flown to Tingwall together with Ånje Nilsen.

The seven survivors were reunited at the hospital in Tingwall. After being examined at the hospital they were given rooms at Lerwick Hotel, and shortly afterwards questioned by the Scottish police.

10.4 The search for the missing

The rescue boat from the "Highland Valour" picked up three of the survivors. The rescue boats of the other vessels were, however, more suitable under the prevailing weather conditions. The crew therefore returned to the "Highland Valour" again. The vessel continued to search for the missing.

Captain Grim Are Bergtun of the "Olympic Hercules" stated that his vessel was called up by the rig at 17:10. They came up to the casualty after about 20 minutes and immediately launched their MOB boat to search for those still missing. At that point the seven survivors had already been picked up by the "Viking Victory" and the "Highland Valour". Various minor objects from the casualty were found, among other things life-jackets and lifebuoys, but no persons. They continued the search through the evening, the whole night and the next day.

At 17:43 (4) it was stated that two persons had now been taken aboard the "Viking Victory". One of them, Bjarte Grimstad, was dead. The survivor was, as previously described, Ånje Nilsen. Ånje Nilsen testified that after he had been taken aboard the rescue boat of the "Viking Victory", Bjarte Grimstad was found. Nilsen was quite certain that Grimstad was already dead when he was brought aboard the "Viking Victory". According to Nilsen, Grimstad was not wearing a life-jacket or survival suit, but only camouflage trousers and a jumper.

In the introductory phase of the rescue operation there prevailed uncertainty with regard to the number of persons who had been on board the "Bourbon Dolphin". According to the Transocean emergency response log (3), not until 18:39 was it confirmed via information from the company that the correct figure was 15. Before this, the various logs were operating with 12, 14, 15 and 16 persons. In the first hectic and confusing part of the operation, there were also divergent messages about the number of survivors and missing. In the rig's towmaster log (1), for example, it was entered at 17:34 that the "Highland Valour" reported eight survivors, whereas the correct number was seven. It was made clear that this was an unconfirmed message. There was also erroneous log information at 17:57 (4) to the effect that five survivors had been taken on board the "Viking Victory", whereas the correct figure was four. These four were Ånje Nilsen, Geir Tore Syversen, Per Jan Vike and Øystein Sjursen.

At 17:30 (4) the rig got confirmation that two helicopters would be assigned to the rescue operation and were expected to arrive at the location at 18:10. The helicopters were on the spot at 18:22 (4) and 18:26 (4), and immediately began searching for people in the sea. The first helicopter reported at 18:34 (4) that they had picked up one person and were ready to land on the rig. At 18:40 (4) the other helicopter reported that they, too, had picked up a person. At 18:44 (4) both persons were brought aboard on the rig. In both cases the log used the term "casualty". According to Chevron, this term is used until the facts are established, in case the communication is being monitored by unauthorised persons. At 18:56 (4) both were declared dead. The deceased were Captain Oddne Remøy and First Officer Kjetil Rune Våge. The log information does not say who was on which helicopter.

Later in the evening the airborne search was further intensified with the use of Nimrod mari-

time surveillance aircraft. The first plane was deployed in the operation at 19:00 (4), and was later relieved by another aircraft of the same type. These planes could be used to localise the missing.

Captain Halvor Magnus Enoksen of the "Vidar Viking" testified that he was notified of the capsizing by mayday at 18:15. The "Vidar Viking" had left the field at 13:25. They were back at the location and began to search for missing at 22:00. With the "Vidar Viking" in place, at this point five vessels were participating in the rescue operation. The search for the missing continued the whole night. Next morning at 08:12 (4), the "Vidar Viking" reported that they had found the MOB boat from the "Bourbon Dolphin" 15 nautical miles from where the capsizing happened. There was otherwise a good supply of vessels volunteering to participate in the operation. For example the vessel "Ice Flower" offered to assist in the rescue operation at 20:16 (4); she was not used, but sat on standby in case she was needed later.

At 19:52 (4) the coastguard was informed of the names of the persons who had been saved. In this context it might be mentioned that not until 00:21 (UK time 23:21) was the operations centre in Sunnmøre able to confirm the names of the survivors. This was information that came via Bourbon Offshore Norway AS' office at Fosnavåg, and not from British rescue authorities.

At 20:56 (4) one of the helicopters was released from the rescue assignment by the coastguard, in order to transport survivors to Tingwall. Shortly after the other was sent to Shetland to refuel and bring navy divers back to the accident site. After that time the helicopter was not used to search for the missing. Through the night, the helicopter capacity was used to evacuate the platform crew. Airborne search for the missing continued through the night with the Nimrod aircraft.

At 21:25 (4) yet another standby-vessel offered its assistance. This was the vessel "Grampian Frontier" which had been on the BP Foinaven field. The coastguard had earlier asked vessels for equipment for diving operations, and the "Grampian Frontier" had a compression chamber for divers. The vessel arrived at 23:28 (4).

At 22:00 (4) word went out that the search should continue through the night. The "Highland Valour" was designated to command the participating vessels and also monitored the position of the "Bourbon Dolphin". At 22:32 (4) the "Highland Valour" reported that the casualty was lying deeper in the water. In subsequent reports through the night, no changes in the casualty's buoyancy were reported.

At 22:56 (4) the helicopter with three divers landed on the rig. The divers were to operate from the "Grampian Frontier". At 00:37 (4) the divers were ready to fly out to the "Grampian Frontier". At 01:57 (3) one of the divers was transferred to the "Subsea Viking"; he was to go through pictures taken by a ROV minisub with a view to making sure that it would be safe to dive underneath the casualty. At the same time, the other two divers undertook a closer inspection of the hull of the "Bourbon Dolphin". Thereafter these two were also taken on board the "Subsea Viking" in order to evaluate the pictures taken of the bottom of the "Bourbon Dolphin". It was also the intention that the ROV should accompany the divers and observe their work.

Through the night further observations were undertaken with the ROV. The weather conditions were difficult, and at 05:48 (4) it was decided to suspend further investigations with the ROV until the current had slackened. The weather conditions meant that the divers did not find it advisable to enter the water. At 09:56 (6) pessimism with regard to the chances of being able to dive was expressed. In the coastguard's log the time is given as 08:56 GMT.

In the morning a new ROV investigation was made. At 12:53 (11:53 GMT) it was entered in the coastguard log (6) that pictures taken by the ROV showed something that was thought might be one of the missing, on the bridge. Even though the conditions were difficult, it was decided that the divers should undertake an investigation of the casualty. The first diver was in the water at 13:41 (4), and in time all three of the divers participated in the operation. In the light of the filming done by the ROV, the divers concentrated on the bridge of the "Bourbon Dolphin", so as if possible to find the missing. The divers were not in the vessel, but for safety reasons were instructed to make their observations from outside. The diving continued up to 14:50 (4). The divers then returned to the "Grampian Frontier" and stated that it was not possible to make further dives because of excessive current and waves. At 15:26 (4) the divers reported that they had seen no signs of any of the missing. They later stated that they were 95 % certain that none of the missing were on the bridge.

At the same time as the divers arrived at the site, a partial evacuation of the drillrig was under way, since a collision between the casualty and the rig and/or mooring system was feared. After the

divers had been taken out to the "Grampian Frontier", the precautionary downman of the rig began. It was decided to evacuate personnel who were not vital to the safety of the rig. This covered 72 of a crew of 99. Evacuation began at 00:21 (4) and was, according to Peter Lee, completed at 06:00 next morning. In the course of the night, at 02:20 according to the Transocean emergency response log (3), there was also contact with technical manager Bjørn Bergsnes of Bourbon Offshore in order to discuss a possible release of the "Bourbon Dolphin" from the chain.

At 15:45 (4) the rig was informed by coastguard that the operation was changing its nature from a rescue action to a salvage operation. The vessels participating in the operation should nevertheless continue searching for missing.

During the Commission's hearings it was stated by Transocean's Rig Manager Adrian Brown that a scenario featuring the capsize of a vessel in anchor-handling was not something they had ever drilled for. According to him, this was an event that was impossible to foresee. In the light of the near-miss at 16:25, he was asked whether a collision between two vessels, and a possible casualty, was something they drilled for; he answered in the negative. Transocean's procedures had no requirements for rescue drills with a view to such situations. In the procedures there was a requirement that they drill for man over board situations and collisions between rig and vessel. The testimony from Brown is included in special Annex 2 Part 8.

Peter Lee told the Commission that, the week after the accident, Chevron undertook an evaluation of the rescue operation. Everyone who had a role in the emergency response participated. Some experiences were gained and it was recognised that certain things could have been done differently, but by and large the emergency response had been as effective as it could be, given the tragic circumstances. One of the things they had learned was that it was important to have a local representative in Shetland in order to support for survivors after they came ashore. In this case it had worked well, because they were lucky enough to find a suitable person (a retired police officer). Chevron has now formalised this element of future incidents.

It was also found that jurisdiction had created various problems. There was a lack of clarity regarding the responsibility of the various British and Norwegian authorities. They had to deal with two different police districts in connection with the destinations of the deceased and the 72 evacuees. Uncertainty also prevailed with regard to Norwegian jurisdiction over the deceased. This had resulted in contradictory instructions. Chevron and Transocean have held a meeting with the police authorities in order to get this to function more flexibly in future.

10.5 The Main Rescue Centre at Sola/ the local police in Norway

The Main Rescue Centre at Sola, outside Stavanger, (Norwegian abbreviation HRS) was notified of the capsizing at 18:24 (7) by the MRCC (Maritime Rescue Co-ordination Centre) in Aberdeen. About fifteen minutes had then elapsed since the capsizing, which took place at about 18:08 Norwegian time. According to the log the message was that the "Bourbon Dolphin" had capsized north-west of Shetland during an anchor-handling operation. The situation was described as unknown, without this being amplified further. The HRS was requested to find the owner and obtain information about how many were on board. MRCC Aberdeen stated that there were normally 12 persons, but that they lacked precise information.

Via various electronic searches the HRS found the owner, Bourbon Offshore AS. Contact was established with the Operation Manager, Bjørn Idar Remøy. He would set himself up at the company's offices at Fosnavåg, and estimated that there were 15 persons on board the "Bourbon Dolphin". At 19:04 (7) the company reported that they were in place on the premises at Fosnavåg. At the same time, it was confirmed that the number of persons on board was 15.

The "Bourbon Dolphin" had her home port at Fosnavåg in Sunnmøre. Sunnmøre Police District is thus the Local Rescue Centre (Norwegian abbreviation LRS). After several enquiries about a possible ship casualty, at 20:54 (8) the LRS contacted the HRS, which confirmed the capsizing and stated that five persons were missing. The HRS immediately forwarded the crew list to the operations centre in Sunnmøre.

According to the police log, the HRS stated that they had in fact alerted the local police, though this does not appear in the logs of either the HRS or the LRS.

At 21:14 (8) the Sheriff of Herøy & Sande Municipality was commissioned by the LRS to establish contact with the company. Sheriff Per Otto

Myklebust and Sergeant Detlef Sandanger proceeded immediately to the company's premises at Fosnavåg. As early as 21:15 (8) the LRS was contacted by the Designated Person Ashore in Bourbon Offshore, Eli Oksavik. She stated that the Managing Director was Trond Myklebust and gave the police the necessary telephone numbers. She also stated that a full catastrophe system had been initiated. Oksavik also informed the police that the company had a list of all the next of kin.

At 23:46 (8) Sergeant Sandanger from the company offices stated that the following of the crew had phoned home or to the company and confirmed that they had been rescued: Geir Tore Syversen, Per Jan Vike, Egil Atle Hafsås, Thomas Arnesen and Kim Henrik Brandal. A little later, at 00:21 on 13 April (8), Sandanger stated that the aforementioned persons plus Ånje Nilsen and Øystein Sjursen were now in the hospital in Shetland. None of them were said to be seriously injured physically.

Sergeant Sandanger stated that it had been Able Seaman Per Jan Vike who had called the company and given the information, so that it was finally confirmed that seven of the crew had survived the accident. At the same time, Sandanger expressed frustration that they had such big problems getting information from the emergency management team in Lerwick and Aberdeen. As mentioned above, it was the survivors themselves who had called the company and reported their rescue. The Norwegian Foreign Ministry was contacted, and they would contact the Norwegian consul on the spot. Only a few minutes after the identity of the seven survivors had been confirmed, Sandanger stated that the next of kin of the survivors had been informed. At the same time he stated that three persons were confirmed dead, but that he had not been able to confirm their identity.

At 00:30 (8) the Norwegian consul-general in Scotland contacted the LRS. He wanted to be put in touch with the emergency management team in Scotland, in an attempt to improve the flow of information. Shortly afterwards the consul-general reported that the police in Aberdeen were apologising for the lack of information, at the same time as the Norwegian police were given a contact number. Calls to this number were not answered.

At 03:42 (8) the Sheriff of Herøy and Sande stated that the company would send out a plane to Shetland. The Sheriff decided to send Sergeant Detlef Sandanger to Shetland as liaison. This was desired by both the company and the Scottish police. The decision was sanctioned by the Chief of Police the next day.

At 08:15 (7) the British emergency management team told the HRS that they did not consider it necessary to have the helicopter continue search for the missing.

At 17:02 (8) Sergeant Sandanger stated that two deceased were on board the platform, whereas the third deceased was still on board one of the vessels participating in the rescue operation (the "Viking Victory"). None of the dead had been identified. Sandanger, who was now in place in Lerwick, was able to state that divers had again searched for missing in the capsized vessel, with no results.

At 20:39 (8) Sergeant Sandanger stated that the coastguard had, earlier in the afternoon, decided that they no longer had a search and rescue action for survivors, but a search for missing. The correct time for the calling-off of the rescue operation was 15:45 British time (Norwegian time 16:45), so that the fact that the operation had entered a new phase was not known to the LRS until almost four hours later. The subsequent communication between the HRS/LRS and the British authorities concerned mostly the treatment of the deceased – who was responsible for taking them away from the rig and the "Viking Victory" and back to Norway. The next of kin, the police, Transocean and Chevron all reacted to the fact that the deceased were left a very long time on board the "Viking Victory" and the rig.

Chapter 11
The salvage attempt

11.1 Introduction

After the "Bourbon Dolphin" capsized, the emergency management team (Transocean Rather Emergency Response Team) was concerned to rescue survivors, search for the missing and safeguard the rig. Since the rig was connected to the casualty via about 1,800 metres of chain, they were worried about what might happen to the rig were the "Bourbon Dolphin" to sink. At 17:18 tension on mooring line 2 was read off at 170 tonnes (4). Orders were given to read off tension on the rig's winch every five minutes, so that any changes could be discovered quickly. In time, on Thursday evening, they began also to focus on the condition of the "Bourbon Dolphin" after her capsize. The first logged information was at 21:11, and said that the casualty was lying deeper in the water. After midnight, on the early hours of Friday 13 April, updates came much faster, at the maximum twice an hour.

11.2 Log information on the "Bourbon Dolphin" until she sank

The Commission has received several logs from Transocean, Trident and Chevron, and an extensive account based on log information. When the salvage attempt is to be assessed, it is expedient to reproduce this information regarding the condition of the "Bourbon Dolphin" after the capsizing. This was important information for the assessments undertaken by Smit, Transocean, Chevron and SOSREP.

The Commission has found the explanations presented by Smit to be exhaustive, and saw no need to ask questions of a confrontational, amplifying or clarifying nature.

The information about the casualty's condition and development up to when she sank is obtained from the following documentation:

1. Towmaster log, kept on the rig, see Annex 1, Section 5.1.
2. Ballast control room log, kept on the rig, see Annex 1, Section 5.4.
3. Transocean emergency response log, see Annex 1, Section 5.3.
4. Chronological list of events at site, see Annex 1, Section 5.5.
5. Joint account from Chevron, Trident and Transocean.

As in the chapter on the rescue operation, references will be given solely to document number.

12 April

At 17:10 "Bourbon Dolphin" lay 1,490 metres from the rig (5).
At 21:11 "Highland Valour" reported that the Dolphin's hull was lying deeper in the water (1).
At 22:30 "Highland Valour" reported that the Dolphin's hull was still visible, but that there was less freeboard than when the vessel capsized (1).

13 April

At 01:08 Unchanged condition for Dolphin (1)
At 01:38 Unchanged (3)
At 02:31 Still unchanged (4)
At 03:04 Unchanged (4)
At 04:02 Unchanged (4)
At 04:32 Unchanged (4)
At 05:11 Unchanged (4)
At 05:36 Unchanged (4)
At 06:00 Unchanged (4)
At 06:40 Unchanged (4)
At 07:15 Unchanged (4)
At 08:05 Unchanged (4)
At 08:30 Grampian Frontier reported that there was oil in the sea around the casualty (4)
At 09:07 Unchanged (4)
At 09:35 Unchanged (4)
At 10:00 Unchanged (4)
At 10:30 Unchanged (4)
At 11:05 Unchanged (4)

At 12:03 Unchanged, but more oil visible than previously (4)
At 13:02 Unchanged (4)
At 14:00 Unchanged (4)
At 15:00 Unchanged (4)
At 16:00 Unchanged (4)
At 16:32 Unchanged (4)
At 17:13 Unchanged (3)
At 17:32 The bows are lying a bit deeper (4)
At 19:42 "Vidar Viking" took over monitoring of the casualty (4)
At 20:17 "Subsea Viking" took over monitoring from "Vidar Viking" (4)
At 21:04 Unchanged (4)
At 22:00 The casualty had moved a few metres westwards, but otherwise unchanged (4)
At 23:00 Unchanged (4)
At 23:28 The casualty was moving slowly westwards (4)
At 23:59 Unchanged, drifting had stopped (4)

14 April

At 01:00 Unchanged (4)
At 02:00 Drifted 30-40 m westwards (4)
At 03:00 Drifted a little back in an easterly direction. Otherwise no change (4)
At 04:55 Unchanged (4)
At 07:00 Unchanged (4)
At 07:57 Drifted 100-150 m eastwards. Otherwise no change (4)
At 09:00 Unchanged (4)
At 10:00 Unchanged (4)
At 10:57 "Vidar Viking" took over monitoring the casualty. Otherwise no change (4)
At 12:00 Unchanged (4)
At 13:00 Drifted a few metres westwards. Otherwise unchanged (4)
At 14:06 Unchanged (4)
At 16:57 Drifted 70 m eastwards (4)
At 17:12 Drifted a new 30 m eastwards (4)
At 20:15 Drifted 10 m westwards (4)
At 21:40 The hull was still stable, no change (4)
At 21:58 "Subsea Viking" took over the monitoring from "Vidar Viking" (4)
At 22:20 The chain was secured in "Olympic Hercules'" shark-jaws (4)
At 22:28 The chain was cut (4)
At 22:57 Unchanged (4)
At 23:07 Drifted slowly west / north-west (4)
At 23:13 "Vidar Viking" took over the part of the chain that went to the rig (4)

15 April

- At 04:00 The casualty was now drifting away from the rig's mooring lines (pattern) (4)
- At 11:35 "Olympic Hercules" reported that "Bourbon Dolphin"'s bows were lower (1)
- At 13:55 "Bourbon Dolphin" lying even deeper (1)
- At 21:13 The hull was now floating vertically (5)
- At 21:15 "Olympic Hercules" frees the chain (5). Everyone informed that "Bourbon Dolphin" has now sunk.

Between at 13:55 and 21:13 no messages are registered. Captain Grim Are Bergtun of the "Olympic Hercules" testified that on Sunday morning he considered that the "Bourbon Dolphin" was slowly sinking.

11.3 Events until the salvage contract was signed on Friday 13 April

As will be seen from log data from 12 April at 21:11 (1), the casualty was lying deeper in the water late on Thursday evening than she had done just after the capsizing. After midnight no changes were reported.

At 02:20 on 13 April (3) Bjørn Bergsnes was in contact with the Transocean Emergency Team in Aberdeen. He was brought up to date on the situation. He himself was able to state that the insurers would attempt a salvage operation for the capsized vessel. According to the log, Bergsnes stated that they had no concrete plans yet. He recommended waiting and seeing until it became light and until divers had investigated the casualty.

In the course of the night investigations were made with a ROV from the diving vessel "Subsea Viking". At 06:00 (3) the "Subsea Viking" reported that ROV searching showed that the workwire of the "Bourbon Dolphin" stretched down to a depth of 225 metres. It was connected by a swivel and chain.

At 07:18 (3) the company informed Transocean that they had initiated collaboration with the salvage company Smit Salvage.

At 07:45 (3) SOSREP Robin Middleton spoke to Transocean. He had been contacted by the UK Department for Trade & Industry (DTI), as the responsible authority for pollution and salvage operations. Middleton's deputy was already en route to Aberdeen. The function of SOSREP is described in Section 11.5.

11.4 Smit Salvage

After the accident a standard salvage contract was signed with Smit Salvage in The Netherlands. It was a so-called Lloyd's Open Form (LOF) contract, with the addition of a Scopic clause that includes standard rates for calculation of the consideration and sets aside the principle of "no cure, no pay". Smit Salvage is the world's leading salvage company, with a market share of more than 50%. It is a Dutch enterprise headquartered in Rotterdam, but with a number of branches worldwide. The salvage contract was formally made with the company, but it was the insurers who had chosen Smit. The "Bourbon Dolphin" was insured with the Norwegian company Gjensidige. Gjensidige covers only the loss of the vessel. As regards personal injury, the crew were partly covered in the Norwegian national insurance system, and for accident insurance with the Norwegian Shipowners' Association. Gard had P&I insurance on the vessel. The connection with Smit was established on the recommendation of the insurers, and further contact with Smit was at all times a collaborative venture between the company and the insurers. Bjørn Idar Remøy signed the contract on behalf of Bourbon Offshore.

Reinder Peek, Smit's contract officer, has stated that the salvage contract was formally made on Friday 13 April at 11:00. But as early as the evening of the accident there was contact between the company and its insurers and Smit. Smit immediately commenced the work of assembling a salvage team.

Jan van der Laan was designed salvage manager by Smit's head office in Rotterdam. This was in the morning of Friday 13 April. Smit had already begun to prepare a salvage operation before the contract was formally signed at 11:00. When van der Laan arrived at head office in the morning, the planning meeting was already under way. The first thing that had to be done was to set up a salvage plan for submission to SOSREP for approval. Thereafter they could get going on mobilising a salvage team. There was good communication with SOSREP, who at this point in time was collaborating with Smit in connection with the salvaging of a container ship in the English Channel. Van der Laan was briefed on the search and rescue operation that had been in progress, and was still continuing, following the capsize of the "Bourbon Dolphin". Via SOSREP he also received a relatively detailed account of the circumstances around the accident and the current condition of the ship.

At 13:46 (3) there was a conference call involving SOSREP, Transocean, Chevron and Smit, at which the situation was reviewed and explained. They were still waiting for the results of the investigations of the casualty by the ROV. It was expected that these would be ready in the course of the afternoon.

11.5 SOSREP – Secretary of State Representative for Marine Salvage and Intervention

The offshore activity in the UK Sector belongs under the Department of Trade and Industry (DTI). In incidents involving an imminent danger of pollution, it has been found expedient to authorise a single person to act on behalf of the DTI. This is the background to the establishment of the SOSREP function. SOSREP is to monitor and if necessary intervene so as to prevent or limit damage to the environment from pollution or danger thereof. SOSREP may put together a Salvage Control Unit to assist him. In cases where attempts are to be made to salvage lost vessels or equipment, a salvage plan shall be submitted to SOSREP and approved by him.

Together with the Maritime and Coastguard Agency, the DTI has established a system for notification of SOSREP in incidents that involve a danger of pollution. The DTI and SOSREP were notified of the capsizing just after 18:00 on Thursday 12 April. SOSREP Robin Middleton contacted his deputy, Hugh Shaw. Shaw went to Aberdeen on Friday 13 April and established himself with his Salvage Control Unit in the premises of Transocean. Hugh Shaw has stated that at 17:08 a conference call began in which SOSREP and his deputy, plus Transocean, Chevron and Smit, participated. A proposed salvage plan was presented, at the same time as all the parties had the opportunity to make their assessment of the situation and what choices they were facing. According to Hugh Shaw, a salvage plan was approved by SOSREP at 18:48.

11.6 The salvage plan

The draft salvage plan was prepared in the afternoon of Friday 13 April. According to the plan, estimated time of arrival on the field was about midday on Sunday 15 April. The salvage team was to consist of a four-man diving team, of which one

man was leader and another salvage manager. In addition to the "Zeus", which was a tugboat, the "Highland Valour" was also chartered on 14 April.

The plan divided the operation into 11 stages:

1. Preparation of the separation of anchor chain no. 2 from the casualty
2. Installation of towing gear on the casualty
3. Separation of the casualty from anchor chain no. 2
4. Inspection of the casualty, if possible
5. Increase of the air pockets inside the vessel, if possible
6. Towing of the casualty to Colla Firth with the aid of two towing vessels
7. A full inspection of the casualty with divers
8. Removal of bunkers and flammable substances with equipment for hot connection
9. Preparation of the turning operation
10. Turn the casualty over
11. Return the casualty to her owners

According to the plan, in all stages of the operation the necessary precautions should be taken to avoid or minimise damage to the environment. As regards oil spills, a separate plan was to be made for removal of bunkers and flammable substances. If circumstances so demanded, the plan would be adjusted along the way

One of Smit's naval architects, Alex Gorter, was in contact with DNV in order to arrange for modelling of damaged stability. In parallel with this, Reinder Peek of Smit's sales department was in contact with the tugboat brokers with a view to considering what resources were available in the vicinity of the casualty and that could be chartered for the salvage operation.

It was quickly made clear that two tugs would be needed. The first would be commissioned to transport salvage equipment, including diver equipment, that was cleared for dispatch from Smit's warehouse. For this purpose the tugboat "Zeus", based in Den Helder, was chartered in the afternoon. This vessel would thereafter serve as diver support vessel.

The other tug's job was to tow the casualty to a suitable location in Shetland. At the time of the accident there were several other anchor-handling vessels in the vicinity. Complete information was acquired about the "Olympic Hercules", the "Viking Victory" and the "Highland Valour". It was concluded that the "Highland Valour" was best suited to the assignment. Smit considered that the vessel's anchor-handling equipment on the working deck, which included a gypsy for handling 76 mm chain, was best suited to the salvage operation. The "Highland Valour" was not available immediately. It was stated that she was going to port to change crew, and that she needed to bunker. She was expected to be available in the course of 16-20 hours.

Smit calculated that the actual tow would take about 40 hours. That was assuming that the casualty could be towed at 2 knots.

The salvage plan was approved by SOSREP. No information has been received about any objections being made to the plan's content.

11.7 SCR –Special Casualty Representative

At 13:30 on Friday morning, Steffen Schultz, of STS Marine Consult in Denmark, received an enquiry from Gard P&I of Norway. He was asked to undertake the assignment of SCR (Special Casualty Representative) in connection with the salvage of the "Bourbon Dolphin". A SCR is to safeguard the interests of the ship's owner in a salvage action. Until the SCR is in place, the salvage manager shall send daily reports to the ship's owner. Thereafter it is the SCR who shall have the daily report. The salvage plan shall be submitted to and discussed with the SCR. After this the salvage manager shall report exclusively to the SCR. The salvage manager still leads operation and is responsible. If the SCR disagrees with the salvage manager he may make a separate report. The salvage manager shall if possible consult with SCR, and SCR shall be empowered to give the salvage manager advice. The SCR shall endorse the salvage manager's daily report.

11.8 The salvage team (minus the salvage manager) goes to the scene of the accident

The diving and salvage equipment was readied and loaded on board the "Zeus", which set course for the accident site at 19:25 on Friday evening. The salvage team had previously gone to Rotterdam airport, where they had chartered a private jet. The team consisted of salvage inspector Eric de Graaf, deputy salvage manager Dennis van Harten and three divers. They were to fly to Lerwick and be transported on to the accident site by helicopter.

Salvage Manager Jan van der Laan was to travel from Rotterdam the next morning.

The salvage team landed in Lerwick at 18:00, and were then told that helicopter transport to the accident site was not feasible because of fog. The team was taken to Scalloway, where the coastguard vessel "Anglian Sovereign" was waiting. Departure from Scalloway took place at 19:35.

11.9 SOSREP's decision to free the "Bourbon Dolphin" from anchor chain no. 2

At 18:00 on Friday 13 April Smit held a conference with SOSREP Robin Middleton. Attending for Smit was Salvage Manager Bert Kleijwegt. SOSREP wanted to hear Smit's views on cutting the chain that attached the "Bourbon Dolphin" to mooring line 2. Kleijwegt indicated clearly that the chain ought not to be cut. On a general basis he indicated that nothing should be done that could change the casualty's condition until the salvage manager with his team and equipment had been on the spot and evaluated the situation.

After about an hour Smit was told that SOSREP, following conversations with Transocean and Chevron, had given permission to free "Bourbon Dolphin" from the anchor chain. Transocean had argued that, because of the unpredictable current direction, the drifting pattern of the "Bourbon Dolphin" could change at any time in such a way that she would drift against the rig and collide with it. Transocean also argued that the "Bourbon Dolphin" could sink and collide with the rig and damage the underwater structure and the mooring system. These were scenarios that could expose the rig and its crew to danger.

In one of the Commission's hearings OIM Patrick O'Malley stated that the reason the chain was cut was the potential risk to which it could expose the rig. Moreover, according to testimony from Eric de Graaf, the OIM argued that given the poor weather outlook there was no realistic chance of putting people on board the hull of the "Bourbon Dolphin" for the purpose of fixing a proper tow.

To questions from the insurers as to whether 1,800 metres of chain (the rig's chain + the vessel's chain) at 1,100 metres depth was enough for the rig not to be damaged if the vessel sank, the OIM confirmed this. He testified also that it would have been possible for the rig to pay out wire if the casualty was in process of sinking, without this preventing a collision if the current shifted.

11.10 The situation on the field on Friday 13 April

As can be seen from data obtained from the log, the "Bourbon Dolphin" was lying lower in the water late on Thursday evening than she did just after the capsizing. The frequent reports from midnight and up to 17:32 show that the casualty's condition was unchanged. At 17:32 (4) it was reported that she was going lower at the bows. Nothing happened to the condition of the casualty the rest of that day, apart from her drifting somewhat westwards between 22:00 and midnight.

Captain Bergtun of the "Olympic Hercules" stated that he spent Friday 13 April searching, until it got dark. He states also that there were several conferences with the rig and Chevron, who expressed fear that the "Bourbon Dolphin" might drift against the rig or sink and create problems for the other moorings. Because of this fear, Transocean wanted to cut the chain. In the coastguard's log for 11:12 it is written that Transocean was pressing to get the emergency management team to agree to cut the casualty loose from the anchor chain. According to this log, Transocean threatened to do this itself. At 12:18 (5) it was logged that it was SOSREP, and not Transocean or anyone else, who was to take a decision on cutting the chain. Nor was the chain cut for about another 35 hours, with the approval of SOSREP.

11.11 The salvage team arrives on the field

The salvage team (with the exception of Salvage Manager van der Laan) arrived at accident site in the early hours (04:15) of Saturday 14 April with the coastguard vessel "Anglian Sovereign". It was agreed that the team was to be taken on board on the rig later, when it was light.

In the morning the team was given an information package with more information about the investigations with the ROV and what kind of chain and wire connection there was between the Bourbon Dolphin" and the rig. In addition they were given a detailed work plan for the operation of freeing the "Bourbon Dolphin" from the anchor chain so that she could be towed away from the rig and the drilling site.

The salvage team asked the master of the "Anglian Sovereign" to go closer to the casualty. At a distance of about 200 metres, salvage inspector

Eric de Graaf could see that the "Bourbon Dolphin" was floating with her keel almost straight, perhaps a little down at the bows, with a freeboard of one or two metres. The propeller was clear of the water aft and the azimuth propeller was clear of the water forward. The vessel "Zeus", which was carrying the diver and salvage equipment, had not yet arrived at the location, and so the team could not do anything other than acquaint themselves in purely visual terms with the situation and the casualty's condition.

At 10:50 the salvage team went on board the rig. Due to the wave height this was not without its complications. As soon as the team was on board, they were given an update by the OIM. He gave them detailed information about the circumstances of the capsizing. It was during this update that the salvage team became aware that the capsizing occurred during the deployment of the anchor, and that it was therefore possible that anchor no. 2 was on board during the capsize. They had hitherto believed that the capsizing occurred during the recovery of anchor no. 2.

De Graaf explained the salvage plan to the OIM and emphasised that Smit's advice was that the situation around the casualty ought not to be changed until the salvage manager arrived and had the chance to make an assessment of the casualty's condition. Despite their objections to freeing the "Bourbon Dolphin", the OIM made it clear that the plan was to free the chain later that day, with the approval of SOSREP.

Transocean was worried that the "Bourbon Dolphin", if she sank or drifted against the rig, might damage the drilling site or damage the rig's other moorings. Chevron shared these concerns. Moreover, the OIM maintained that the already poor weather conditions would deteriorate. In his opinion there were no realistic prospects of transferring personnel to the hull of the "Bourbon Dolphin" with a view to fastening a proper tow.

De Graaf contacted Smit in Rotterdam and told them that Transocean intended to continue with their plan and was going to cut the anchor chain. For De Graaf it was clear that the salvage plan would now consist of two phases. Phase One would be to free the casualty from the anchor chain, and let her drift with the current away from the rig while attached to the "Olympic Hercules". Phase Two would be to evaluate the casualty's condition, if possible improve buoyancy and get a towline on board so that the "Highland Valour" could tow the casualty to Yell Sound in Shetland.

11.12 Development of the casualty's condition on Saturday 14 April

It may be seen from the logs that in the course of this day there was no change in the casualty's condition. Sometimes she drifted a bit, alternately in a westerly and an easterly direction. There were, however, no reports that the buoyancy was poorer. Nor were there any immediate changes after the chain was cut at about 23:00.

11.13 The "Bourbon Dolphin" is freed from anchor chain no. 2

The draft plan to free the "Bourbon Dolphin" from the anchor chain was submitted by Transocean and Chevron in the early morning of Saturday 14 April. The draft, with procedures and risk analyses, was submitted to all involved parties for comments. This meant the "Olympic Hercules", the "Subsea Viking", the "Vidar Viking", the "Transocean Rather", Trident and SOSREP. All of them, with the exception of SOSREP, participated in a conference call in which the plan was discussed. SOSREP approved the plan and wanted to give permission for the cutting of the chain when it had been taken aboard the "Olympic Hercules". This was logged at 05:45 (3) and (5).

In the morning there was a conference between the "Olympic Hercules" and Transocean, Chevron and Trident, in which plans were laid for how the casualty was to be freed from mooring line no. 2. At this point in time the "Olympic Hercules" was still under charter to Chevron. At 12:40 (4) the "Olympic Hercules" was told to deploy her grapnel, and the operation to free the casualty was under way.

The plan was (according to Jason Bennet of Smit) that the "Olympic Hercules" was to manoeuvre in such a way that she held the weight of the chain neutral. That is to say, the "Olympic Hercules" should not tow the casualty, but hold her position constant in relation to it and permit the "Bourbon Dolphin" to continue drifting towards the north-east, away from the rig.

As mentioned above it was decided that the "Olympic Hercules" should use her grapnel, and with positioning help from a ROV she should get hold of the chain, which lay over mooring line 3. For safety reasons it was desired to have as much chain as possible between the "Olympic Hercules" and the "Bourbon Dolphin". Should the

"Dolphin" sink during the operation, the "Hercules" would have to ensure that the risk to herself was minimised.

The chain was slowly taken up onto the deck of the "Olympic Hercules" in a bight and fastened in both shark-jaws without a safety bolt, so that the chain could be quickly released should the "Bourbon Dolphin" suddenly sink. Then the connection between the casualty and the mooring line was to be cut. At 21:40 (5) the "Olympic Hercules" had gotten the chain up onto her stern roller, and SOSREP then gave final permission for the chain to be cut. The chain length that went to the rig was sent over to the "Vidar Viking". The portion of the chain that went to the "Bourbon Dolphin" was retained on board the "Olympic Hercules". The "Vidar Viking" measured that there was about 60 metres left of the 76mm chain. Between the "Bourbon Dolphin" and the "Olympic Hercules" there was 860 metres of chain and 225 metres of wire hanging down from the winch of the "Bourbon Dolphin" and fastened to this chain. The length was measured by the ROV from the "Subsea Viking".

The "Bourbon Dolphin" was finally freed from the anchor chain at about 23:00. Smit has made it clear that they did not participate in this operation at all. As previously mentioned it was important to Smit that nothing at all was done, out of fear that the casualty's condition would change.

The "Olympic Hercules" handed over the rig's portion of the chain to the "Vidar Viking" at 23:13 (4). The "Bourbon Dolphin" was then drifting a little away from the rig in a north-easterly direction, with the current, at the same time as the "Olympic Hercules" kept the distance between the two vessels constant. Thereafter the "Hercules" used dynamic positioning (DP) and kept the "Bourbon Dolphin" in position with minimum force. They were to lie and wait for the "Highland Valour", which had been chartered by Smit and was bringing personnel from Smit. The plan was for the "Valour" to return to the field to take over, and then begin a tow. Due to poor weather the "Highland Valour" did not get back on schedule.

11.14 The situation of the "Bourbon Dolphin" deteriorates

In the morning of 15 April Captain Grim Are Bergtun considered that the "Bourbon Dolphin" was about to sink. He had seen the trend in the casualty's buoyancy from pictures. Bergtun told the Commission that he could have begun to tow the "Dolphin" at midnight on Saturday. He had contacted the rig and asked for permission to begin the tow, since he had seen that the "Dolphin" was beginning to lie lower in the water. From the chart he saw that about 50 nautical miles away, in an easterly direction, there was a depth of 200 metres. In his testimony to H&SE in Scotland, SOSREP's representative Hugh Shaw stated that he was not aware that Bergtun had proposed that the "Olympic Hercules" could attempt to tow the casualty to shallower waters.

Grim Are Bergtun testified that he presented the situation to Smit's representative on board the rig. The representative had consented to the "Hercules" commencing the tow. According to Bergtun, this happened at about 10:00. Eric de Graaf of Smit has stated that it was difficult to consider or concur with the proposal from Bergtun, since Smit had neither control of nor access to the casualty. Bergtun has stated that shortly after this, at 10:20, he was telephoned from the rig (the towmaster) and told that Chevron had not given the green light to start towing. They were told to stop. Bergtun has testified further that Smit's representative called and explained that there was an ongoing meeting between Smit, Chevron, Transocean and the British authorities about what was to be done. They hoped that Smit would shortly take over the charter of the "Olympic Hercules" from Chevron so that the tow could resume. Bergtun has also stated that some time in the afternoon he was called again and informed that there was still no solution, but that the meeting was still in progress.

In the afternoon there had been an ongoing discussion between Chevron and Smit about whether Smit should take over as charterer of the "Olympic Hercules", which was attached to the "Bourbon Dolphin" by the anchor chain. Smit was not prepared to take over the chartering of the "Olympic Hercules". The salvage manager had not arrived at the accident site, and had not had an opportunity to evaluate the condition of the "Bourbon Dolphin". Moreover, the "Olympic Hercules" had taken over the custody of the "Bourbon Dolphin" against Smit's express advice. Smit did not have control of the decision to cut the anchor chain and the situation related to this. Nor was the tow ready. According to Smit it was important to consider how the tow link itself was to be, and in their opinion the connection between the "Olympic Hercules" and the "Bourbon Dolphin" was not suitable for towing at sea. The connection

was a workwire that ran from the top roller at the forward end of the work deck and was fastened to a length of the anchor chain, which had been grappled, cut and attached to the "Olympic Hercules".

Smit's plan was to consider the condition of the casualty and arrange a satisfactory tow connection on that portion of the casualty's hull that stuck up out of the water, perhaps via the rudder shafts aft. It had been concluded that the "Highland Valour" was the vessel in the vicinity of the casualty that was best suited to take over the anchor chain and tow the casualty. In the course of the Sunday there was miscellaneous conversation about whether Smit should take over the chartering of the "Olympic Hercules". Salvage Manager van der Laan has stated that a little over an hour after he had arrived at the casualty, at 19:40, he was told that Smit had taken over the charter of the "Olympic Hercules".

Due to the weather conditions prevailing at the location it was never possible for Smit's personnel to undertake an inspection of the casualty, neither of the protruding parts of the hull nor of the part that was under water.

Bergtun has stated that in the evening he informed the rig that the "Bourbon Dolphin" was in the process of sinking. He has also testified to the Commission that he could see no rational grounds for the "Olympic Hercules" not being allowed to commence the tow. He was of the opinion that they would at least have managed to tow the "Dolphin" into shallower waters. But he recognised that the tow could have accelerated the deterioration of the casualty's situation. Bergtun also testified that no measures to stabilise the "Bourbon Dolphin" were taken.

11.15 Salvage Manager Jan van der Laan comes belatedly to the field

Salvage Manager van der Laan left The Netherlands on the morning of Saturday 14 April, and travelled via Edinburgh to Lerwick in Shetland. Because of fog in Shetland the plane was delayed and he did not arrive in Lerwick until 19:00 on the evening of Saturday 14 April. At that point the rest of the salvage team were in place on the rig; they had been transported by the vessel "Anglian Sovereign". Due to fog, it was not possible for van der Laan to get helicopter transport out to the rig on Saturday evening.

On the morning of Sunday 15 April there was still fog, and it was therefore uncertain when Salvage Manager van der Laan could get out the rig. In the morning he was told that the earliest departure would be 10:30. Later in the morning he was told that there were nevertheless no prospects of helicopter departure in the course of the day. Once more he had to turn to the coastguard vessel "Anglian Sovereign", which would transport the salvage manager from Scalloway and out to the rig.

In the course of the trip out to the accident site van der Laan was in telephonic contact with his colleagues de Graaf and van Harten on board on the rig. They were able to tell him that the "Olympic Hercules" had informed them that the situation was steadily deteriorating through the day. The salvage team could not make independent observations because the casualty had drifted about four nautical miles away from the rig.

Due to the weather conditions it was not possible for Smit's divers to examine the casualty at all. The vessel "Zeus", which had all the necessary equipment, would according to van der Laan's information not be at the site before 18:45.

At 18:30 Salvage Manager van der Laan arrived at the accident site. He asked the master of the "Anglian Sovereign" to make a closer approach to the casualty. Van der Laan observed that the casualty was floating differently to what he had seen on pictures previously. When they held the planning meeting two days previously, the "Bourbon Dolphin" had had a freeboard of 2 – 2.5 metre and was floating evenly. He could now see that the stern had one or two metres of freeboard, whereas the bows were visibly lower in the water than previously. As a reference he had the azimuthal propeller forward. This had previously been quite visible, but was now wholly submerged. The "Bourbon Dolphin" was rolling heavily in the waves, which he estimated at about 4 metres from the south-west.

11.16 The "Bourbon Dolphin" sinks

At 18:45 van der Laan observed that a large quantity of air was coming out of the "Bourbon Dolphin". He could also see that there was an oil slick around the casualty. Shortly afterwards he could see the bow sinking deeper. Van der Laan discussed with the master of the "Olympic Hercules", who according to van der Laan agreed that the casualty's situation was deteriorating.

At 19:40 van der Laan was told by Smit in Rotterdam that the "Olympic Hercules" was now hired for the salvage assignment. In a situation with powerful sea and waves of three or four metres beating over most of the casualty's hull, according to van der Laan there were no realistic prospect of attaching a tow. There was no prospect of divers being able to work because of the rough seas and considerable current. In the course of the next hour, van der Laan could watch the "Bourbon Dolphin" gradually sinking bow first. At 21:15 the vessel righted herself vertically and then sank. Van der Laan called up the "Olympic Hercules" and asked him to free the chain, which was done immediately.

The casualty settled at a depth of 1,140 metres. Filming with the ROV shows that the "Bourbon Dolphin" sustained considerable damage, including to the tank structure, due to implosion and/or when she hit the seabed with great force. She remained in an upright position, listing markedly to port. The wire runs over the cargo rail on the starboard side in a south-westerly direction.

11.17 Evaluation

The first hours after the accident the main focus was on rescuing any survivors from the capsized vessel. As early as Thursday evening, however, there was contact between the company/insurers and Smit Salvage. Smit immediately started the work of planning the salvage operation.

It appears clear that two interests were diametrically opposed to one another after Smit was given the assignment of salvaging the casualty. Chevron and Transocean wanted to free the casualty from mooring line no. 2 as soon as possible, as they were worried about the safety of the rig, For its part, Smit wanted her to lie untouched. In addition there was SOSREP, who was to address the authorities' interest in avoiding environment damage.

There were several alternative courses of action. The rescue operation itself continued up to 15:45 on Friday 13 April. It was then considered that there was no longer any hope of finding survivors, and the coastguard called off the actual rescue component of the operation. The Commission considers it entirely natural that the work of cutting the anchor chain did not begin as long as the rescue operation was in progress. In a situation where one is searching for the missing, and the casualty is apparently lying stably in the sea, it would not be sensible to do anything without being quite sure that the condition would not change. In that case, they would be facing a situation in which the casualty constituted a clear danger to the rig and crew.

Next it may be asked whether the chain ought to have been cut as soon as the rescue operation was called off. The operation was terminated at 15:45 on Friday 13 April, and the vessel did not sink until 21:15 on Sunday evening. Provided that the development of the vessel's condition would have been the same, they would have had more than 50 hours for the cutting of the chain and towing into shallower waters. The work of cutting the chain was initiated at 12:40 on Saturday 14 April and was completed at about 23:00, that is to say, this operation took more than ten hours. Smit calculated that the tow would take about 40 hours. It cannot be ruled out that the Bourbon Dolphin" could have been taken into shallower water if the preparations for the tow had been initiated as soon as the rescue operation was called off. Nor would there have been anything to prevent working on a salvage plan in parallel with the search for survivors.

The preparation of procedures for cutting the chain were ready in the morning of Saturday 14, at 05:45 (5). At 23:00 the work of cutting the chain was complete. There were still 22 hours to go before the "Bourbon Dolphin" sank. Captain Grim Are Bergtun stated in his testimony before the Commission that he saw no rational grounds why the "Olympic Hercules" could not start towing the casualty towards shallower waters as soon as his vessel had taken over the connection with the "Bourbon Dolphin". It is difficult to draw reliable conclusions as to whether this would have proven feasible. The towing point on the "Bourbon Dolphin" was midships, which was not favourable.

When the "Olympic Hercules" began the tow on Sunday morning, the casualty had already started to sink. A successful salvage operation was then probably impossible.

As mentioned above, Smit did not want anything to be done with the casualty until they had had a chance to examine the vessel. Smit's salvage team, and particularly Salvage Manager Jan van der Laan, were delayed by the weather conditions. This will hardly have been of any significance for Smit's salvage success. According to Jan van der Laan, Smit's vessel, with the diving and salvage equipment, did not arrive until 18:45 on Sunday evening. By the time that all the members of the salvage team and the vessel with the neces-

sary equipment were finally in place at the accident site, it was in any case too late.

From Thursday evening and up until the chain was cut late on Saturday evening, there were very small visible changes to the buoyancy of the "Bourbon Dolphin". Apart from an observation at 17:32 on Friday (4), that the bows had settled a little deeper, there were no reports that the casualty was floating more heavily. Nor were there any immediate changes to the casualty's buoyancy in connection with the cutting of the chain. When the hull began to float deeper the next day, the weather had become poor. No conclusions can be drawn to the effect that the cutting of the chain accelerated the process that ended with the casualty's sinking.

The Commission finds that it cannot criticise Smit's assessment that it was best to allow the casualty to remain untouched until it had been examined and stabilised. After the "Bourbon Dolphin" settled rather deeper in the sea in the first hours after she capsized, she stayed in approximately the same condition up to Sunday morning.

Nor does the Commission find reason to criticise the chain being cut on Saturday evening with the approval of SOSREP. Again, there is no reason to believe that the cutting caused changes in the casualty's buoyancy. The weather became poorer through the Sunday, leading to greater movement of the casualty, which gradually began to emit air and take on water.

The chance of getting the "Bourbon Dolphin" into shallower water would probably have been greatest if the anchor chain had been cut as soon as possible and a tow commenced immediately thereafter, as Transocean and Chevron wanted. But given the fact that this was a complicated operation in which the margins were small, it also appeared sensible to examine and stabilise the casualty as long as its condition appeared unchanged. Any criticism of Smit's assessments would therefore have the nature of hindsight.

Chapter 12
Summing-up: causes and responsibility

12.1 Introduction

An accident is often a result of several contributory causes – both direct or proximate and indirect or underlying causes, that is to say, factors that have not directly caused the incident to take place but have contributed to the incident or the failure to avoid it.

On the background of the evidence available, the documentation reviewed and the technical and other investigations performed, in this chapter the Commission will undertake an analysis of cause and effect in relation to the accident.

Over and above describing the proximate and triggering cause of the loss of the "Bourbon Dolphin", the Commission will describe the indirect causes of the accident. These include first the factors that caused the emergency to arise in the first place and then the factors that meant that the emergency was not avoided.

In the Commission's view, the underlying causes are extremely important for and understanding of the entire course of events and not least for future preventive safety work in that part of the petroleum activity that demands input from several players in complicated situations.

As will be shown below, the Commission is of the opinion that failure in the handling of safety systems on the part of the company, the operator and the rig alike are major contributory factors in the coming out of control of the operation on 12 April 2007. In addition, weaknesses in the design meant that the vessel had poor stability characteristics, without either the shipyard or the company having clearly communicated this to the owners. Seen all together, system failure in the players at several levels meant that necessary safety barriers were missing, were ignored or were broken, so that crew and vessel were exposed to an uncontrolled risk, resulting in the accident.

12.2 The proximate and triggering cause

Vessels that capsize must always have been exposed to forces that were so considerable that the rectifying forces in the vessel were not strong enough to preserve or regain her stability.

What forces in the capsizing situation affected the vessel and what counter-forces the vessel was able to respond with are described in Section 9.10.

Despite some discrepancies and minor disagreements in the chronology, the actual course of events on 12 April seems clear. Statements from witnesses are thus compatible with the registrations in computer plots, logs and weather observations.

The vessel manoeuvred on instructions from the towmaster towards the west, on a heading that meant the mooring line attacking the vessel more from the side. The angle of attack of the mooring line thus became relatively high (40/60°). Before this order was given the vessel had already developed a persistent list to port of a bit less than 5°. The first list appeared almost immediately after the inner starboard towing-pin was depressed. It is natural to think that in this situation the master would try to change the vessel's heading so that the forces from the mooring line causing the list were reduced. When the vessel, in consequence of the first serious list, lost her propulsion and steering ability on the starboard side, it became difficult to manoeuvre the vessel in such a way. A new and more serious list, due to the tension in the anchor line, could not then be prevented.

In the Commission's assessment, it is not possible to demonstrate that *a single error,* technical or human, caused the accident. The accident is explicable in terms of a number of unfortunate circumstances interacting and resulting in the loss of the "Bourbon Dolphin".

In the Commission's opinion, the capsizing occurred as a result of a number of factors that

had accumulated at a particular point in time on 12 April:

- the weather and current conditions
- the vessel's stability characteristics
- the vessel's current load condition
- the use of roll reduction tanks
- the initial list to port (less than 5°)
- an unfavourable heading in relation to attack from external dynamic forces
- changed point of attack from the weight of chain aft (depressing of the towing-pin)
- powerful list to port
- reduced manoeuvrability due to blackout of the starboard engines
- wrong understanding of the ability to release the chain quickly.

It is clear to the Commission that it was particularly the changed angle of attack from the chain, together with the vessel's heading and reduced manoeuvrability, plus influence from external forces, that, together with the vessel's stability characteristics and current load condition, made the accident possible.

12.3 Indirect causes of the emergency

In order to identify and evaluate the factors that led the emergency arising at all, it is vital to take a closer look at the vessel and at the work operation the vessel was performing when the accident happened. In the Commission's opinion four main elements stand out:

In the first place – design, construction, certification and the company's operation of the vessel, including the manning of the concrete operation.

In the second place – conditions on board during the operation.

In the third place – the planning of the anchor-handling operation, including requirements for the vessels.

In the fourth place – the implementation of the operation.

12.3.1 Defects in the vessel and the company

The "Bourbon Dolphin" was designed and built as a combined supply, tug and anchor-handling vessel and was the first of the A102 design. Equipment for all these functions was fitted on board.

The vessel possessed all necessary certificates and had no directives outstanding when she capsized. The vessel had four non-conformances in the audit of the safety management system, as described in Section 4.6.

Chapter 5 describes the vessel and the construction process. As mentioned above, there were weight changes to the vessel, and the distance above baseline for the vertical centre of gravity was increased. During the shipyard's first swing test, in which the vessel was loaded for optimal stability, a heel angle of 17 was registered. A new swing test, with lower speeds and less rudder, gave a smaller heel.

The winches were located over three decks. Section 5.6 provides a detailed description of the winch package. The winches had a pulling power of 400 tonnes. The winch package also had a function for emergency release. As also described in Section 5.6, the vessel had the usual equipment for anchor-handling on the afterdeck – two shark-jaws, each with a pair of depressible towing-pins.

The stability book for the "Bourbon Dolphin" was approved by the Norwegian Maritime Directorate. The stability book's load conditions for anchor-handling were not subject to special approval, confer Section 5.4.1. It is, however, apparent from the example conditions for anchor-handling that with certain forces on the winch the shark-jaw/towing-pins cannot be used without challenging the vessel's stability, see Annex 1 Section 1.3 – extracts from Final Stability Manual, pages 1-195 and 1-206. It was inter alia stated that having 300 tonnes on the winch was only permissible if drag on the vessel was within 0.5 metres of the centreline. Use of the shark-jaw required chain or wire to be about 1.7 m from the centreline. It is not documented that the vessel's stability characteristics were such that the equipment could be used at its full capacity.

The restrictions were not communicated directly and clearly in the stability book or in any other way to those who were to operate the vessel.

The company does not appear to have realised what significance the change of weight in the vessel had for her stability. There was a dialogue between the company, including Frank Reiersen, and the shipyard regarding the vessel's load conditions. Frank Reiersen wanted the preparation of more, and more realistic, load conditions over and above what had been presented by the shipyard. As far as the Commission is aware, this dialogue ceased in September 2006, without further clarification. The company ought, however, to have investigated this more closely.

Such important information as the fact that roll reduction tanks ought not to be used during

anchor-handling did not emerge clearly from the stability book. Nor did the "Bourbon Dolphin" have on-board instructions for the use of roll reduction tanks as demanded by the Norwegian Maritime Directorate's regulatory system.

Both the regular masters on the "Bourbon Dolphin" testified that they had expected a vessel with better stability characteristics. Use of bunkers and ballast tanks in various operations could be a challenge. A recurrent feature was that they had made it a habit to have lots of bunkers on board in order to give the vessel good stability. Captain Hugo Hansen had experienced a stability-critical incident with the vessel, but this was not reported to the company. There are no requirements about training in the use of load calculator; but as long as the load calculator is available as an on-board aid, companies ought to see to adequate training routines.

The company's safety management system is described in detail in Section 4.3. As shown in Chapter 7, there were a number of weaknesses in the system. These concern in part the *establishment* of routines, primarily the procedure for anchor-handling. The absence of such a procedure helped make the implementation of the operation more demanding for the crew and to a greater extent governed by happenstance.

There were also defects in the company's procedures for familiarisation (induction) of masters, not least routines for overlap. The Commission finds that it merits perticular criticism that the company did not ensure that Captain Remøy had a period of overlap before he took up his duties as master on board. He was thereby given command of a vessel with which he was unfamiliar and a crew he did not know. Remøy had experience as master of another and bigger Bourbon vessel, but in the Commission's opinion it is precisely this background that may rather have led him to misestimate the vessel's characteristics. The Commission would also note that the time allocated for handover of such a complicated operation was not sufficient either.

As pointed out in Section 4.7.5, the officers on the bridge were relatively inexperienced in the kind of operation which the "Bourbon Dolphin" initiated at the end of March 2007, which was primarily due to the fact that the company did not have a policy for identifying levels of training over and above the requirements of the STCW Convention. The lack of experience of anchor-handling in general and deep-water operations with strong current in particular may also help to explain the operational choices of the "Bourbon Dolphin" on 12 April 2007, confer Section 12.3.2 below.

There were also defects in the implementation of the safety management system on board. This concerns primarily defects in the preparation of risk assessments, which did not cover hazards to which the vessel could be exposed.

Nor did the company's internal control manage to detect the fact that no protection against all identified risks had been erected on board. It also merits criticism that DNV had not in previous audits pointed out the failure to prepare a procedure for anchor-handling, since the ISM Code demands a procedure for key operations. This criticism is also directed against the Norwegian Maritime Directorate, which audits DNV. Questions may also be raised as to whether the non-conformances were so serious that the "Bourbon Dolphin" ought not to have been issued with a safety management certificate following the DNV audit.

The "Bourbon Dolphin" was certified for 180 tonnes in continuous bollard pull. On the market the vessel was presented as a "DP 2 anchor handling tug supply vessel" with 194 tonnes in bollard pull and 400 tonnes pulling power on the winch. It was stated in the RMP that at certain stages of the operation one might encounter forces that demanded a bollard pull of over 174 tonnes. With full use of thrusters, however, bollard pull would be reduced to as little as 125 tonnes, as described in Section 5.5.

When the vessel was chartered, the company undertook no technical assessment of whether the vessel had sufficient capacity to complete the operation in question. Charter of the vessel was vested, according to the company's organisational chart, in the marketing department. In the Commission's opinion, the presentation for market purposes involved a danger of the operator expecting to get a bigger and more powerful vessel than he actually obtained.

Despite the fact that the company had a brand-new vessel – with a new design – that was to be used in a demanding anchor-handling operation at great ocean depths, the company did not acquire information about the operation and thereby had no chance of assisting along the way with concrete advice, instructions or support. The Commission finds that there was continuous contact between vessel and company in the form of daily written reports by e-mail and otherwise telephone conversations with company employees. The company was informed that equipment had been damaged and it was taking longer than expected,

but it was not stated by anyone that the operation was unusual or was experienced as difficult.

A briefing with review of the RMP was held with the operator's representative. The company had no requirements or guidelines for such meetings. Captain Reiersen had signed the form that confirmed that the "Bourbon Dolphin" was to have the function of AHV C, in the RMP designated as "assist vessel". The Commission has been informed that this was not communicated to the company prior to the accident.

The winch system was certified and the emergency release function was thus in conformity with the authority requirements. The emergency release function is time-consuming. The Commission has uncovered the fact that not only the relevant crew, but also other crews in the company had the perception that the emergency release function on the winch was a quick-release that would cause spontaneous and full exit of wire/chain/last on the winch immediately upon activation. In the Commission's opinion this misunderstanding may help to explain why this emergency measure was not taken earlier.

12.3.2 Activity on board on 12 April

Sections 8.1 and 8.2 describe the briefing and the crew change.

Up to deployment of anchor no. 2, the operation was by and large performed in conformity with the RMP, though with the reservations discussed in Section 8.3. It is thus clear that the "Bourbon Dolphin" was used at least as much as the other vessels and that the designation AHV C did not involve any limitations in the kind of missions the vessel was assigned, see Section 8.3.4.

The Commission has no information to suggest that there were problems of any kind on board. All the witnesses testified that there was a good working environment, good contact and good working conditions on board.

The master has the paramount responsibility for the safety of the vessel and the crew during maritime operations. Even if the anchor-handling manual on board was not a perfect aid, it appeared that nothing in this manual relieved the master of his responsibility for the safety of the crew and the vessel. This involves an undisputed right and duty to halt an ongoing activity, even if the company and others, for example the operator, were to object. The master's orders are thus the last human safety barrier for crew and vessel.

During an operation involving several players, good communication and flow of information between them is of considerable significance. All parties have an independent responsibility for ensuring that all available information is continuously exchanged. This is stated in the NWEA guidelines and is also pointed out in the anchor-handling manual for the "Bourbon Dolphin".

On board were a number of aids to the vessel's manoeuvring and operations, among other things a load calculator, a screen showing engine operations and navigation screens for use by the master or the duty officers on the bridge. It was thus easy to read off any drift away from the mooring line. The most important informants are, however, the crews on board, who from their workstations – on the bridge, on deck, in the engine-room or by the winches – are continuously following external conditions, the vessel's movements, performance and stresses.

The Commission must find that there was insufficient understanding on the bridge of the fact that the engine-room several times warned that the thrusters were running at full power, that they had no more to give and that overheating was feared. As early as around 15:00 the First Engineering Officer warned the bridge that if they did not throttle back the thrusters, he would have to cut them out to prevent damage.

In retrospect, it seems difficult to understand that this was at no point perceived as critical and complied with on the bridge or referred on to the towmaster. The "Bourbon Dolphin" gradually developed considerable drift, which the vessel could not compensate on its own resources. Instead of suspending the operation, the vessel chose to ask the rig for assistance with grappling the chain. The Commission will return to the rig's role in this context in Section 12.3.4.

After the unsuccessful attempt at grappling the chain, the "Bourbon Dolphin" was instructed by the rig to proceed westwards, away from mooring line 3. As described under Section 9.9, the inner starboard towing-pin was depressed, possibly on the initiative of the towmaster. The measure was first considered on the "Bourbon Dolphin", thereafter implemented.

The vessel already had a list of less than 5° to port. The Commission is aware that this was partially compensated for by transfer of ballast between the port and starboard tanks. The change in point of attack from the starboard to the outer port pin had catastrophic consequences.

As the Commission interprets the situation, the master and the chief officer must, during the first list, thought that it was still possible to avoid the loss of the vessel by manoeuvring her out of the situation, even with reduced capacity. Probably it was this that Captain Remøy was attempting in the last minutes before the capsize, confer Section 9.9. This is supported among other things by the fact that the witnesses observed the vessel making some zig-zags, that they waited before activating the emergency release function on the winch, that they did not activate the Abandon Ship alarm or take other emergency procedures.

In retrospect, it is difficult to understand why the operation was not suspended. There were several situations up to the capsizing that, seen in isolation, could support such a decision. And there is reason to ask whether the crew of the "Bourbon Dolphin" were aware of the consequences of depressing the towing-pin and at the same time bearing up to westwards, so that the chain's angle of attack out from the vessel caused a powerful heeling to port.

There is reason to believe that during this phase of the operation the vessel did not fulfil all the stability requirements.

The officers on the vessel had, however, had several unusual experiences. Captain Hugo Hansen was surprised by an unexpectedly big heeling during a tow at Mongstad. Both Hansen and Frank Reiersen found that they had to have an unusual quantity of bunkers on board to preserve stability. In addition the crew found that the vessel did not have the cargo capacity specified. Chief Officer Grimstad had visited the shipyard for that purpose, and in this meeting he is said to have remarked that no one on board understood the ballasting system. These factors suggest that there must have been uncertainty on board in relation to the vessel's hydrostatic characteristics. The company did not, however, have adequate systems for detecting and making use of this experience so that good operating routines could have been established.

12.3.3 Planning of the rig move, including vessel requirements

The operator regarded and described the rig move in the RMP as an ordinary rig move in deep water, that is to say, depths greater than 300 metres. West of Shetland the water depth is more than 1,100 metres. This means that the mooring system had to tolerate considerable stress and fulfil the requirements of the regulatory system.

In Chapter 6 the Commission evaluated the planning of the operation. The plan and the procedures contained weaknesses on a number of points and lacked reference to assessments of risk in planning and performance of the operation. This applied particularly to estimation of expected forces. The Commission has pointed out a failure to incorporate sufficient margins to take account of static and dynamic forces on the mooring lines (chains and wire) due to weather, wind and current during recovery and deployment of anchors. Nor was there sufficient reflection over the fact that the need to relieve the rig's winches by use of a two-boat method would cause increased risk for the vessels, which could have created greater problems than it actually did.

The Commission has also demonstrated that the plan did not contain any clear weather criteria.

The operator, the rig company and consultancy firm had allocated the various functions and assignments in connection with the planning. The focus of the planning appears to have been directed particularly at the needs of the rig, its mooring and safety. Over and above specifying requirements for bollard pull, there was little attention paid to the vessels that were to be involved.

Selection of vessels appears to have reflected the ships available in the area concerned when the rig move was to start. This involves a risk that vessels too weak for the operation are both offered and selected. Not only the operator, but also the company has a responsibility to make a realistic assessment of the individual vessel's suitability for the concrete mission. In a market with small time margins, few vessels to choose between and different day-rates for big and smaller anchor-handling vessels, it is of particular importance that the parties are realistic about both what they are demanding and what they are offering.

The RMP specified the towing power at 180 tonnes. The operation was to be performed in demanding waters in which current, weather and wind could offer big challenges. Mooring that was to be deployed in particular positions demands that the vessels master lateral forces. That the vessels must then use thrusters for manoeuvring is obvious. The plan's analysis of the need for bollard pull was incomplete and gave an over-optimistic picture of expected forces.

On behalf of the operator, the vessels were inspected by the Stewart Group (broker) and by the operator's consultant (Trident) before the con-

tract was signed. The inspection appears to the Commission to be superficial. The operator's representative was not himself on board the "Bourbon Dolphin". Nor did the operator see to obtaining the vessel's risk assessments before the operation began, or undertake any closer inspection of the vessel's operational and expertise-related capability to perform the operation. There was no contact between the operator and the company.

12.3.4 The implementation of the operation

Sections 6.2 and 6.4 deal with key and marine personnel with the operator and on the rig. Section 8.3 provides a brief presentation of the factual implementation of the operation up to 12 April. In Chapter 9 the Commission has gone through the events of the day of the accident in greater detail. The weather situation is dealt with in Section 9.5.

Several people noticed that after the last crew change the "Bourbon Dolphin" was unpractised and had to be guided during the operation. They spent more time on their operations than other vessels. Despite this, the vessel had been able to operate under prevailing conditions up to the day of the accident.

As mentioned above, at several places in the report, the operation of moving the rig was longer and more demanding than originally foreseen. Equipment was damaged, the rig's winches were overstrained and there were several pauses due to both the weather and repairs to the winches. It proved necessary to use two vessels for work operations that under the procedure should have been performed by one vessel alone. Even if the procedure was deviated from several times, the changes were not made in conformity with the procedures contained in the operator's manual and the guidelines (NWEA) that the parties had agreed should apply to the operation.

The rig company is the duty-holder and the OIM is the duty-holder's responsible officer on board the rig. The OIM's primary mission is related to drilling, but throughout the operation he has paramount responsibility for addressing the overall risk. The rig company had the responsibility of moving the rig and, via the consultancy firm, hired external towmasters to perform that part of the job without their having participated in the planning. The operator had its Marine Representative on board on the rig. During the last phase of the operation, however, the same person performed the function of both the rig's towmaster and the operator's representative on the rig.

Both the towmaster and the OIM have key roles during a rig move that involve anchor-handling operations. The towmaster has the responsibility for directing the vessels to various work assignments in the operation and ensuring that these are performed and logged. From his position the towmaster has access to navigational data, weather data and means of communication with the vessels. The OIM has access to the same information, but no responsibility for directing of vessels. As supreme commander on the rig, however, he has the authority to stop any operation that might threaten the safety of the rig. This presupposes that the OIM is kept continuously informed.

The very last phase of the operation was, in the Commission's opinion, characterised by major safety failures in several areas – not only on the vessel, as described above, but also on the rig. Whereas the vessel was very active in her attempts to get anchor no. 2 into the right place, the rig adopted a passive observer role. The most important factors are:

- The drifting during deployment of anchor no. 6 was not evaluated and communicated to the OIM.
- The operation was begun in marginal weather conditions.
- The operation did not follow the written procedure prescribed for deployment of anchor no. 2.
- Drifting was observed from the rig at an early point, but the towmaster did not ask for an explanation.
- The drifting increased without an explanation being given or requested.
- The causes and consequences of the drifting were not considered.
- The request for assistance from another vessel was granted without risk assessment.
- Grappling at a different stage of the operation than described in the procedure.
- Improvised grappling was unsuccessful.
- Two vessels almost collided.
- The OIM was not given current information and did nothing to keep himself informed.

The Commission is of the opinion that wind and waves by themselves made the weather conditions marginal. In combination with an unexpectedly powerful current, the deployment of anchor no. 2 ought not to have been initiated.

In its summary to the Commission the consultancy firm Trident noted how, when deploying the

six first anchors, it was not experienced that any of the vessels drifted. The Commission would remark, however, that in the deployment of the penultimate anchor (diagonal anchor), the largest of the vessels, the "Olympic Hercules", was unable to hold the line, sustained a drift of 730 metres and had to have assistance from the rig to get back on track. Given such an unexpected incident, it is incomprehensible that they did not stop and evaluate the causes of drifting before continuing on anchor no. 2 with a vessel with considerably less bollard pull. The rig also thought that the crew of the "Bourbon Dolphin" were less experienced in this kind of operation.

Around 16:40 the "Bourbon Dolphin" was instructed by the towmaster to proceed westwards, away from mooring line no. 3. This resulted in the vessel getting a changed angle of attack for the mooring line, which had fatal consequences.

The Commission shall not, and cannot, decide whether the operator, the rig company, their hired consultancy firm or persons who performed tasks for any of these, have acted in contravention of the British regulatory system. But even if there has been no breach of regulations, the Commission finds it difficult to accept that the operator's representative on the rig, who had direct contact with the vessels during the operation, did not take the moral and human responsibility of assuring himself that also the crew of the "Bourbon Dolphin" were comfortable and safe during the last phase of the operation and understood the scope of the instructions given and the measures proposed. This applies to both the measures initiated by the vessel itself and the towmaster.

12.4 Why the emergency was not prevented

No chain is stronger than its weakest link.

Where human beings are involved, experience shows that mistakes are made. That is why it is necessary to have safety systems that detect human error and make sure that it does not lead to accidents.

The crucial and obvious precondition for averting an emergency is knowing that such a situation actually exists.

When a list is developing into a capsize, things happen very quickly. There will rarely be time to initiate procedures such as evacuation, use of survival suits etc. It is therefore necessary that the preventive measures be taken before it is too late.

In the Commission's opinion, during the last phase of the operation an important safety barrier was missing, in that the functions of Transocean towmaster and Chevron Marine Rep were vested in the same person. In contradistinction to the towmaster, whose responsibility is primarily the performance of the rig move, the operator's representative will have paramount responsibility for all the players whom the operator has chartered to work for him.

In the RMP, in the companies' manuals and in the guidelines (NWEA), boundaries are drawn for the various players' roles, their tasks and areas of responsibility. The anchor-handling vessels have specified duties, and the master has the supreme responsibility for the vessel's maritime activity during the operation. In a complex operation, however, it is required that everybody also take responsibility for one another. The towmasters had long practice and experience from a number of rig moves. In their testimony they made it expressly clear that operations must often be suspended – also at the demand of the vessel – and that they have never been in situations where this has created problems.

In his Marine Operation Safety Brief, which was distributed to the vessels in advance of the operation, Ross Watson, who was towmaster up to 9 April 2007, emphasised the importance of the vessels informing the rig immediately if something is not proceeding "correctly", and particularly underlined that from the rig's side there "is never any intention to put pressure on you to do anything that is not safe".

Sometime around 16:30, Towmaster Sapsford was unwilling to release the "Olympic Hercules" even if this vessel was finished with her work. To questions from the Commission, Sapsford could not provide any further explanation of how he had envisaged using the "Olympic Hercules". This suggests that the towmaster must have experienced the situation as difficult and unpredictable. It may seem as if the rig "hoped for the best and feared the worst".

The Commission has no reason to believe other than that the operation would have been stopped had the "Bourbon Dolphin" requested this. In the Commission's opinion, the crew of the "Bourbon Dolphin" must not have been aware of what a dramatic situation was developing, until the first roll had actually occurred.

No failures or weakness have been demonstrated, nor has the Commission been able to uncover any, in the technical aids for communication

or navigation on the rig or the vessels. Everyone communicated on the same VHF channel with English as their working language. There was thus time, space and opportunity for continuous contact and follow-up.

Both short-term drifting and deliberate manoeuvring away from the line occur during anchor-handling, for example because of strong current. This is generally seen as a part of the vessels' choices and adjustments. But when communication and common understanding are emphasised as vital, it is difficult for the Commission to understand that there was no contact from the rig to the vessel for long periods when the vessel – without further explanation – drifted steadily more away from the line and over towards mooring line 3. When the drift was as lengthy and considerable as here, it cannot be explained as a part of the vessel's ordinary manoeuvring. It is difficult to accept that the rig waited upon events out of fear of interfering in what was thought to be the master's responsibility. The Commission would also refer to the fact that on the previous day the rig had assisted the "Olympic Hercules" in a drifting situation as described in Section 9.2.

It is the opinion of the Commission that neither the vessel nor the rig had understood the risk caused by the vessel – while thrusting or heading in the direction of her anchor deployment station at the same time as steadily drifting in the opposite direction – getting an ever-more critical lateral point of attack from the chain tension. The chain lay pressing against the inner starboard towing-pin. When this was depressed, the changed angle of attack, together with the vessel's westerly direction, lack of stability and external influence from the current and waves, caused the capsize.

12.5 Deficient safety management

As the Commission has several times pointed out, to a considerable extent there exist authority requirements, regulatory systems, safety management systems, guidelines, agreements, plans, procedures, manuals and other written materials of relevance to the case. There is thus no shortage of written material of both the obligatory and the advisory kind. The problem is, however, that much of this material is general and standardised. The challenge is to get the individual player on any level to have ownership of the safety regulatory system, to understand it, identify with it, implement it in his own activity and live up to it in practical day-to-day life.

As far as the Commission knows, there have never been capsizing accidents with anchor-handling vessels that are directly comparable with the loss of the "Bourbon Dolphin". The Commission does, however, know of Norwegian-owned anchor-handling vessels being rebuilt in consequence of poor stability.

In the light of the fact that the "Bourbon Dolphin" was a brand-new vessel, built at a recognised shipyard with modern technical solutions, certified and approved by Norwegian authorities, regulation-manned with certified personnel and operated together with other vessels under a known procedure, it was initially difficult to understand how this accident could happen.

In the report, however, the Commission has pointed out that a number of safety barriers were breached. This applied to the design, construction and equipment of the vessel, her certification, her manning and her operations. Moreover, breaches of various safety requirements during the planning and the implementation of the RMP have also been identified.

Some of these breaches can have been directly contributory to the accident. Other safety barriers could have helped to prevent it.

In Chapter 3 the Commission reviewed the safety regulatory system for vessels and company, generally and for the operation in question. The operator and rig are subject to a comprehensive regulatory system, to be complied with also by those participating in an anchor-handling operation; see report from Research Fellow Hanne Sofie Logstein, Annex 1, Part 7 and Section 3.6.

The big challenge is to make the safety systems operational at all stages and in such a way that the individual feels ownership of his portion of them. The next challenge is in dismantling the boundaries between the individuals' spheres in such a way that a common understanding and human care is achieved, at the same time that this is not experienced as interference, micromanagement and surveillance.

Because the history of the "Bourbon Dolphin" was such a short one, only very limited experience with the vessel during different work operations was acquired. Nor was there time to acquire other than ordinary and elementary operational experience with the vessel. No two vessels are alike, and this one was not similar to some of the company's other vessels. As is usual, both the

company and the crew would gain experience of the vessel as they got to know her better.

Lateral forces exerted by mooring lines during anchor-handling have not been in focus in relation to stability in the regulatory system, probably because it is not usual for vessels to get so far off-track during deployment of anchors. Neither the company, therefore, nor anyone else had paid particular attention to this.

A drillrig is surrounded by a safety zone of 500 m with special requirements of due care for traffic within the zones. No such safety zones apply to the mooring lines. If a mooring line is disturbed, it may have direct significance for the rig's mooring and thereby its safety. In the Commission's opinion it was defects in the rig's safety management that permitted the "Bourbon Dolphin" to drift against line 3 without the rig correcting this.

12.6 Liability

It is stated in the terms of reference that the Commission shall evaluate factual circumstances that can be envisaged as justifying criminal liability for individuals or other liability in connection with the accident.

Through the factual presentation of the circumstances surrounding the accident, the Commission has illuminated a number of factors. The Commission regards this review as a sufficient basis for authorities and private parties to consider errors, negligence etc. and to decide whether this will or should trigger liability in criminal or civil law. The questions of liability will otherwise pertain to the courts as the final instance.

The Commission has nevertheless in some contexts found reasons to be clear in its characteristics of the behaviour of individuals, enterprises or institutions, without thereby taking a position on whether the provisions of the criminal law or other sanctioned rules have been contravened.

Insofar as it has found it necessary and expedient to fulfil its terms of reference, the Commission has to a certain extent also considered factors linked to foreign enterprises and individuals. These are not subject to Norwegian jurisdiction. It will therefore be up to the British authorities to take a position on whether the circumstances should trigger any form of liability.

Chapter 13
Recommendations

13.1 Introduction

Both the "Scandinavian Star" disaster in 1990 and the Commission of Inquiry after the loss of the express catamaran MS "Sleipner" on 26 November 1999 demonstrated a number of faults and errors that were directly and indirectly responsible for the accident. Even if the two accidents were materially different in origin, development and scope, they showed the importance of everybody working in passenger transport at sea being aware that operating passenger vessels involves a considerable responsibility for human safety (NOU 2000:31, page 146). The recommendations made by the Sleipner Commission were particularly focused on this.

Neither the vessel "Bourbon Dolphin" nor the circumstances around the accident are directly comparable with the two above-mentioned accidents. Where safety at sea is involved, however, it is always possible to learn lessons from other accidents.

Due to the style of work in international fora, it takes time to incorporate changes in the conventions as such, whereas amending amplifying and advisory regulatory systems is a faster process. It is in principle right and important for Norwegian authorities to endeavour to get changes to safety rules implemented internationally, because shipping has an international character. Nevertheless, when a need for new safety rules is uncovered, the Norwegian Maritime Directorate must consider whether the need is so urgent that the new rule should be introduced as a special national requirement until work in international fora has borne fruit. Generally speaking, weighty reasons are required before Norway introduces special national requirements to rules that have an international origin.

Traditionally, Norwegian authorities have been free to impose special national requirements when they thought it necessary. Now, however, the EEA Agreement has become a barrier in this area. The regulatory area of relevance for the loss of the "Bourbon Dolphin" is, to a smaller extent than other areas, for example passenger ships, subject to harmonised EU rules. The Act No. 101 of 17 December 2004 on European Notification Duty nevertheless demands that proposals for new technical regulatory systems that are not harmonised within the EEA shall be notified to the ESA in accordance with a special notification procedure.

Certain of the recommendations below presuppose changes in the current regulatory system. Some of the proposed changes are intended for international implementation. Until such changes have been made, the Norwegian Maritime Directorate must consider whether it is realistic to get special national requirements enacted. Other changes are of a supplementary nature, where it is assumed that we will not come into conflict with the international rules. Most of the recommendations nevertheless apply to the practicing of the current regulatory system.

In its report, the Commission has reviewed and pointed to a number of factors that mean that safety barriers were breached. This also involves a direct challenge to be aware of and deal with critical elements in any work operation. The implementation of the Commission's recommendations will strengthen these barriers in future operations.

The "Bourbon Dolphin" was built and equipped to perform various work operations in the offshore industry. When the accident happened, she was engaged, with a crew of 14 persons, in anchor-handling in waters 1,100 metres deep.

Part of the terms of reference of the Commission of Inquiry into the loss of the "Bourbon Dolphin" was to analyse factors of significance for preventing the recurrence of such an accident in future. In this chapter the Commission will describe measures that in the Commission's opinion may help to reduce the risk of serious accidents with anchor-handling vessels.

As far as the Commission knows, no incidents have occurred with Norwegian anchor-handling vessels that are directly comparable with the loss

of the "Bourbon Dolphin". In 2003 the Danish anchor-handling vessel "Stevns Power" was lost during a barge operation in shallow waters off Nigeria. The vessel capsized and sank very quickly when, having lifted an anchor from the seabed, she was pulled astern into the pipelaying barge that was running-in the anchor wire at an excessive speed. The afterdeck was pulled down and filled with water. Eleven people died. Over and above the general measures taken after this accident, the specific measures do not have direct transfer value to the kind of anchor-handling that the "Bourbon Dolphin" was doing.

Modern anchor-handling/supply vessels are multifunctional. It is expected that they can employ different methods during varied operations, in different waters and with different equipment. In addition to pure anchor-handling they shall be able to do supply and towing operations. These vessels are operating in an international market.

It will therefore be a challenge to think of measures that can improve the safety of those working on board without this being at the expense of the vessels' operability, flexibility and cargo capacity.

13.2 The Norwegian Maritime Directorate's immediate measures

The Commission sees from the Norwegian Maritime Directorate's immediate measures that the focus has been on the stability factors that have been critical for the capsize of the "Bourbon Dolphin". The measures are guidelines that involve recommendations to the industry. The Commission also sees, however, that there is a need for measures with a wider scope. These must be more tangibly purely operational in relation to addressing passive safety (fail-safe). They must have a content that make it easier to evaluate whether the vessel has the capacity to perform given job and enable the crew to apply ordinary methods of stability control. The measures proposed by the Commission aim to address the stability-related factors that the immediate measures are meant to cover.

13.3 Stability of anchor-handling vessels

13.3.1 Stability calculations

Neither the IMO's regulatory system nor Norwegian regulations have concrete requirements for the stability of anchor-handling vessels. The Commission has acquired information from British and Danish authorities confirming that they do not have separate stability requirements for anchor-handling vessels either.

Some vessels, however, have stability books with calculations for anchor-handling conditions (example conditions). The content of the conditions may vary from vessel to vessel, and depends on who has prepared the calculations. The Commission cannot see that the industry has developed any standardised practice. This makes it difficult for the crew to master the vessel's stability characteristics for anchor-handling.

In order to create robust safety barriers during anchor-handling operations, including making sure that bollard pull and winch pulling power for AH vessels at the design stage are chosen independently of the stability criteria, the Commission would make the following proposals:

Preparation of rule conditions for anchor-handling:

- All conditions shall be prepared with 10 and 100% bunkers.
- All winches shall be full of the heaviest possible line type.
- External force with following characteristics:
  1. Vertical load:
     - In vertical load, the full winch capacity shall be used between the outer towing-pins. The winches have full pulling power in the first layer. The requirement that the weight of the wire shall at the same time be set equivalent to full drums is justified by the fact that an extra margin is desirable.
       List arm shall be calculated from the centre of the vessel to the outer edge of the roller and with vertical point of attack in the upper edge of the stern roller.
       During this vertical load, the vessel shall have a maximum list angle corresponding to a GZ value equal to 50% of max GZ.
  2. Run-out of chain:
     - In running-out of chain a maximum force from the mooring line shall be calculated. The maximum force shall have its basis in both static and dynamic loads.
       This force shall be decomposed into a vertical force and a horizontal force in the vessel's transverse direction.

The list arm for the horizontal component shall be calculated from the height of the working deck at the towing-pins to the centre of the propulsion propeller, or the aft lateral propeller if this is deeper. The heeling arm of the vertical component shall be calculated from the centre of the vessel to the outer edge of the stern roller and with vertical point of attack in the upper edge of the stern roller.

The mooring line shall have an angle of attack of minimum 25° in relation to the vessel's longitudinal axis in the horizontal plane.

The angle in relation to the vertical plane shall be set as the one that gives the biggest list angle for the vessel.

If the power from the mooring line is less than the maximum bollard pull, the angle shall be set at 90°. Under the influence of forces from the mooring line, the vessel shall at maximum have a list angle that corresponds to a GZ value equal to 50% of max GZ.

The maximum manageable force from mooring lines that emerges these calculations will be the vessel's capacity for this type of operation.

– If it is necessary to ballast the conditions to achieve a given manageable force, the ballast used shall form the basis for ballast instructions dedicated to anchor-handling.

KG-limit curves

Specific KG-limit curves shall be prepared for anchor-handling operations that introduce two new criteria (in addition to existing requirements for supply ships).

A static moment shall be used, related to the vessel's maximum vertical load during operation of the winch. List arm shall be calculated as shown above. Under the influence of this moment, the vessel shall at a maximum develop a list angle that corresponds to a GZ value equal to 50% of max GZ.

Under the influence of the maximum manageable force from the mooring line, a curve for list moment shall be calculated. List arms for the vertical and horizontal component shall be calculated as shown above. Under the influence of this moment, the vessel shall at a maximum develop a list angle that corresponds to a GZ value equal to 50% of max GZ.

The proposed requirements for stability will mean that the shark-jaws can be used under all stability conditions in the whole area between the outer towing-pins.

13.3.2 The stability book

The stability book must contain a supplement of calculations in line with the recommendations described above, subject to the approval of the authorities.

Under the current regulatory system, it is a requirement that the stability book contain instructions "that in a rapid and simple manner enable the master of the vessel to enjoy precise guidance about the ship's trim and stability under different sailing conditions".

The Commission has the impression that these instructions have been standardised and consequently fail to communicate vessel-specific factors. A vessel-specific content would make it easier to safeguard stability on board. The following shall be dealt with in the instructions:

– concrete operational restrictions,
– capacities for given operations, and
– other operational factors of significance for the vessel's stability.

Operational restrictions may for example include the use of roll reduction tanks and ballast tanks in various operations.

Capacities for given operations may for example include maximum manageable force from the mooring line during running-out and maximum capacity for carriage of deck cargo.

Other factors may for example include the need, during any unusual use of the winch, for special attention related to stability, demanding that stability factors be studied more closely.

13.3.3 Training/operations

Use of simulator training is a positive measure for raising the level of expertise, and is encouraged in the training of personnel. The very best thing would be for simulators to be vessel-specific. Simulator training should include variations in the forces that the vessel must be expected to handle and provide relevant feedback to the operator about the consequences.

The Commission would recommend to maritime educational institutions that they review ex-

isting training activities in stability with a view to these also addressing factors related to towing and anchor-handling operations.

It is also recommended that companies and the maritime milieu establish a stronger focus on maintenance of operational stability on board.

13.4 Design and certification

The Commission has considered, but not found reason to propose, design changes to existing vessels, for example an increase in beam or the construction of "buoyancy boxes" or other devices that can help prevent capsizing. The Commission regards its proposals for stability, planning and the implementation of anchor-handling operations as sufficient in that they are focused on preventing this type of critical situation from arising.

13.4.1 The bollard pull certificate

A list of the Norwegian fleet operating as anchor-handling vessels shows that it includes some smaller vessels, i.e. vessels with certified bollard pull under 180 tonnes. It is therefore important that the companies have a realistic understanding of these vessels' real capacities and limitations under various operational conditions.

In order to certify that the vessel has a minimum manoeuvrability, the bollard pull certificate should indicate two kinds of effect output: first, it should specify a maximum continuous bollard pull that can be achieved by use of the vessel's main propeller alone. Second, it should register an effect output in which the reduction in bollard pull with full loading of the axle generator is taken into account.

13.4.2 Testing of the emergency release system

Before installation, the functions of the winch package should be tested with maximum operational capacities. Certification on the basis of a type approval can verify such a test. This is to ensure the equipment's functionality in all operational loads. The Commission would ask the Norwegian Maritime Directorate to consider requirements for a quick-release function, perhaps in a modified version, for use in a situation in which crew and vessel are facing a clear and present danger (casualty situation).

13.4.3 Certification of winch operator

The loss of the "Bourbon Dolphin" has uncovered a consistent lack of understanding of the emergency release function. The STCW Convention makes no qualification requirements for winch operators. In any use of the winch, the operator is a key player, and it is important that this person is well-qualified. Requirements ought to be made that winch operators undergo formal training, preferably in collaboration with the manufacturer. Certification of winch operators should also be considered.

13.4.4 Direct emergency exit from the engine-room

The "Bourbon Dolphin" had in all five emergency exits, of which four (two on either side) left the area under the main deck. This was in conformity with the requirements of the regulatory system. In the loss of the "Bourbon Dolphin" the chief engineer, the first engineering officer and the electrician perished. They were probably in the engine-room. The Commission has received a suggestion from the next of kin to the effect that a direct emergency exit be created from the bottom of the engine-room that can be used in a capsize where the vessel is lying upside down.

The Commission thinks the suggestion is interesting. It does, however, involve technical and practical challenges that demand further professional evaluation. The Norwegian Maritime Directorate, in collaboration with the industry, is requested to consider the suggestion further.

13.5 Equipment

13.5.1 Rescue floats

When the ship capsized only one of the six rescue floats released immediately. Subsequent observation of the casualty showed that a further four floats were released, while the sixth was released, but is caught in the vessel. Similar release mechanisms have since been tested with good functionality. There is therefore reason to believe that this mechanism functioned.

Since only one float came to the surface after the capsize, the placement or installation of the floats in the cradles probably prevented them floating up. The vessel remained upside down for three days without the remaining floats being freed. The

Commission considers that requirements should be made for placement that would ensure that floats were freed even when the vessel is in an upside-down condition. It should also be considered whether current installation requirements for floats are sufficient for various casualty situations.

13.5.2 Survival suits

The "Bourbon Dolphin" had survival suits placed in all crew cabins and at the various workstations. The vessel was thus equipped with more survival suits than the regulatory system demands. The Commission has since evaluated the functionality of equivalent suits and notes that the suits may be difficult to use in an evacuation situation, among other things because their footgear is not very user-friendly. Particularly when a vessel is listing, it may be difficult to move. The better the functionality, the lower the threshold will be for donning the suit in an emergency. In the loss of the "Bourbon Dolphin" only life-jackets were used. The Commission would request the Norwegian Maritime Directorate to take an initiative to improve the suits.

13.5.3 Emergency transponder

The emergency transponder was placed on the wheelhouse roof. As far as the Commission is aware, the emergency transponder failed to release when the vessel capsized and float up to the surface as intended. Since there were many vessels in the vicinity, this was of no significance for the rescue operation. Without vessels in the immediate vicinity, signals from such a transponder would have been of crucial significance for rapid location of the casualty. The Commission is aware of the problems related to release of emergency transponders, and would request the authorities to evaluate the placement and release mechanisms of such transponders.

13.5.4 Voyage recorder

The IMO has introduced requirements for voyage recorders for vessels over 3,000 tonnes, entering into force on 1 January 2008 for existing vessels. In the Commission's opinion such a requirement should be introduced also for rigs and smaller vessels. Sound recovery can secure important information, for example documentation of the instructions issued by the towmaster. It can also make important contributions to clarification of other situations that arise, for example delays, loss of equipment and so forth.

13.6 Requirements for the company's safety management

In Chapter 4, the Commission uncovered several safety defects in the company's management. The general impression is that the problem does not lie in the regulatory system's requirements, but in the company's implementation of the requirements laid down. There is reason to believe that other companies may also have potential for improvement in many of the same areas. It is therefore a challenge both to the Norwegian Maritime Directorate and the classification societies that act on behalf of the authorities to follow up these matters in subsequent audits and the rest of the strategic safety work, so that the ISM Code can be better complied with in future.

It is vital that the individual company has a "living" safety management system. The system shall and must have a real content that is implemented practically in day-to-day operations on board the individual vessel.

Anchor-handling is demanding and risky. The risk assessments have been particularly related to hazardous individual operations. Risk assessments, which generally follow a fixed format, with completion of various forms, have first and foremost focused on the dangers of working on deck. Various risks have been handled by means of use of equipment, prohibitions on being on deck during winch operations, man over board, and so forth.

The assessments must also embrace the risk to which the vessel can be exposed. During recovery and deployment of anchors, the vessel will often be affected by great forces. The Commission's investigations have discovered that large parts of the industry have apparently failed to take into account in their risk analyses that *the vessel as such* may be exposed to a considerable safety risk. They have therefore failed to make use of all available aids to foresee and avert situations that can challenge the safety of the vessel.

Companies should moreover ensure that the crews are competent to perform risk assessments.

13.6.1 Vessel-specific anchor-handling procedure

Anchor-handling procedures ought to be prepared by the companies, and they ought to be vessel-spe-

cific. Procedures should also include requirements for the crew's undertaking of assessments of expected mooring-line forces as described in the rig move procedure. For further indication of what such a procedure may contain, see Section 4.7.3.

13.6.2 Overlap/familiarisation/handover

Safety management systems should have barriers that mean that a master who has not previously been on board a vessel is given a certain form of overlap and familiarisation (induction). It is not sufficient that the master comes from another of the company's vessels.

In the same way, it is important that companies and operators facilitate the allocation of sufficient time for handover in a crew change. The crew changes must ensure that there is time for a sufficient review not only of the vessel's and the equipment's technical condition, but also for information about the operation with which the vessel is in progress.

13.6.3 Identify need for qualifications

Anchor-handling is a demanding maritime operation and makes requirements for extended expertise in comparison with ordinary supply activity. An anchor-handling operation includes complicated winch operations, connection of heavy equipment and mastery of big external forces. When anchor-handling is to be done in great water depths under challenging sea, current, and wind conditions, it demands expertise far beyond the STCW Convention's minimum requirements. Of particular importance is a high level of expertise on the part of the senior officers of the watch on the bridge (the master and chief officer) to handle safe operation of the vessel. Any lack of experience must be compensated for by adding extra experienced personnel.

Safe anchor-handling also makes requirements for qualifications, among other things in the use of load calculator and other computer programs, including weight and power calculations. Such expertise and qualifications should be defined in a company's safety management system.

Companies must also ensure that time and money are allocated to the implementation of sufficient training and expertise enhancement in these areas.

13.7 POB lists on departure offshore

During the rescue work after the accident it was discovered that duty-holder and the operator did not know how many people were on board the "Bourbon Dolphin" and who they were.

When a vessel is contracted, the companies must therefore ensure that the operator and duty-holder at all times have complete lists of the crews on the individual vessel. The lists must be continuously updated electronically.

13.8 Planning of the rig move

The operator has the paramount responsibility for the safety of the entire operation. Rig moves must be planned and implemented pursuant to applicable requirements and guidelines. The procedure must reflect the realistic forces to which the vessels can be exposed. They must make sure that sufficient time is allocated to preparations before the operation commences, so that the vessels are guaranteed the necessary understanding of what it involves.

All offshore operations are very expensive. Time is thus a critical factor. It is important that for example the weather requirements are clear and unambiguous, so that no disagreement arises as to when an operation can be initiated or suspended.

The procedure must be operation-specific and easy for those who are to carry it out to understand.

The Commission has discovered that no explicit risk assessments were prepared for the operation. Use of risk analyses in the planning phase establishes safety barriers. These many be of a technical, operational and expertise nature.

13.9 Execution of the rig move

Demand for efficiency must never be at the expense of safety.

In the implementation, safety and coordination must be subject to continuous evaluation. It is important that the individual vessel and not least the operator has insight and understanding of what tasks can be imposed on the individual player on the basis of the vessel's capacity and the crew's experience.

13.9.1 Start-up meeting and communication

Under the NWEA guidelines a start-up meeting should be held in advance of the operation. The guidelines do not contain any further requirements as to who shall be present. In Section 61A of the Norwegian OLF guidelines, however, it is recommended that operational personnel from the rig, the operator and the vessels meet, but this practice is not always followed on the Norwegian Shelf. The Commission considers that it must be a mandatory requirement that the operator ensures that the necessary time is allocated for a joint meeting onshore before the operation commences. The RMP shall be submitted to the vessel and the company in advance of such a meeting.

Review of hazard factors, previous experiences, weather and current conditions and coordination of technical challenges related to the operation are natural agenda items for such a meeting.

Operators must ensure that risk analyses are prepared by the vessels before they start the operation, which was not done in this case, but which follows from the NWEA guidelines. The rig must also get access to the analyses.

Communication between the vessels and the rig is over an open VHF channel. All involved have access to this channel. The working language shall be common. It is important that communication be used actively and that what is said is understood by all. Communication is important for creating trust and a positive attitude, and can help everyone to feel secure during the operation. The towmaster has a key role in this, but the masters and officers on the vessels are also important contributors.

According to a report from the Danish Commission of Inquiry (the Danish Maritime Authority), after the "Stevns Power" accident it was discovered inter alia that the routines for safety cooperation during the operation were defective.

13.9.2 Tandem operations

When two or more vessels are working together during an operation, it is not sufficient to focus on the safety of the individual vessel alone. The vessels are facing different challenges and requirements. At the same time, they are dependent on one another to carry out the operation. In this form of operations the individual's area of responsibility cannot be restricted to his own vessel.

13.9.3 Attention zones for running-out of anchors

An attention zone should be introduced along mooring lines that indicate a maximum distance that the vessel shall observe when running out anchors. If the zone is violated, the vessel must report to the rig and explain the cause. At the same time, the towmaster should be mandated to demand an explanation of the situation. If the vessel, with normal use of thrusters, is unable to keep inside the zone, measures shall be observed. The width of the zone and what measures are to be taken must be apparent from the RMP.

13.10 Duty of notification of maritime accidents outside Norwegian territory

The Commission is aware that Norwegian authorities are looking more closely at requirements for a duty of notification in connection with contraventions of Chapter 18 of the Maritime Act. The Commission will leave it to the authorities to consider the scope of this duty further.

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