



Australian Transport Safety Bureau



ATSB TRANSPORT SAFETY REPORT
Marine Occurrence Investigation No. 261
MO-2008-013
Final

Independent investigation into the fatality on board the
Australian registered floating storage and offloading tanker

Karratha Spirit

off Dampier, Western Australia

24 December 2008



Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT

Marine Occurrence Investigation

MO-2008-013

No. 261

Final

**Independent investigation into the fatality on
board the Australian registered floating
storage and offloading tanker**

Karratha Spirit

off Dampier, Western Australia

24 December 2008

Published by: Australian Transport Safety Bureau
Postal address: PO Box 967. Civic Square ACT 2608
Office location: 62 Northbourne Ave, Canberra City, Australian Capital Territory, 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

© Commonwealth of Australia 2010.

This work is copyright. In the interests of enhancing the value of the information contained in this publication you may copy, download, display, print, reproduce and distribute this material in unaltered form (retaining this notice). However, copyright in the material obtained from other agencies, private individuals or organisations, belongs to those agencies, individuals or organisations. Where you want to use their material you will need to contact them directly.

Subject to the provisions of the *Copyright Act 1968*, you must not make any other use of the material in this publication unless you have the permission of the Australian Transport Safety Bureau.

Please direct requests for further information or authorisation to:

Commonwealth Copyright Administration, Copyright Law Branch
Attorney-General's Department, Robert Garran Offices, National Circuit, Barton, ACT 2600
www.ag.gov.au/cca

ISBN and formal report title: see 'Document retrieval information' on page v

CONTENTS

THE AUSTRALIAN TRANSPORT SAFETY BUREAU	vii
TERMINOLOGY USED IN THIS REPORT.....	ix
EXECUTIVE SUMMARY	xi
1 FACTUAL INFORMATION	1
1.1 <i>Karratha Spirit</i>	1
1.2 Import hose arrangement	3
1.2.1 Import hose disconnection procedure	4
1.3 Mooring hawsers	5
1.3.1 Mooring hawser connection procedure.....	6
1.3.2 Mooring hawser disconnection procedure.....	8
1.4 Tropical cyclones.....	10
1.4.1 Tropical Cyclone Billy.....	11
1.5 The accident.....	11
2 ANALYSIS	19
2.1 Evidence	19
2.2 The accident.....	19
2.3 Connection and disconnection procedures	21
2.3.1 Import hose	21
2.3.2 Mooring hawser pickup lines.....	22
2.4 Shipboard review of procedures	23
2.5 Risk analysis.....	25
2.6 Human factors.....	26
2.6.1 Crew competence and experience.....	26
2.6.2 Shared mental model	27
2.6.3 Situational awareness.....	28
2.7 Emergency response.....	28
2.7.1 Communications	28
2.7.2 Helicopter evacuation	31
2.7.3 Automatic external defibrillator.....	33
2.8 Regulatory jurisdiction	33
2.8.1 Safety management system audits	36

3	FINDINGS.....	41
3.1	Context	41
3.2	Contributing safety factors	41
3.3	Other safety factors.....	42
4	SAFETY ACTION.....	45
4.1	Teekay Shipping Australia	45
	4.1.1 Safety management system procedures	45
	4.1.2 Safety management system review and familiarisation	45
4.2	The Australian Maritime Safety Authority	47
	4.2.1 Jurisdiction.....	47
4.3	National Offshore Petroleum Safety Authority	47
	4.3.1 Oversight.....	47
	4.3.2 Jurisdiction.....	48
	APPENDIX A: EVENTS AND CONDITIONS	51
	APPENDIX B: SHIP INFORMATION.....	53
	APPENDIX C: SOURCES AND SUBMISSIONS.....	55

DOCUMENT RETRIEVAL INFORMATION

Report No.	Publication date	No. of pages	ISBN	ISSN
261-MO-2008-013	September 2010	68	978-1-74251-062-0	1447-087X

Publication Title

Independent investigation into the fatality on board the Australian registered floating storage and offloading tanker *Karratha Spirit* off Dampier, Western Australia on 24 December 2008.

Prepared By

Australian Transport Safety Bureau
PO Box 967, Civic Square ACT 2608 Australia
www.atsb.gov.au

Reference Number

Jun10/ATSB93

Acknowledgements

The chart section in this publication is reproduced by permission of the Australian Hydrographic Service. © Commonwealth of Australia 13 October 2002. All rights reserved. Other than for the purposes of copying this publication for public use, the chart information from the chart sections may not be extracted, translated, or reduced to any electronic medium or machine readable form for incorporation into a derived product, in whole or part, without the prior written consent of the Australian Hydrographic Service.

The *Karratha Spirit* photographs (Figures 3, 4 and 8) are courtesy of Teekay Shipping Australia.

The chart showing the track of Tropical Cyclone Billy (Figure 9) is courtesy of the Australian Bureau of Meteorology.

Photographs of *Karratha Spirit* (Cover and Figure 1) and of the CALM buoy (Figure 6) are courtesy of the Western Australia Police.

Abstract

At about 1815 on 24 December 2008, the Australian registered floating storage and offloading tanker, *Karratha Spirit*, began disconnecting from its mooring buoy at the Legendre Oil Field, about 60 miles north of Dampier, Western Australia, because of an approaching tropical cyclone.

The master was on the forecandle, directly controlling the operation. Before the mooring hawsers could be released from the ship, the import hose drifted under the hawsers and he ordered the main engine to be run astern for about 1 minute in an attempt to pull the hose clear. At about 1954, after the wire suspending the oil import hose parted suddenly, the master ordered the crew to finish letting go the hawser pickup lines so that the ship could depart the mooring buoy.

An integrated rating applied the port winch drum's brake to stop the drum moving and then stepped between the cheeks of the drum to cut the lashing that held the end of the heavy hawser pick line on the drum. At about 1958, when the lashing parted, the last three turns of heavy line rapidly unwound from the drum, striking the rating on the head and throwing him under the winch drum. He died as a result of his injuries.

The ATSB investigation found the procedures for connecting and disconnecting from the mooring buoy had not always been followed and that the difference between the procedures and shipboard practice had not been identified during any shipboard review and the risks associated with this amended practice had not been assessed.

The investigation also found that it is possible, under some circumstances, that facilities like *Karratha Spirit* can fall outside the jurisdiction of the safety regulators. The report issues one recommendation and one safety advisory notice to address these safety issues.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the Transport Safety Investigation Act 2003 and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which ‘saved the day’ or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: The ATSB’s assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

EXECUTIVE SUMMARY

On 24 December 2008, the Australian registered floating storage and offloading (FSO) tanker, *Karratha Spirit*, was moored to a CALM¹ buoy at the Legendre Oil Field, about 60 miles² north of Dampier, Western Australia.

At about 1800³, the master made the decision to disconnect from CALM buoy and depart the oil field because of an approaching category four tropical cyclone.

The master, chief mate and crew assembled on the ship's forecastle deck and disconnected the oil import hose and started to fit a blank flange to the hose. At the same time the master ordered the preventer lines, which stop the hose from drifting under the mooring hawsers, to be let go.

The master then instructed the chief mate to go to the bridge while he remained on the forecastle, controlling the operation, as he wanted to experience the operation first hand from the forecastle. He then ordered the crew to release the mooring quick release hooks and begin lowering the hawsers and chafe chains using their pickup lines. However, before the hawsers could be lowered away from the ship, the import hose drifted under them. At about 1945, the master ordered the main engine to be run astern for about 1 minute to pull the import hose out from under the mooring hawsers.

The astern movement resulted in the hose hoist wire, the hawsers and the hawser pickup lines coming under tension. The hose was still suspended from the hoist wire and the crew began to lower it using the winch motor. The pickup lines were lowered away, the port side by releasing the winch brake and the starboard side using the winch motor.

At about 1954, the hose hoist wire parted suddenly with a loud bang. The master ordered the crew to, 'Cut through and let go'.

The starboard pickup line reached its end first and an integrated rating (IR) climbed under the winch drum, between the drum's cheek plates, to cut the lashing which was securing the end of the line to the drum. At about 1958, another IR on the port winch applied the drum's brake and stepped between the cheeks of the drum to cut the lashing at the end of the port hawser pickup line. There were still about three turns of pickup line, under tension, on the drum and the IR struggled to cut through them with his knife. When the lashing parted, the pickup line rapidly unwound from the drum, striking the IR on the head and throwing him under the winch drum and into the base of a pedestal roller fairlead.

The seriously injured IR was moved to the ship's hospital where the crew attempted to resuscitate him. The master and the chief mate tried unsuccessfully to telephone the emergency services ashore. The master then contacted the Dampier Port Authority using the ship's VHF radio requesting assistance and they, in turn, telephoned the police. The Australian Rescue Coordination Centre (RCC), the authority best placed to coordinate medical advice and a medical evacuation, was

¹ Catenary Anchor Leg Mooring, a buoy moored to the seabed using anchors and cables.

² A nautical mile of 1852 m.

³ All times referred to in this report are local time, Coordinated Universal Time (UTC) + 9 hours.

not contacted directly from the ship and the RCC was not informed of the accident until 2050, almost 1 hour after it had occurred.

At about 2150, after numerous attempts to contact the ship using a satellite telephone had failed, a doctor ashore was finally able to contact the ship. After consulting the master, the doctor concluded that the injured IR was deceased and advised the master that resuscitation attempts could stop.

The ATSB's investigation identified five safety issues. The report acknowledges the safety actions already taken by appropriate organisations and issues one recommendation and one safety advisory notice to address the outstanding safety issues:

- The ship's procedures for connecting and disconnecting from the CALM buoy did not provide explicit, succinct and unambiguous guidance and there were differences between the procedures and the actual shipboard practices that increased the level of risk associated with those operations. *[Minor safety issue]*
- The procedures for connecting and disconnecting the import hose and disconnecting from the CALM buoy in place on board *Karratha Spirit* were signed off as being satisfactory and reflecting shipboard practice, but they had not been effectively reviewed on board the ship. Consequently, the ambiguities in the procedures and the discrepancies between the procedures and the ship's practices were not identified during any shipboard review or audit and were not made known to the ship's managers through any review process. *[Minor safety issue]*
- The Job Hazard Analysis (JHA) for disconnecting from the CALM buoy did not provide an accurate assessment of all of the hazards and associated risks in performing the task. In addition, the crew did not use it to assess the risks associated with undertaking an unfamiliar operation and it was reviewed without any involvement from the crew. Consequently, the JHA was not an effective means for assessing and controlling the risks associated with the operation of disconnecting from the CALM buoy. *[Minor safety issue]*
- The National Offshore Petroleum Safety Authority (NOPSA) does not undertake the audits necessary for maritime compliance and the Australian Maritime Safety Authority (AMSA) is only able to do so, while the facility is on station, with NOPSA's cooperation. NOPSA had carried out annual occupational health and safety inspections on board the ship and AMSA had carried out the necessary third party audits of the system to meet its certification requirements. However, none of these audits or inspections had identified the discrepancy between the mooring hawser procedures and actual shipboard practices or that the ship's internal review processes had not identified the discrepancy. *[Minor safety issue]*
- In this instance, the consensus of the regulatory authorities is that *Karratha Spirit* was not in a navigable form at the time of the accident and was therefore under NOPSA's jurisdiction according to the Offshore Petroleum and Greenhouse Gas Storage Act (OPGGSA). However, the point at which *Karratha Spirit* became 'navigable' is not clearly defined in the OPGGSA and is open to interpretation. Consequently, during some operations, it is possible that the ship would not come under the jurisdiction of any Australian safety regulatory regime. *[Significant safety issue]*

1 FACTUAL INFORMATION

1.1 *Karratha Spirit*

Karratha Spirit (Figure 1) is an Australian registered floating storage and offloading tanker (FSO). It is owned by Teekay Corporation, Bahamas, managed by Teekay Shipping Australia (Teekay), and classed with the American Bureau of Shipping (ABS).

Figure 1: *Karratha Spirit*



The ship was built in 1988 as a single hulled Aframax⁴ tanker by Hyundai Heavy Industries, Korea, and named *Pioneer Spirit*. In 2001, it was converted to an FSO and renamed *Karratha Spirit*. It has an overall length of 255.00 m, a moulded breadth of 42.67 m and a moulded depth of 21.52 m. At its summer draught of 14.66 m, it has a deadweight of 106 672 t.

The accommodation superstructure and helicopter landing platform (helideck) are located at the after end of the ship and the ship's nine cargo oil and two slop tanks are located forward of it. The ship has a total oil storage capacity of 124 222 m³.

Propulsion is provided by a B&W 6S60MC single acting, direct reversing, two-stroke diesel engine developing 10 165 kW at 92 rpm. As part of the conversion to an FSO, the main engine was modified to enable it to run at reduced speed for extended periods of time, as necessary, to prevent the FSO from drifting up onto the CALM buoy and to reduce snatch loadings on the moorings while the ship is moored to a CALM buoy. Fitting the 'slow steaming' fuel injector nozzles to the ship's main engine effectively reduced the power output of the engine which, together with the growth on the ship's hull, reduced the ship's speed.

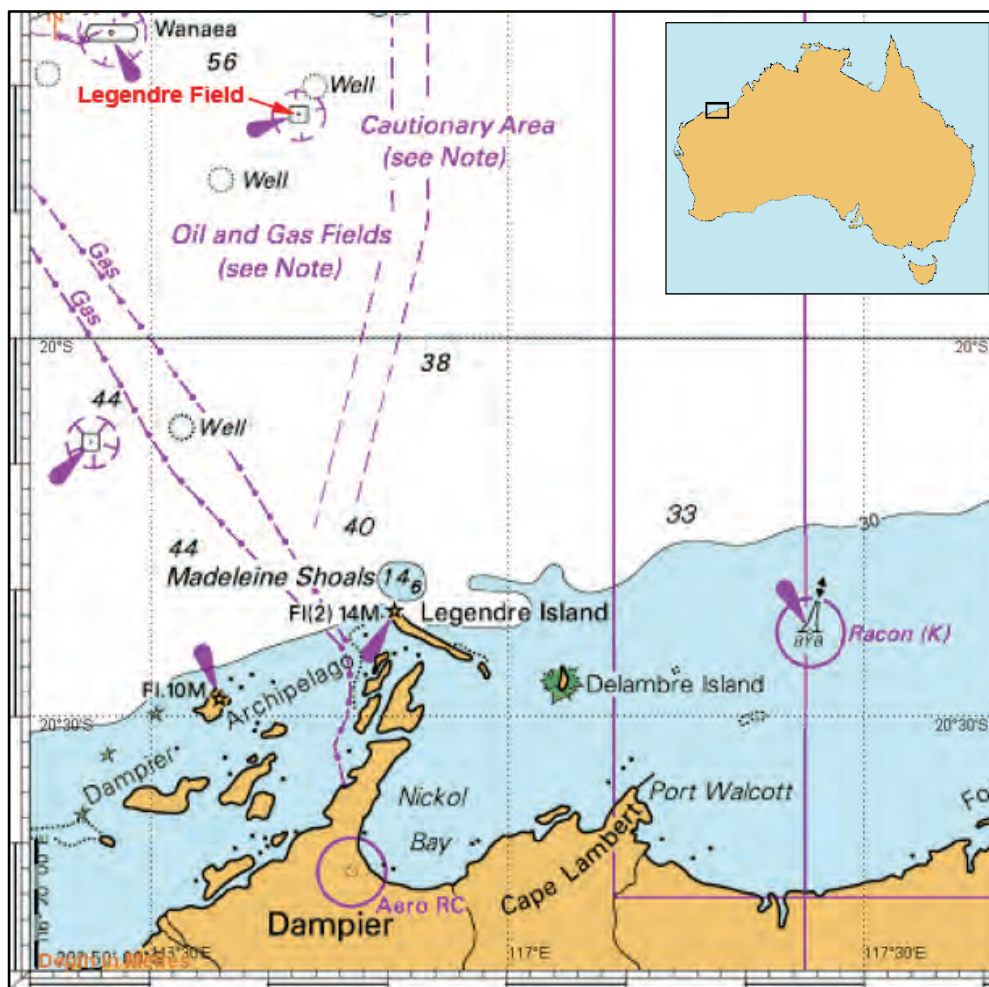
Most of the time, *Karratha Spirit* remains moored to a CALM buoy, providing storage and offloading facilities for *Ocean Legend*, an oil production platform located at the Legendre Oil Field (Figure 2), about 60 miles north of Dampier, Western Australia (WA). When an off-take tanker arrives to load a cargo of oil from *Karratha Spirit*, it is moored astern of the FSO and oil is transferred between

⁴ A tanker, usually between 80 000 and 120 000 deadweight tonnes.

the two ships through a floating export hose. On average, about four times per year, *Karratha Spirit* needs to disconnect from the CALM buoy and depart the oil field because of an approaching cyclone.

The ship's navigation bridge is equipped with navigational equipment consistent with SOLAS⁵ requirements, including global maritime distress and safety system (GMDSS) communications equipment.

Figure 2: Section of navigational chart Aus 4722 showing the location of the Legendre Oil Field



At the time of the accident, *Karratha Spirit*'s crew of 17 Australian nationals consisted of a master, three mates, four engineers, one chief integrated rating (CIR) five integrated ratings (IRs), a trainee integrated rating (TIR), a cook and a caterer. All of the crew worked on a 4 weeks on/4 weeks off duty roster.

The master had 38 years of seagoing experience and has held an Australian certificate of competency as master since 1988. He had been a ship's master with Teekay since 2004 and had been *Karratha Spirit*'s master for about nine months. He had rejoined the ship 1 week before the accident. In addition, he had 18 months experience as chief mate on both *Karratha Spirit* and *Dampier Spirit* in preceding years and had recently completed a 3 day FSO practical ship handling refresher course.

⁵ The International Convention for the Safety of Life at Sea, 1974, as amended.

The chief mate had 25 years of seagoing experience and held an Australian certificate of competency as master. He had been a chief mate with Teekay for 4 years and had been *Karratha Spirit*'s chief mate for about 1 year. He had acted as relieving master for 1 week before the master rejoined the ship.

The ship's most experienced chief integrated rating (CIR A) had over 33 years of seagoing experience. He held a certificate of proficiency as chief integrated rating and had worked as a CIR for 15 years. He had been *Karratha Spirit*'s CIR for the previous 7 years. He left the ship the day before the accident.

The chief integrated rating on board at the time of the accident (CIR B) had about 16 years of seagoing experience. He held a certificate of proficiency as an integrated rating. He had worked on board *Karratha Spirit* for about 14 months and had joined the ship as an IR about 3 weeks before the accident. He was promoted to CIR the day before the accident.

The integrated rating who was fatally injured (IR 3) held a certificate of proficiency as chief integrated rating and had over 18 years of seagoing experience, including extensive experience as a CIR on other ships. He had joined *Karratha Spirit* for the first time 6 days before the accident.

1.2 Import hose arrangement

When *Ocean Legend* is producing oil, it is delivered to the CALM buoy through a 250 mm diameter, flexible pipe which lies along the seabed. From the CALM buoy, the oil passes through a 200 mm diameter, 170 m long, floating hose to a manifold connection mounted on the port side of *Karratha Spirit*'s forecastle deck.

The import hose manifold connection incorporates a quick-connect-disconnect (QC/DC) mechanism and an emergency shutdown valve. The emergency shutdown valve can be operated from the cargo control room and from the forecastle to halt the flow of oil in an emergency. The QC/DC mechanism can only be operated locally from the forecastle deck, adjacent to the import manifold.

The import hose is also designed to include a 'Gall-Thompson' breakaway coupling to minimise the loss of oil in the event that the hose fails while it is delivering oil. At the time of the accident, there was no 'Gall-Thompson' coupling fitted to the import hose because it had repeatedly malfunctioned and had been removed for servicing.

From the import manifold connection, the oil is distributed through a piping system along the ship's deck and into the number one, number two or number three centre cargo oil tanks or into the slop tanks. Transfer of cargo to the other cargo tanks is through the ship's original cargo oil piping system.

The import hose is held in place by two 'preventers', which are run off the forward spring winch. The preventers hold the import hose in a bight. This stops any longitudinal torsional loading of the import hose manifold structure from load on the import hose and restricts the hose from moving across the bow and potentially fouling the mooring hawsers (Figure 3).

The cargo export system uses the ship's original cargo pumping system with a cargo pump discharge line led along the deck to the export manifold located on the starboard side of the poop deck. The export system is also fitted with an emergency shutdown valve and a QC/DC.

Figure 3: *Karratha Spirit's* hawsers and import hose at the CALM buoy



1.2.1 Import hose disconnection procedure

The ship's import hose disconnection procedure includes instructions for manipulating and letting go the import hose preventer ropes, releasing the hose from the manifold and lowering it to the water. It states:

Preparing To Release the Hose from the QC/DC

- Confirm that all product flow from the Production Facility has ceased.
- Close the ESD valves and all the cargo tank valves.
- Attach the accumulator hoses to the import hose QC/DC hydraulic valves.
- Operate the hydraulic hand pump to close both valves.
- Drain the section of line between the two butterfly valves into a drum using the ballcock.
- Remove the ballcock on the lower section of the QC/DC coupler and replace with a 3/8" NPT plug.
- Remove the accumulator hoses from the upper QC/DC valve connector and replace with a 3/8" NPT plug.
- Heave in the preventer ropes (keeping them tight) and secure the rope with a sacrificial line at the railings and disconnect the preventer rope from the wire to the spring winch. This will aid in preventing the import hose forming a loop under the hawser prior to letting go.
- Attach the chain blocks to the lifting arms on the QC/DC coupler and take the weight.
- Let go the preventer rope on deck.
- Attach the accumulator hoses to the QC/DC rotating collar connectors.

- Operate the hydraulic hand pump to open the collar and this will release the import hose.
- Lower the import hose using the chain blocks so that the blind flange can be fitted.
- Check the condition of the “O” ring on the hose flange and if necessary, replace. This acts as a seal to ensure a leak tight connection between the import hose spool piece and the blind flange.
- Fit the blind flange to the end of the import hose ensuring there is a bolt in each hole.

Lowering the Hose to the Water Procedure

- Connect the quick release hook on the hose lifting wire to the snubbing chain on the pad eye of the lifting flange.
- Slack the chain blocks so the weight of the hose is taken on the hoist wire.
- Disconnect the chain blocks.
- Attach a slip line to the quick release hook on the hoist wire ensuring that the line is long enough to prevent premature release of the hook.
- Lower the hose to the about one metre above the water and activate the quick release hook.
- Ensure the Hose end does not disconnect over the import hose loop. (If required wait for tide change)
- Heave in the hoist wire and secure all equipment.
- If conditions permit, the workboat crew will secure the import hose to the CALM buoy hawsers.
- The hose is secured between the 5th and 6th hose joint and the secondary floatation buoy and the end of the red pick up rope and the last hose length. This is done to prevent the hose and hawsers fouling the CALM buoy.
- If conditions permit, the workboat crew will close the product valves on the CALM buoy.

1.3 Mooring hawsers

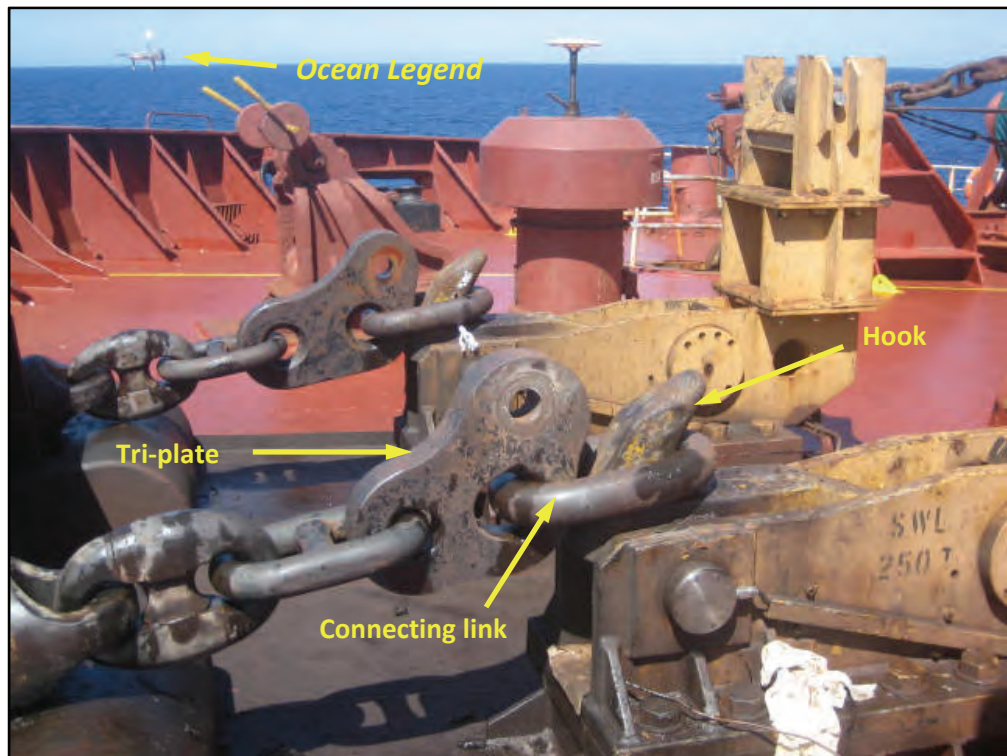
When on station, *Karratha Spirit* is moored to the Legendre CALM buoy by two hawsers (Figure 3). Each of the hawsers is a 60 m long, 19 inch circumference, double braided nylon grommet⁶ with a safe working load (SWL) of 840 t⁷. The mooring load is shared between the two hawsers but each of the hawsers is capable of handling the full design load.

Each of the hawsers is shackled to a 10 m length of 76 mm diameter chafe chain that is attached to a 250 t SWL quick release hook mounted on the ship’s forecastle deck using a tri-plate and connecting link (Figure 4). The chains are in place to prevent the hawsers from chafing on the bow of the ship.

⁶ A continuous loop of rope seized together to form a single rope with an eye at each end.

⁷ TK Standard Operating Practices, SP 0060, ‘CALM Buoy Mooring Arrangements Guideline (*Karratha Spirit*)’, Version 1.

Figure 4: Quick release hooks



The quick release hooks can be tripped manually using a removable bar or remotely using a hydraulic system which has an actuating cylinder within the hook that operates the tripping mechanism. The hooks are remotely released from a control stand at the base of the foremast. The safety case facility description states that, ‘Simultaneous release is provided for both bow hawsers⁸’. However, the quick release hooks cannot be released together.

1.3.1 Mooring hawser connection procedure

While *Karratha Spirit* is not connected to the CALM buoy, a hawser pickup line, made up of 150 m of 80 mm diameter polypropylene rope, is attached to the end of each chafe chain (Figure 5). These pickup lines are left floating near the CALM buoy ready for re-connection (Figure 6).

When *Karratha Spirit* begins to connect to the CALM buoy, two 150 m long, 32 mm diameter messenger lines are loaded on board an offshore support vessel (OSV) from *Karratha Spirit* using the ship’s crane. A heaving line is then passed down from each of the ship’s chafe chain fairleads to the OSV. The crew of the OSV attach one end of the 32mm messenger line to the floating 80mm hawser using a shackle and the other end to the heaving line that has been passed down from the *Karratha Spirit*.

⁸ Teekay Shipping, ‘*Karratha Spirit*’ FSO – Facility Description (Doc No. LR-22-ZF-200) p 14.

Figure 5: Mooring hawser arrangement drawing

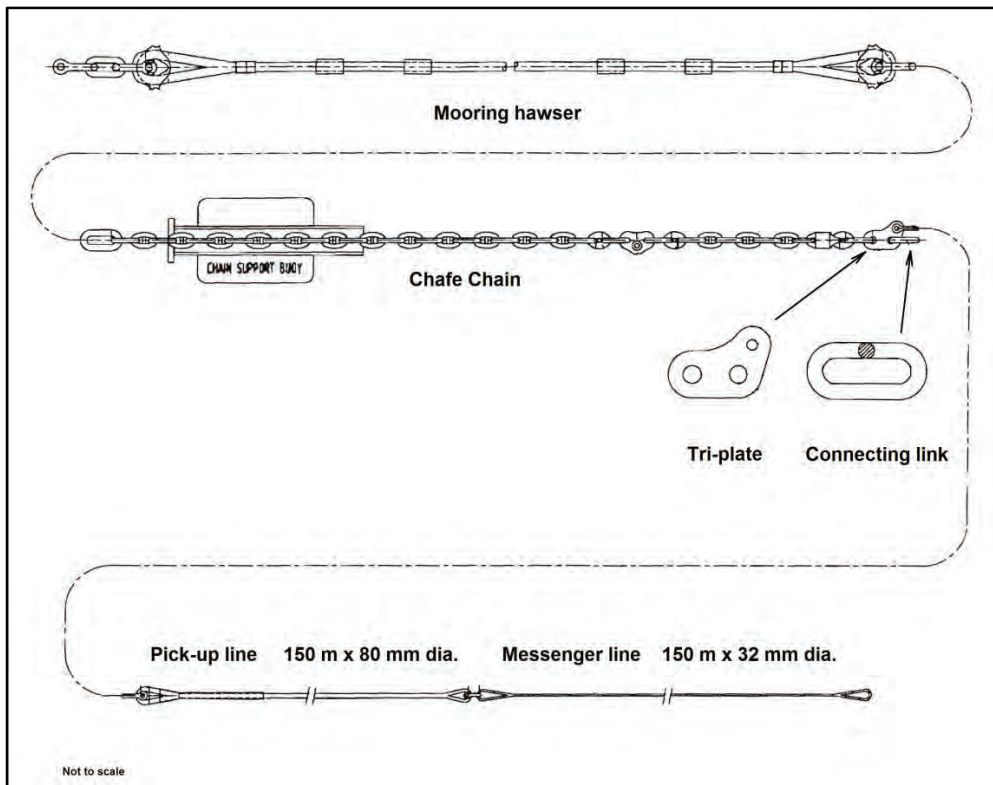
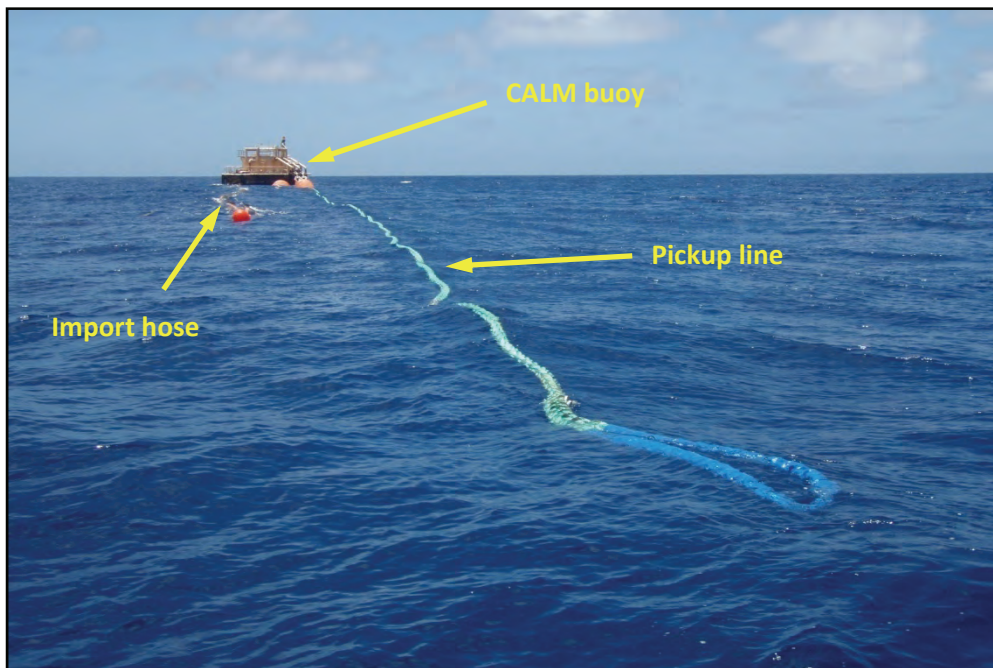


Figure 6: Pick up line and import hose



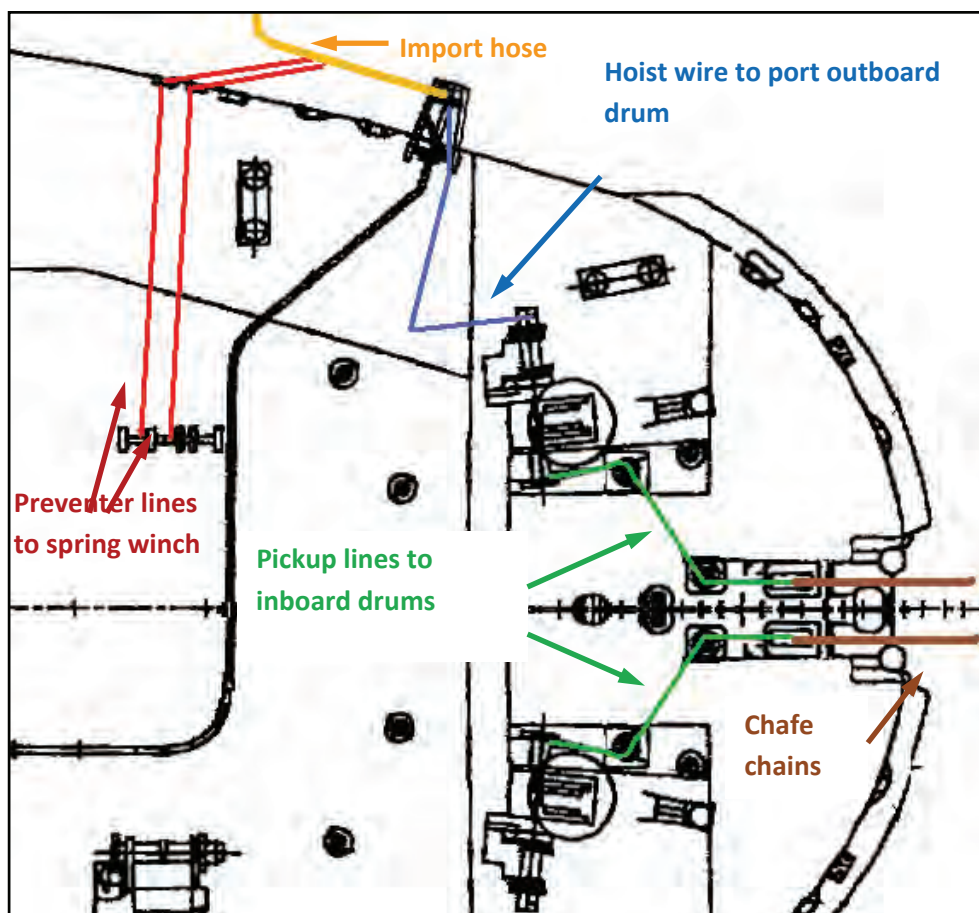
The heaving lines are used to heave the messenger lines up to *Karratha Spirit's* forecastle deck. Each messenger line is then led around two pedestal roller fairleads (Figure 7) and onto the appropriate inboard windlass winch drum (i.e. port or starboard) and heaved in to bring the pickup lines onto the forecastle deck.

The pickup lines are then used to heave the chafe chains up to the forecastle deck. The messenger lines should be laid onto the winch drums first with the pickup lines

laid over them. The chafe chains, connected to the ends of the pickup lines, are then made fast to the appropriate (i.e. port or starboard) quick release hook.

After the hawser chafe chains are secure on the quick release hooks, the pickup lines can be unshackled from the tri-plates and stowed correctly. In order to neatly stow the messenger line on the drum ready for the next disconnection and to prevent it from tangling, the messenger line and pickup line should be run off the drum and then carefully and neatly wound on again.

Figure 7: Forecastle deck layout showing hoist wire and pickup lines

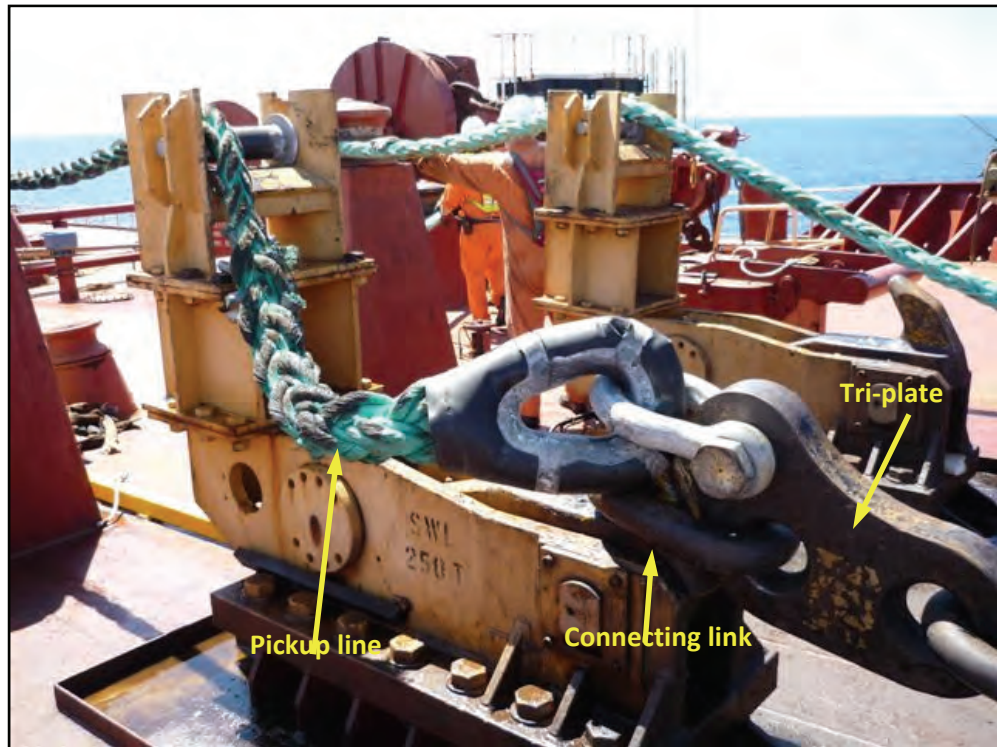


To have the winches set up correctly for disconnection, all of the lines need to be run onto the winch drum while connecting to the CALM buoy as per the procedures.

1.3.2 Mooring hawser disconnection procedure

When *Karratha Spirit* commences a controlled disconnection from the CALM buoy, the crew run the pickup lines from the winch drums, around the pedestal roller fairleads and connect them to the tri-plates using 55 tonne shackles (Figure 8).

Figure 8: Tri-plate and pickup line connected to quick release hook



A ship specific work instruction (SSWI) provides additional guidance⁹ for connecting the pickup lines to the tri-plates. These additional instructions had been developed following an incident in January 2008 where the pickup lines were missing when *Karratha Spirit* attempted to reconnect to the CALM buoy. It states:

- Ensure pick up ropes/shackles are kept connected, extra securing bolts for the 55 ton shackle was secured / tightened properly.
- A secondary safety sling is connected between the green pick up rope (eye of the rope) and the closest chain link. Run the safety sling (10 tonne) through and secure it back to itself using a 12/15 tonne small safety shackle.

The ship's standard operating procedure for disconnection¹⁰ then states:

- Launch the workboat (if possible)
- Put the ship's engine ahead as necessary to take the weight off the hawsers.
- Activate the Quick Release Hooks and lower the pickup ropes until the chafe chains are in the water.
- Pay out the pickup ropes until the 100 m x 32mm messengers can be attached to the pickup lines with sacrificial lashings. Secure a red or green buoy to the end of port and starboard pickup ropes as appropriate or paint the end of the pickup rope red and green for identification.
- Cut the lashing allowing pickup lines and coloured buoys to fall to the sea.

⁹ 'Additional Guidelines for Disconnecting from Calm Buoy', Version 1, Jan 31/08.

¹⁰ TK Standard Operating Practices, SP 0386, 'CALM Buoy Hawser Disconnection Procedure (*Karratha Spirit*)', Version 2.

- Workboat crew will lash (if possible) the end of the pickup ropes to the end of the import hose.
- Workboat crew will close the product valve on the CALM buoy.

Once the workboat has been recovered, *Karratha Spirit* is then able to sail away from the CALM buoy and clear the area.

1.4 Tropical cyclones

The Australian cyclone season officially runs from November to April. The northern coast of WA, between Broome and Exmouth, is the most cyclone prone region of the entire Australian coastline. On average, about five tropical cyclones develop in this area each cyclone season and generally two of these cross the coast, one of which is severe.

Cyclones off the north-west coast usually follow a fairly predictable pattern. Typically, they form north of the area and then move to the west-southwest at speeds of between 3 and 10 knots before turning to a more southerly movement as they get further south. If they do move south of about 22° south latitude or cross the Pilbara coast, they tend to curve to the south-southeast and accelerate.

The intensity of a tropical cyclone is defined by its maximum mean wind speed over flat land or water, taken over a 10 minute period. A cyclone's destructive power is a result of its maximum wind gust speed and the Australian Bureau of Meteorology (BoM) warns that the speed of a wind gust can be up to 40 per cent higher than the mean wind speed. A cyclone's intensity is usually stated as its category (Table 1).

Table 1: Cyclone Intensity

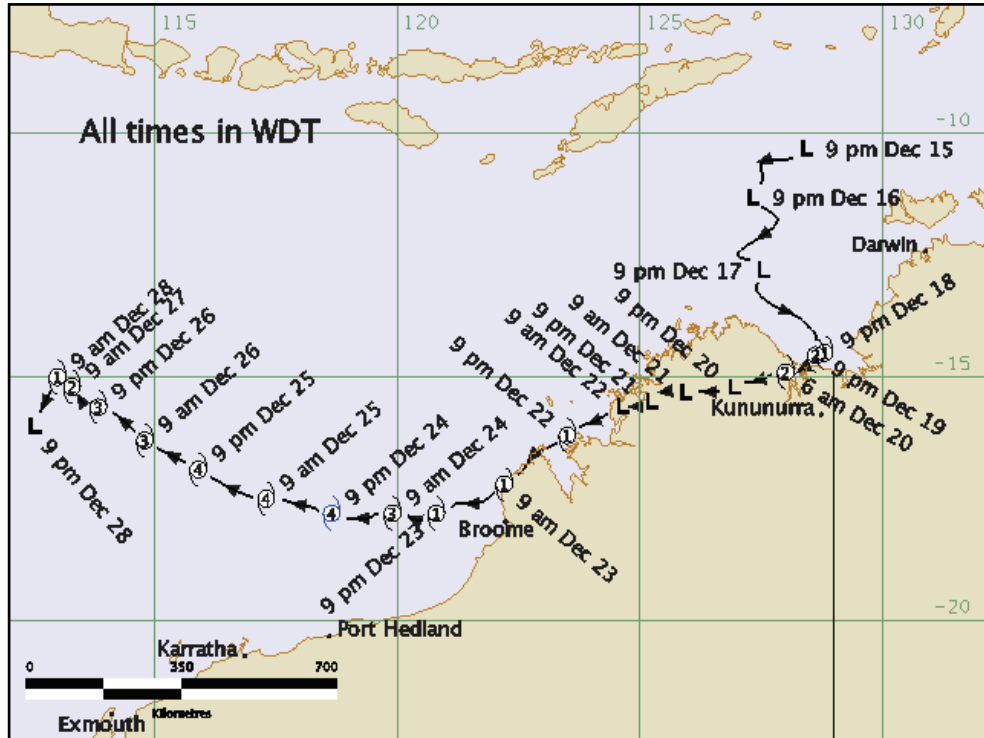
Cyclone Intensity	Wind gusts (knots)	BoM estimated damage description
Category One	50 - 65	Minimal house damage, some damage to trees. Small craft may drag moorings.
Category Two	65 - 90	Minor house damage and significant damage to signs and trees. Small craft may break moorings.
Category Three	90 - 120	Some roof and structural damage. Power failures likely.
Category Four	120 - 150	Significant roofing loss and structural damage. Dangerous airborne debris. Widespread power failures.
Category Five	>150	Extremely dangerous with widespread destruction.

The BoM provides daily weather forecasts for the ports and oil fields in northern WA to allow ship masters, harbour masters and oil platform managers to prepare for changes in the weather. If a tropical depression is approaching, the forecasts are issued every 6 hours and if a cyclone has been declared, the forecasts are issued every 3 hours.

1.4.1 Tropical Cyclone Billy

On 15 December 2008, a tropical low pressure system formed in the Timor Sea, northwest of Darwin, Northern Territory. Over the next few of days, it moved to the southwest and then to the southeast.

Figure 9: Track of tropical cyclone Billy



On 18 December, the low moved into the Joseph Bonaparte Gulf, WA and intensified into a cyclone. It was named tropical cyclone Billy (TC Billy) and it reached category two intensity before crossing the WA coast early on 20 December (Figure 9). After crossing the coast, it weakened over the land and became a low pressure system again.

It moved overland in a west-southwest direction and redeveloped into a cyclone after moving off the northwest Kimberley coast on 22 December. It then moved southwest, along the coast and rapidly intensified on 23 and 24 December after it had moved into open waters. It reached category four intensity late on 24 December, while it was still about 150 miles north of Port Hedland.

On 25 December, TC Billy swung and began to move to the west-northwest, away from the Pilbara coast, weakening in intensity as it moved away from the coast. It eventually weakened below cyclone intensity late on 28 December.

1.5 The accident

On 22 December, *Karratha Spirit* was securely moored to the Legendre CALM buoy and was loading crude oil into the number two centre cargo oil tank.

The master was monitoring the progress of TC Billy, which was located about 420 miles east-northeast of the ship.

In preparation for a possible departure from the CALM buoy before TC Billy came too close to the ship, the chief mate instructed CIR A to explain the disconnection procedures to the other crew members and to make the necessary preparations for the disconnection. Having disconnected from the CALM buoy many times before, CIR A was the most experienced member of the crew in the operation but he was due to leave the ship the following day and so he needed to share his expertise with the rest of the crew before he left.

During the day, CIR A undertook an import hose and hawser disconnection induction on the forecastle and the crew began making preparations to disconnect from the CALM buoy. A few days earlier, CIR A had demonstrated the disconnection and lowering of the export hose after an off-take tanker had completed loading.

At 0600 on 23 December, the master received a BoM weather forecast stating that TC Billy was a category one cyclone, centred about 378 miles east-northeast of *Karratha Spirit*.

At about 0830, CIR A departed the ship by helicopter and another member of the crew, CIR B, took over his duties. CIR B was the next most experienced member of the crew in disconnecting from the CALM buoy, having done it once before. Another IR had previously undertaken a hose disconnection.

During the day, the crew continued to make preparations for departing from the CALM buoy and lashing loose equipment on deck. That afternoon, CIR B again briefed the crew on the disconnection procedure for departing the buoy.

The master continued to monitor TC Billy's progress to ensure that he could make the decision to enable the ship to depart during daylight hours, while the cyclone was still outside the minimum distance prescribed in the ship's procedures.

As part of their preparations for disconnecting from the CALM buoy, the master and the chief mate reviewed the standard Job Hazard Analysis (JHA) form for the task and they stated that they found it to be satisfactory but they did not sign it at that time.

At 0520 on 24 December, *Ocean Legend* stopped pumping oil to *Karratha Spirit* and began to flush the cargo pipeline through with water in preparation for the evacuation of personnel from the platform.

At 0530, CIR B and one IR, IR3, were called by the chief mate to prepare for a helicopter landing. At 0600, they were joined by another IR and the TIR. At 0650, the helicopter touched down and at 0659, it had left the ship.

At 0600, the BoM weather forecast reported that TC Billy had increased in intensity to a category two cyclone and it was centred about 219 miles northeast of *Karratha Spirit*.

At noon, TC Billy was upgraded to a category three cyclone. It was still centred about 200 miles north-east of *Karratha Spirit*.

At about 1300, the personnel were evacuated from the *Ocean Legend* platform.

At 1500, the BoM weather forecast reported that TC Billy was now centred about 183 miles from *Karratha Spirit*. On receipt of this forecast, the master considered the cyclone's intensity and its distance from the ship. He believed that the ship would be able to remain safely moored to the CALM buoy if a category three

cyclone passed within about 135 miles, TC Billy's forecast closest point of approach, predicted for about 0900 on 25 December. He decided that he would reassess the situation after he received the next forecast at 1800.

At 1530, CIR B, IR3 and two other members of the crew went to the forecastle. They ran the pickup lines off the winch drum and around the pedestal roller fairleads in preparation for connecting them to the chafe chains. The crew were briefed on the procedure again by CIR B and he asked them if they had any concerns about it and they indicated that they did not. At 1600, they finished the task and returned to the accommodation.

At about 1720, before dinner, the master asked the chief mate and CIR B if everything was ready to disconnect from the CALM buoy if it was necessary to do so. They confirmed that it was.

At 1800, the BoM weather forecast reported that TC Billy had increased in intensity to a category four cyclone and it was now centred about 169 miles from *Karratha Spirit*. Its predicted path would bring it within about 132 miles of the ship by midday on 25 December.

At this time, the weather at Legendre was good. The wind was from the southwest at about 15 knots and the swell was about 1.5 m. Sunset was not until 1953.

On receipt of the BoM forecast, the master decided that a category four cyclone was too strong and that the ship would need to leave the CALM buoy immediately, before nightfall, to avoid the increased risks associated with disconnecting in the dark.

At about 1815, the master met with the chief mate and CIR B to discuss the latest weather forecast and his decision to leave the CALM buoy immediately. After the meeting, CIR B immediately went to inform the crew. The master and chief mate then signed the previously prepared JHA.

At about 1820, CIR B, IR 3, three other IRs and the TIR assembled on the forecastle. CIR B quickly held another meeting with the crew and he highlighted some of the hazards associated with the task.

During a disconnection manoeuvre, the master would normally take command of the ship on the bridge. However, on this occasion, he wanted to observe how the disconnection was completed on the forecastle and so he went to the forecastle just before CIR B finished giving the crew their final briefing. He had not taken part in any of the disconnection briefings and he did not take part in the final crew briefing or explain to the crew that he intended to be there only as an observer.

After the briefing, the crew connected the hydraulic hoses and prepared to close the QC/DC. At about 1830, the chief mate arrived on the forecastle deck and closed the QC/DC.

The crew then connected chain blocks to the import hose and took its weight before disconnecting the claw couplings on the import manifold and lowering the hose to allow a blank flange to be fitted to its open end. The swell was causing the hose to swing about, making it difficult to fit the blank flange, so the hose was bowsed in towards the manifold platform and secured using a smaller chain block and sling.

While the chief mate and the crew were fitting the blank flange, the master instructed CIR B to release the two hose preventer lines (Figure 7). The preventers

were released by CIR B and the TIR and they then informed the master that it was done.

At 1920, the hoisting wire had been run from the port outboard drum (Figure 7) and it was attached to the end of the import hose using a 'suitcase hook'¹¹. The chain blocks were then removed.

Confident that the chief mate could handle operations on the bridge, the master told him to go to the bridge while the master took control of the operations on the forecastle. He would relay any necessary instructions to the bridge using his handheld UHF radio. By 1930, the chief mate was on the bridge. The main engine and steering gear had been tested and were ready for use.

After the chief mate had left the forecastle, the master instructed the crew to connect the pickup lines to the chafe chain tri-plates and take the weight of the chains and hawsers using the winches. The crew changed over the port winch so that the import hose hoisting wire on the outboard drum was held on the brake and the pickup line on the inboard drum was in gear. The crew then shackled the pickup lines to the chafe chains and heaved in on the winches until the load was off each of the hooks.

The port hook was released first. It did not immediately release so the pickup line was slackened to allow the weight of the mooring hawser and chafe chain to trip the hook. As it released, some load was transferred onto the starboard hawser and the starboard hook also tripped with a loud bang. Once the hooks were clear, the master instructed the crew to lower the pickup lines several metres.

The master then instructed CIR B to finish releasing the hose and secure the hose platform while he controlled the mooring hawser disconnection.

It was at this time that the master saw that part of the import hose was drifting under the mooring hawsers as it was now hanging from its hoisting wire with its body unsecured by the preventer lines.

He remembered that the procedures specifically stated that the import hose should not be allowed to drift under the mooring hawsers while they were being let go. The master decided that the best way to move the hose from under the hawsers was to drag it clear using its hoist wire by running the main engine astern. At 1945, he called the chief mate using his hand held radio and instructed him to run the main engine dead slow astern. At 1946, he ordered the chief mate to stop the main engine.

The winch drums were being held on their brakes and, as the ship moved astern, the hawser pickup lines began to tighten on the winch drums.

At about 1950, the import hose was clear of the hawsers and the master instructed CIR B to release the hose. The hose was still suspended several metres above the water by the hoisting wire. CIR B was unable to pull hard enough on the suitcase hook trip line to release the hook and he informed the master that the hose would need to be lowered to the water before it could be released. The import hose's hoist wire would not run out when the crew started to release its brake. Consequently, the port outboard winch drum was put back into gear so the crew could lower the hose

¹¹ A balanced hook that is tripped when a secondary tripping line, which is fixed to a strong point, takes the weight from the main line, allowing the hook to tip and release its load.

in a controlled manner until the import hose was in the water where it could be released. The port pickup line winch was now out of gear and held on the brake.

As this was happening, the master, continued to direct the remaining crew to pay out the pickup lines from the winches. This, in turn, maintained a high load on the import hose hoist wire.

The hoist wire did not pay out quickly enough to relieve the tension on the wire and at about 1954, it parted suddenly with a loud bang before the crew had lowered it far enough to release the suitcase hook. The IR driving the port winch began heaving in the remaining wire using the winch until it was all back on the drum. Meanwhile, CIR B cut the suitcase hook trip line.

After the hoist wire parted, the master instructed the crew to finish paying out the pickup lines and 'Let go' so that the ship could manoeuvre clear of the CALM buoy.

The starboard pickup line ran out to its end first. The TIR who was driving the winch stopped it and an IR ducked under the winch drum where he cut the single turn of sacrificial lashing securing the end of the pickup line to the drum with a single slash of his knife. The pickup line briefly caught on a pedestal roller fairlead before being lifted clear by the IR. The line then ran out over the bow and into the water.

At this time, the port winch still had about two or three turns of pickup line on the drum. IR 3 tightened the brake on this winch and stepped between the 'cheeks' of the drum to cut the sacrificial lashings as had been done on the starboard side. However, there were several turns of lashing, heavier than the lashing on the starboard drum and he struggled to cut through them. When IR3 applied the winch brake, the ship's astern movement increased the load on the pickup line.

At about 1958, the sacrificial lashing parted and the remaining turns of pickup line on the drum rapidly unwound from the drum. The eye in the free end of the pickup line struck IR 3 with great force, throwing him under the winch drum. His head struck the base of the adjacent pedestal roller fairlead about 2 m away with a loud crack.

CIR B heard the sound and saw, in his peripheral vision, the white flash of the pickup line whipping past. The crew near the port winch also heard the sound and saw IR 3 lying under the winch, bleeding profusely. They rushed to him, placed him on his side to clear his airway, tried to feel a pulse and attempted to stop the bleeding.

After striking IR 3, the eye at the free end of the port pickup line had whipped around the pedestal roller fairlead before catching on a horn above the roller of the port hook. The master tried unsuccessfully to lift the eye off the horn before he asked the TIR, who had been driving the starboard winch, to help. They were then able to lift the eye clear.

At this time the master became aware of the crew shouting that a man had been injured. He saw IR 3 lying motionless on the deck and called the chief mate using his handheld radio and told him that there was a medical emergency on the forecastle. CIR B shouted at him to 'Call for a medivac¹²'. The master instructed the

¹² Medical evacuation.

chief mate to use the telephone to call '000'¹³ to reach the emergency services. He further instructed the chief mate to muster the ship's emergency party and to manoeuvre *Karratha Spirit* clear of the CALM buoy.

At 2000, the third mate arrived on the bridge to take over the watch. The chief mate informed him of the accident and the third mate began mustering the emergency party. The chief mate tried unsuccessfully to contact the emergency services using the ship's satellite telephone. Meanwhile, on the forecastle deck, the crew attempted to perform cardio pulmonary resuscitation (CPR) on IR 3 and to control his bleeding.

At 2015, the master arrived on the bridge and was informed by the chief mate that he had not been able to contact the emergency services. The master called the Dampier Port Authority (DPA) using VHF channel 16. He informed the DPA communications officer that he had a casualty on board, he was not sure if the casualty was still alive and that he needed an urgent medivac of the casualty.

The master turned *Karratha Spirit* towards Dampier, about 60 miles away, and increased the ship's speed to about 6 knots, the maximum speed with the slow steaming configuration of the engine.

On receipt of *Karratha Spirit*'s VHF radio call, the DPA communications officer immediately telephoned the duty police officer. The police officer requested more information about the ship's location and the nature of the casualty.

At 2020, the emergency team arrived on the forecastle and placed IR 3 on a stretcher. Using a flat-bed trolley, they took him to the ship's hospital where they connected the ship's automatic external defibrillator (AED) unit's electrodes to the injured man's chest. The voice prompts from the AED instructed them to continue performing CPR.

At about 2020, the master initiated a 'First Alert'¹⁴ notification and informed the ship's operators of the accident and that the ship was underway, heading towards Dampier.

At 2026, the DPA communications officer contacted the ship using VHF channel 16 and requested the additional information required by the police. The chief mate informed the DPA communications officer that they were seeking a helicopter evacuation for the injured man. By 2032, this information had been passed on to the police.

At 2034, the master called the DPA communications officer on VHF channel 16 and described the injured man's injuries adding that the injured man 'has serious injuries, I think he is a fatality now' and then gave the DPA communications officer the ship's satellite telephone number. The DPA communications officer asked what landing facilities were available for a helicopter. The master stated that the helideck was marked as 'not to be used at night' but that 'in an emergency we have to use it'.

At 2037, the second mate called the DPA communications officer on VHF channel 16 and was given a contact telephone number for the duty police officer. At about

¹³ The Australian landline telephone number for emergency contact with police, ambulance and fire brigade services.

¹⁴ The 'First Alert' is the ship operator's procedure that is used to advise the ship's managers of an incident.

2042, he telephoned the duty police officer and described the condition of the injured man to him, gave him the ship's position and reiterated the request for a helicopter evacuation. This was the first direct contact between *Karratha Spirit* and any of the emergency services.

At about 2050, after this telephone call was completed, the police officer was able to assess the situation and organise the appropriate response. Under the Western Australia Police rescue protocols, all medical evacuations outside port limits, in state waters, were referred directly to the Australian Maritime Safety Authority's Rescue Coordination Centre (RCC) in Canberra. At 2055, the police contacted the RCC and informed them of the accident. After communicating with RCC, the police placed the volunteer marine rescue (VMR) on standby for a 'coordinated deployment'.

At about the same time, the ship's offshore operations manager, based in Perth, contacted the DPA communications officer in response to the 'First Alert' message and requested information regarding the incident. He was told that the DPA communications officer had been contacted by the ship's master seeking a medivac for a crew member who had been struck by a heavy rope and had serious, possibly fatal, head injuries. He was told that the ship's medivac request had been passed on to the police and that the ship's satellite telephone number had also been given to the police. He was then given the police contact number so that he could communicate directly with them.

Before organising a medical evacuation, the RCC needed medical advice so, at 2100, the RCC duty officer contacted a doctor at the Royal Flying Doctor Service (RFDS) Telemedical Advice Centre (TMAC) and passed on the accident information and the ship's satellite telephone number. The doctor and the police then tried unsuccessfully to contact the ship using the satellite telephone number that they had been provided with.

At 2142, the DPA communications officer contacted *Karratha Spirit* on VHF channel 16 and informed the master that all calls to the ship's satellite telephone had been unsuccessful. A nearby ship, which had been listening to the radio traffic, informed the DPA communications officer that the telephone number possibly did not include the correct satellite dialling code. At 2146, the DPA communications officer passed the correct satellite dialling code to the police.

At 2150, the doctor telephoned the master and was informed of the resuscitation attempts and the condition of the injured man. The doctor advised that attempts to resuscitate him could be stopped because all of the indications were that he had died. At this time, *Karratha Spirit* was still 30 miles from the Dampier channel entrance beacon.

At about 2200, the ship's operators notified the Legendre Oil Field's operator of the accident.

The ship continued to steam towards Dampier with the intention of transferring IR3's body ashore using the volunteer marine rescue vessel, *Northwest Shelf Venturer*.

At about 2345, the Dampier Harbour Master granted permission for *Karratha Spirit* to anchor off the port so that the WA police could rendezvous with them.

At about 0130 on 25 December, the ship's operators advised the master that, because of the approaching cyclone, he should not go to anchor off Dampier but

steam in open water. The rendezvous between *Karratha Spirit* and *Northwest Shelf Venturer* was cancelled and the master decided to steam the ship slowly near Dampier until the emergency services could board the ship later that day.

At about 1500, police officers from Dampier boarded *Karratha Spirit* by helicopter to undertake a preliminary investigation into the accident.

At 1730, an investigation team from the National Offshore Petroleum Safety Authority (NOPSA) as well as representatives from Teekay boarded the ship by helicopter. The NOPSA lead investigator placed a 'Do Not Disturb' notice on the forecastle deck until his investigation was completed.

At 1740, the body of the deceased IR was taken ashore by the police.

Karratha Spirit remained at sea until NOPSA granted permission for the ship to return to the CALM buoy. At 1630 on 29 December, the NOPSA 'Do Not Disturb' notice on the accident site expired, allowing the crew to regain access to the area.

After the accident, it was discovered that the foundation plate of the roller, where the port pickup line had caught, was bent and that the port pickup line had parted about 100 m from the ship's bow.

At 1130 on 31 December, *Karratha Spirit* reconnected to the CALM buoy.

2.1 Evidence

On 26 December 2008, two investigators from the Australian Transport Safety Bureau (ATSB) attended *Karratha Spirit* off the coast of Western Australia (WA), near Dampier. The master was interviewed and he provided his account of the accident. Copies of relevant documents were obtained, including log book entries, procedures, navigational charts and statutory certificates.

Other relevant crew members were interviewed in late January and early February 2009, after they had left the ship and received counselling. The master was also re-interviewed at that time.

Information relating to the incident was also obtained from Teekay Shipping Australia (Teekay), the Dampier Port Authority (DPA), WA Police, the Maritime Union of Australia (MUA), the Australian Maritime Safety Authority (AMSA) and the National Offshore Petroleum Safety Authority (NOPSA). A copy of the post mortem examination report was provided by the WA Police on behalf of the WA coroner.

2.2 The accident

An integrated rating on board *Karratha Spirit* (IR3) was fatally injured when he was struck on the head and upper body by a flailing length of 80 mm polypropylene mooring hawser pickup line. The tension on the pickup line was released when IR3 cut the sacrificial lashing securing the end of the line to the winch drum.

At the time, he was standing between the ‘cheeks’ of the drum (Figure 10) to cut the lashing while there were still about three turns of the pickup line around the drum.

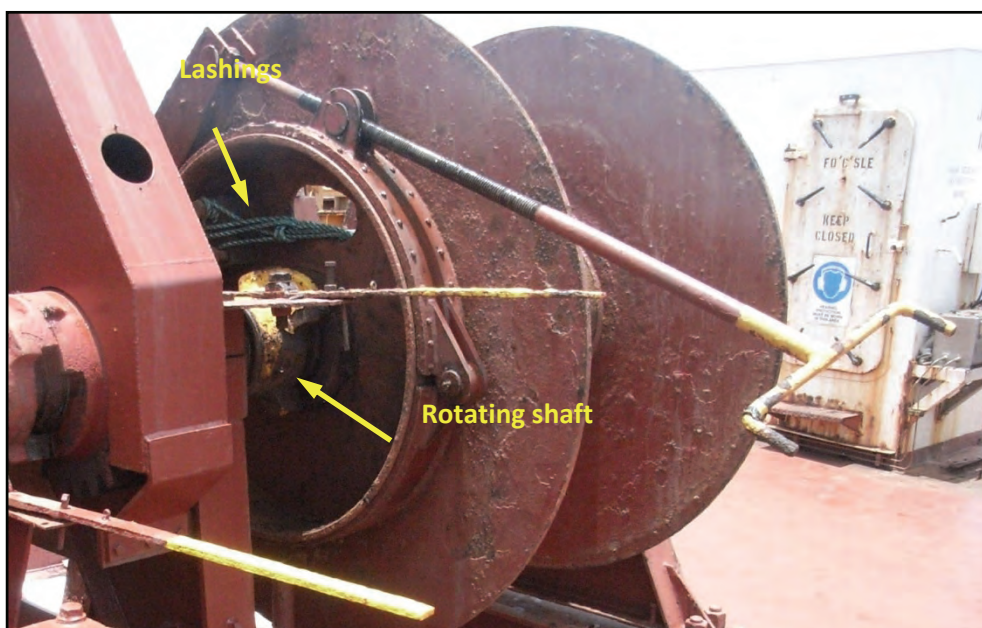
Figure 10: Port winch drum with cut lashings



The lashing could have been cut from outside the cheeks of the drum at the point where it was attached to a strong point (Figure 11). It is not known exactly why IR3 chose to stand between the cheeks of the drum, thereby placing himself in danger. It is possible that he did not cut the lashing from outside the drum because he was concerned about having to lean over the winch drive shaft, which was turning while

the broken import hose hoist wire was being recovered or because he had just seen another IR cut the lashing on the starboard pickup line from a similar position on the starboard winch.

Figure 11: Sacrificial lashings outside the port winch drum



During the disconnection operation, the mooring hawser pickup line should not, and usually would not, have been under tension. The master had briefly run the main engine astern to pull the import hose out from under the mooring hawsers. Before the brake was applied on the port winch drum, the ship's movement would have assisted in pulling the pickup line from the drum. Once IR3 applied the winch brake, the ship's movement would have been arrested by the pickup line, increasing the load on it.

It is also possible that IR3 was so focussed on cutting the lashing that he did not realise how much the load was coming onto the pickup line after he had applied the winch brake. From where he was standing, he could see, at most, 20 m of the 150 m long pickup line. As the ship continued to move astern, the increasing load on the line meant that there was a significant amount of energy stored in the elastic polypropylene rope and this energy was released as soon as the sacrificial lashing was cut.

The crew's expectation, based on the briefings given to them by both CIR A and CIR B, was that there would be no load on the pick-up lines and that it was the normal practice during disconnection operations on board *Karratha Spirit* to cut the lashings at the winch drum. When the starboard pickup line reached its end, it was cut by the attending IR from between and below the drum's cheeks. While cutting the lashing from between the winch drum cheeks was neither safe nor the normal practice of good seamanship, nothing prompted IR3 to question the action he was taking.

The increased load from the astern movement of the ship had also resulted in the import hose hoist wire parting suddenly, increasing the crew's sense of urgency to complete the operation and clear the CALM buoy. Once the hose hoist wire had parted, the master should have been aware of the tension on the pickup lines. At that time, he could have abandoned the operation and moved the crew away from the

forecastle deck until the situation stabilised and the load on the pickup lines could be removed and the lines safely let go.

Despite the efforts of the ship's personnel to revive the severely injured IR3, he died as a result of his injuries.

2.3 Connection and disconnection procedures

The operation to connect and disconnect from the CALM buoy was performed infrequently and many of the crew were new to the ship and had not undertaken the operation before. Consequently, any procedure in place to provide guidance during these operations needed to be explicit and unambiguous. However, the procedures for both the connection and disconnection operations were not sufficiently clear and unsafe practices had been adopted on board the ship without an adequate review of the associated risks.

2.3.1 Import hose

The import hose disconnection procedure stated that the preventer lines (preventers) were used to stop the import hose from forming a loop under the mooring hawsers. The procedure stated that the preventers were to be let go before the import hose was lowered to the water and disconnected from the hoisting wire. While the intent of the procedure was for the preventers to be used to keep the hose clear of the hawsers, the sequence of steps to be followed was contradictory by having the preventers released while they were still needed to hold the hose away from the hawsers.

On 24 December, the master instructed the crew to release the import hose preventers while the chief mate and crew were fitting the blank flange to the hose. This task was undertaken well before the hose was lowered to the water and released from the hoist wire. The master's instruction was in accordance with the ship's procedure as it was written. This was the first time the master and most of the crew had carried out this task and they did not fully understand the process. The procedure was ambiguous in that it stated both the need for the preventers to be in place and also that they should be let go before the hose was disconnected and were, therefore, still needed. Consequently, when the preventers were released, the import hose drifted ahead and formed a loop under the hawsers, as had been anticipated in the procedure.

With no preventers in place to control the loop in the hose, the master was left with few options. He elected to briefly run the main engine astern in an attempt to pull the hose clear. However, once the hose was clear of the hawsers, he did not run the main engine ahead to arrest the ship's movement, as was stated in the mooring hawser disconnection procedure. This resulted in the import hose hoist wire, which was still carrying the weight of the suspended hose, coming under increasing tension. Although the hoist wire was being held on the winch brake, it did not pay out as expected when the crew began to release the brake and they were concerned that it might pay out wildly if they fully released the brake. Consequently, the port outboard winch drum was put back into gear so the hose could be lowered in a controlled manner. However, the hoist wire did not pay out quickly enough to relieve the tension on the wire and it parted suddenly before the crew had lowered it

far enough to release the suitcase hook. This also had the knock-on effect of increasing the crew's sense of urgency.

The master and crew had followed the steps in the import hose disconnection procedure but the procedure was ambiguous and did not provide sufficient clear guidance to prevent the import hose forming a loop under the mooring hawsers during its disconnection from the manifold. Furthermore, the master's efforts to regain control of the operation resulted in the hawser pickup lines coming under tension, making the hawser disconnection more difficult and increasing the risk.

2.3.2 Mooring hawser pickup lines

According to the ship's procedures, a 150 m length of messenger line should have been made fast to the winch drum. A single turn of light sacrificial lashing should then have been used to secure the pickup line to the messenger line so that the sacrificial lashing could be cut at a safe location, away from the winch drum, thus allowing the heavy pickup line to fall safely into the sea. Given that the lashing should not be carrying any load other than the weight of the pickup line from the forecastle to the waterline, about 3 kg/m, a single turn of 6 mm¹⁵ lashing would probably have sufficed.

However, at the time of the accident, there was no messenger line on either the port or starboard drums and on the port drum, the heavy pickup line had been secured directly to the strong point outside the drum with three turns of a relatively thick, 12 mm¹⁶ sacrificial lashing. The additional turns of lashing meant that IR3 had to spend longer between the drum's cheeks and, as the tension on the port hawser pickup line increased, he was exposed to this danger for longer.

The ATSB was told that the mooring hawser connection procedure had not been followed when *Karratha Spirit* had last reconnected to the CALM buoy in that the messenger line had not been kept on the winch drum. During the connection operation, the winch drum was only used as a 'drum end' for the messenger line to provide sufficient friction to heave in the pickup line. The messenger line was led off the drum and coiled up. When several turns of the pickup line were on the drum, its eye was lashed to the drum with the 12 mm sacrificial lashing.

By walking the messenger line off the drum, *Karratha Spirit*'s crew had simplified the operation by eliminating the need to perform the extra work of running the lines off the drum and then re-stowing them neatly after the chains were secured to the hooks. However, what this meant was that the subsequent disconnection operation had to be performed without the added safety provided by the use of the relatively light 32 mm messenger line.

With the 80 mm hawser pickup line made fast directly to the winch drum, it was impossible for the crew to follow the hawser disconnection procedure and walk out the pickup lines, replace the shackle between the pickup line and the messenger line with a single turn of light sacrificial lashing and then cut the sacrificial lashing between the messenger and pickup lines in a safe place. The absence of a messenger line meant that the sacrificial lashing securing the pickup line to the drum needed to

¹⁵ A single length of 6 mm polypropylene rope has a breaking strain of 5 kN or about 510 kg.

¹⁶ A single length of 12 mm polypropylene rope has a breaking strain of about 16.8 kN or 1700 kg.

be cut at the drum, thereby increasing the risk to the crew member cutting the lashing if there was any tension on the line.

In the past, *Karratha Spirit*'s crew had not experienced any difficulty cutting the lashings at the winch drums because there had not been any load on the pickup lines. In fact, in the past the pickup line generally needed to be physically carried to the ship's side and thrown overboard. However, on 24 December, there was tension on the pickup lines, due to the ship's astern movement to pull the hose clear, which progressively increased once the winch brakes were applied so that the sacrificial lines could be cut. The amended connection and disconnection practice had been used on board *Karratha Spirit* on several occasions and while this departure from the ship's procedures had increased the risks, there had been no apparent adverse consequences and so the practice was continued.

On 24 December, after the master had briefly run the main engine astern to pull the import hose from under the hawsers, the hawsers and their pickup lines were under tension. The weight should have been taken off the hawsers and pickup lines but this was not done because the master had lost situational awareness and did not realise how much tension was on the lines. Consequently, he did not 'Put the ship's engine ahead as necessary to take the weight off the hawsers' as stated in the procedure.

This was the first time he had been on the forecastle deck for a disconnection and he did not fully appreciate the significance of the load on the hawsers. However, he was an experienced seafarer and should have known of the dangers that any mooring line under tension poses to those crew members which might be working around it. In addition, none of the other crew on the forecastle deck brought the fact that the lines were coming under tension to the attention of the master. Consequently, a dangerous situation developed with the lines coming under tension and the master took no action to correct it.

Karratha Spirit needed to depart the CALM buoy, on average, about four times per year. This operation is very similar to letting go a tanker from a single point mooring and, as such, is not unusual for a tanker. In the years leading up to the accident there had been a regular turnover of crew members which, coupled with their four weeks on/four weeks off duty cycle, meant that most of the crew had not taken part in connection/disconnection operations. In order for the crew to have been able to have safely and effectively undertaken these operations, the procedures needed to be both accurate and adequate.

Procedures need to be clear and succinct in order to maximize the likelihood that they will be read, understood and followed. The ship's procedures for connecting and disconnecting both the import hose and the mooring hawsers did not provide sufficiently explicit and unambiguous guidance and there were some differences between the procedures and the actual shipboard practices that increased the level of risk associated with those operations.

2.4 Shipboard review of procedures

The shipboard practices for connecting and disconnecting from the CALM buoy did not conform to the procedures contained in the ship's safety management system (SMS). Furthermore, there was no record of this issue being raised at any safety committee meeting, shipboard management meeting or directly with the ship's operator.

The procedures for connecting and disconnecting the import hose and disconnecting from the CALM buoy were developed when the facility first came on line in 2001. They were based on the experience gained on board *Dampier Spirit*, a similar FSO, which had already been on station for 3 years. In most aspects, the procedures had remained largely unchanged since then.

The written connection/disconnection procedures had not been amended to match the shipboard practice and no risk analysis had been undertaken to determine the safety implications of any changes. Consequently, potentially unsafe practices had been accepted by the ship's senior officers and crew without any formal process to adequately consider the risks or validate the changes to the procedure in a hazardous ship operation. The ship operator's SMS included procedures for the management of change in procedures¹⁷ and for a shipboard review of the SMS¹⁸ procedures.

The SMS on board was required to be reviewed annually by the master. Any changes that emerged from this review could then be made using the company's 'management of change' (MoC) process. The full MoC process involves identifying the procedural change, assessing the risks and the impact of the change before getting the change approved at an appropriate management level. However, urgent procedural changes could be implemented immediately by issuing a 'General Notice' (GN) until the amendment to the procedures had passed through the MoC process. Less urgent changes were incorporated into the SMS and issued to the ship quarterly on an update disc. Any changes to a shipboard procedure must be approved by an appropriate manager ashore before a GN is issued. Furthermore, the ship's crew could also develop and implement ship specific work instructions (SSWIs). Not all requested changes are approved by the operator and these are noted in the MoC and GN logs.

Health Safety Environment and Quality (HSEQ) Committee meetings were held monthly on board *Karratha Spirit*. The standard HSEQ agenda and templates for the minutes included a section entitled, 'Deviations in safety procedures since last meeting'. This was an opportunity for any deviation from procedures to be raised so that the MoC process could be initiated or the procedure reviewed in more depth.

A review by the ATSB of the ship's HSEQ meeting minutes from January 2007 to November 2008 showed that housekeeping issues were raised on three occasions and that non-compliance with the Teekay footwear policy was also raised. However, the difference between the mooring procedure and the ship's practice was not raised at any of the HSEQ meetings.

There were, however, a number of amendments to parts of the procedures, including the ship specific work instruction (SSWI) issued in January 2008 to attach the secondary safety sling between the pickup line and the chafe chain following an incident where the pickup lines were missing when *Karratha Spirit* attempted to reconnect to the CALM buoy. Rather than enhance the operation, these amendments made the procedure less clear, more complicated and more difficult for inexperienced crew to follow.

¹⁷ Teekay Standard Operating Practices, SP 0634, 'Managing Change to Shipboard Standard Operating Procedures', Version 2.

¹⁸ Teekay Standard Operating Practices, SP 0343, 'Shipboard ISM Code Review', Version 5.

The procedures for connecting and disconnecting the import hose and disconnecting from the CALM buoy in place on board *Karratha Spirit* were signed off on board the ship as being satisfactory and reflecting shipboard practice, but they had not been effectively reviewed. Consequently, any ambiguities in the procedures and the discrepancies between the procedures and the ship's practices were not identified during any shipboard review or audit and were not made known to the ship's managers through any shipboard review process.

2.5 Risk analysis

The ship's SMS included a procedure for identifying the hazards associated with shipboard tasks, analysing the risks and listing control measures to address the risks. The procedure¹⁹ stated:

Before work is performed, an informal or formal Risk Assessment (Job Hazard Analysis) is completed after physically reviewing the work place (where possible). The risk assessment will identify risks and measure the severity and likelihood of any hazard. As a result, proper control measures are taken in order to mitigate the risk.

Disconnection from the CALM buoy had been identified as a hazardous task and a job hazard analysis (JHA) form had been prepared for it. This JHA listed five task steps in its analysis and identified two hazards or potential incidents that could be associated with them and, to control them, the JHA included control measures.

The JHA identified the hazard, or potential incident, of 'excessive weight and parting of the pickup line'. This was listed against the task steps of 'Lowering pickup line' and 'Disconnecting pickup line and lowering it to water'. The control measure in both of these task steps was stated as 'Keep hawser slack. Back off slowly'.

There was no mention of the use of a messenger line so that the pickup line could be disconnected safely. The JHA did not provide specific details of all of the task steps with their associated hazards or risk control measures.

The JHA also did not include or consider any hazards associated with cutting the sacrificial lashing on the pickup line. Critically, it did not consider the hazard of cutting the lashing from within the confined space between the 'cheeks' of a winch drum. Even if the shipboard practice had been not to use a messenger line, which resulted in the practice of cutting the lashing on the winch drum, the JHA should have considered this hazard.

The SMS procedure for risk assessment and job hazard analysis stated:

Retain a copy of the JHA and use, review and revise as necessary when the task is repeated.

This implies that the JHA was to be reviewed by the personnel undertaking a task every time the task was performed. The JHA for disconnecting from the CALM buoy was checked by the master and chief mate on 23 December, in anticipation of disconnecting, and was signed off by them as having been checked before the operation was started on 24 December.

¹⁹ Teekay Standard Operating Practices, SP 0002, 'Risk Assessment and Job Hazard Analysis (JHA) Guideline', Version 9.

In accordance with the ship's procedures, all of the crew who would be working on the forecastle for the disconnection should have reviewed the JHA before they started disconnecting the import hose and hawsers. On 24 December, the crew held a briefing before starting the task, during which any safety concerns could be addressed. However, despite the fact that almost all of the crew were unfamiliar with the disconnection operation, they did not review the formal, written JHA. The master, who had reviewed the JHA with the chief mate, did not take part in the crew's briefing and so could not share his knowledge of the JHA with the crew.

The SMS procedure for risk assessment and job hazard analysis did not require a regular, systematic, formal review of a JHA. Consequently, the amended shipboard work practice continued without the associated risks being considered. Had the JHA been reviewed with regard to the actual shipboard practice, it may have been found that the practice was too risky to continue.

The JHA did not provide an accurate assessment of all of the hazards of the disconnection task and their associated risks. In addition, the crew did not use it to assess the risks associated with undertaking an unfamiliar operation. The review of the JHA was undertaken by the master and chief mate without any involvement from the crew and it had not been amended to include any deviation from the written procedures or the absence of the messenger line on the drum. Consequently, the JHA was not an effective means for assessing and controlling the risks associated with the shipboard practices used for disconnecting from the CALM buoy.

2.6 Human factors

2.6.1 Crew competence and experience

All of the crew involved in the disconnection operation on 24 December 2008 held appropriate qualifications for their positions on board the ship. However, their experience on board the ship, and in particular with disconnecting from the CALM buoy, was limited.

The CIR who left the ship on 23 December had served on the ship since it came onto the Legendre Oil Field in 2001. He had completed many disconnections and was the most experienced member of the crew at disconnecting from the CALM buoy. Of the other crew, the CIR on board the ship at the time of the accident had completed one previous disconnection as an IR. The chief mate had completed one disconnection on the forecastle and none from the bridge. The master had never taken part in a disconnection from the CALM buoy. None of the other crew on the forecastle had any experience of disconnecting from the CALM buoy.

Despite the lack of experience at disconnecting from a CALM buoy, the entire crew, with the possible exception of the trainee, had extensive experience with handling mooring winches and mooring lines. The disconnection from the CALM buoy involved using mooring winches, potentially lines under load, and was little different from normal shipboard mooring operations. Had they been provided with details that were specific to the task and to the ship, it should have been possible for them to apply their experience to the disconnection operation.

When a crew is inexperienced on a ship, it is even more vital that the procedures are explicit and unambiguous and that they state the safest way to perform the tasks.

Using only the written procedure, a suitably qualified seafarer should be able to safely undertake any task on board a ship. Furthermore, a review of the JHA should have provided the additional information needed to augment the seafarer's competence so that they could perform the task safely.

2.6.2 Shared mental model

The concept of a shared mental model helps explain one aspect of how teams, regardless of the environment in which they operate, are able to cope with difficult and evolving task conditions. Shared mental models serve three critical purposes: they help people to describe, explain and predict events in their environment²⁰. A shared mental model ensures that each member of a team has similar knowledge and similar expectations to the other members of the team.

On 22 December, the most experienced crew member (CIR A) explained the disconnection process to the crew. On 23 December, after CIR A had left the ship, his replacement (CIR B) reviewed the disconnection process again. On 24 December, just before the crew started disconnecting from the CALM buoy, CIR B explained the process one last time.

The master had not undertaken a disconnection operation on board the ship and his knowledge and expectations of the process were based on his previous seagoing experience and by reviewing the procedures. The disconnection operation was very similar to letting go a tanker from a single point mooring and, as such, was not unusual for a tanker. The master had extensive experience on tankers and should have fully understood the process.

However, he did not take part in any of the crew's briefings and he did not discuss his shipboard experience or expectations with the crew. As the practice being used differed from the written procedures, the master's understanding of the process differed from that held by the rest of the crew. By not taking part in the briefings and not sharing his knowledge and expectations with the crew, they did not form a shared mental model with him.

Similarly, the chief mate did not attend the pre-briefings either. He had disconnected from the CALM buoy once before and had some understanding of the actual practices used, the potential difficulties and what was contained in the written procedures but he did not share this information with the master.

Consequently, on 24 December, there were effectively three different mental models being used by various members of the crew when they began disconnecting from the CALM buoy. This lack of a shared mental model meant that, when the master took control of the operation on the forecastle, his expectations of how the operation would proceed and his understanding of its operational constraints differed from the crew he was directing.

The fact that the master had taken control of the operation would suggest to the crew that he understood it. With their limited experience of the operation, the crew were less likely to question the master's decisions or challenge his operational

²⁰ Cannon-Bowers, JA, Salas, E, Converse, S A (1993). *Shared mental models in expert team decision making*. In Mathieu, J, Heffner, T, Goodwin, G, Salas, E, Cannon-Bowers, J. *The influence of Shared Mental Models on Team Process and Performance*. Journal of Applied Psychology 2000, Vol 85, No. 2, pp. 273-283.

command. Consequently, the crew did not alert him to the increasing load on the pickup lines, believing that he was aware of it and that he had control of the developing situation.

2.6.3 Situational awareness

Situational awareness can be defined as the process of using cognitive processes to develop and maintain a mental model upon which decisions are made. Situational awareness requires the accurate and timely perception of the current status of the operation and the environment which is then projected forward in time to determine the future status of the operation.

The basis of situational awareness is an effective mental model. On 24 December, the master's mental model was neither complete nor accurate. As the operation evolved and moved further away from his understanding of the process and his expectations, his overall awareness of the situation diminished.

As each problem emerged, the master took corrective action. However, with his limited experience in undertaking this operation on board the ship and having not undertaken the briefings with the crew, he did not have sufficient understanding of the overall operation to predict the consequences of each of his decisions and the impact that these decisions would have on other parts of the operation.

The master stated that, when the import hose hoist wire parted, he was not aware that the hoist wire winch was in gear, the port pickup line was out of gear and on the brake or that the use of the main engine had increased the load on the pickup lines. Without accurate awareness of the current status of the operation, he could not make effective decisions or predict the risks associated with them.

Had the master remained as an observer to learn about the disconnection operation and not been in control of the operation, and made that role clear to the crew on the forecastle, he would not have needed to make decisions under pressure that he was not adequately prepared for. He would have been able to provide an overview of the operation and question the practices that, in hindsight, were proven to be unsafe.

2.7 Emergency response

2.7.1 Communications

The *Ocean Legend* platform was equipped with a mobile telephone repeater station which extends the network coverage to include *Karratha Spirit*. When *Karratha Spirit* was on station at the Legendre CALM buoy, most day-to-day communications use mobile telephones and a wireless broadband internet network.

At about 2000, immediately following the accident, *Karratha Spirit's* master told the chief mate to call '000' to reach the land based emergency services using the telephone. The mobile telephone network was no longer in service after *Ocean Legend's* crew had been evacuated so the chief mate tried to call the emergency services using the satellite telephone. He was unsuccessful because he did not realise that '000' is a domestic number for use in Australia only and cannot be used by international callers, including satellite telephones.

Besides the satellite telephone, *Karratha Spirit* was equipped with communications equipment that met all of the global maritime distress and safety system (GMDSS) requirements. Ships are required to have this equipment so that they can contact the appropriate maritime rescue centre directly in an emergency.

The ship's SMS included a procedure to be followed in the event of an injury or illness on board. The procedure²¹ was a general guideline for the operator's worldwide fleet. Under the section entitled, 'If assistance is required from shore', it detailed the information to be collated before requesting medical advice and stated:

When helicopter assistance is required, contact an MRCC and prepare for helicopter operation.

The SMS also included the Teekay Emergency Response Manual²² which provided emergency contact details for the company, as well as emergency contact details of other shore based response agencies such as AMSA's Rescue Coordination Centre (RCC) and NOPSA. It also included contact details for hospitals, doctors and helicopter operators. There were two copies of this manual kept on board, one in the cargo control room (CCR) and one in the master's office.

The Teekay Emergency Response Manual included a flowchart for 'Injury or Illness Requiring Medical Attention (Medivac)' which stated:

If injuries appear to be life threatening or condition cannot be determined, contact Production Facility and immediately request shoreside assistance.

The production facility, *Ocean Legend*, had been evacuated so the master could not contact them. The Teekay Emergency Response Manual flowchart did not give instructions for what to do if the platform was unmanned. However, the master could have contacted the field operator using the contact details provided in the Emergency Response Manual or immediately requested shoreside assistance by the most appropriate means.

At that time, he was master of an Australian registered ship with an Australian crew, operating almost exclusively in Australian waters. Furthermore, both the master and the chief mate held a current GMDSS operators certificate and therefore, it should have been apparent to them that the first point of contact for any shipboard emergency should have been the RCC in Canberra and the most appropriate means of contacting the RCC would have been the GMDSS equipment.

The Australian Seafarers Handbook states, under 'Medical Assistance'²³, that:

Vessels at sea can request medical advice via HF DSC radio or Inmarsat satellite services.

RCC Australia will put the vessel in contact with the Duty Medical Officer at the Royal Flying Doctor Service (RFDS) Telemedical Advice Centre (TMAC) in Cairns, Qld.

²¹ TK Standard Operating Practices, SP 0283, 'Injury/Illness On Board Procedure', Version 3.

²² TK Standard Operating Practices, MO 0016, 'Emergency Response Manual (FSO Team Australis)', Version 1

²³ Australian Hydrographic Service (2004), '*Australian Seafarers Handbook*', First Edition, Australia, p143.

The master should have instructed the chief mate to contact RCC directly to obtain medical advice and to request a medical evacuation rather than attempting to telephone the land based emergency services.

At 2015, although *Karratha Spirit* was well outside the port limits for Dampier, the master called the Dampier Port Authority (DPA) communications officer using VHF channel 16. While this is a normal practice for ship's that are within port limits, it is not a usual practice for ships at sea and *Karratha Spirit*'s crew rarely contacted the DPA using VHF channel 16. Consequently, when the DPA received the radio call, the communications officer was not familiar with the ship, its operations or its capabilities.

The DPA communications officer immediately telephoned the police and informed them of a medical emergency requiring evacuation from a vessel. When the police officers were notified, they were not in the police station so they asked the DPA to collect more information from the ship. By 2032, the police officers had returned to the station and the DPA communications officer had provided them with all of the requested information; including the ship's satellite telephone number which the DPA had been given by the master.

The ship's satellite telephone number was posted in the ship's office, adjacent to the telephone. The correct satellite dialling code, which is necessary for calling a satellite telephone, was not with the satellite phone. When the satellite telephone number was given by the ship to the DPA and then to the police, the correct satellite dialling code was not provided. Consequently, all attempts to contact *Karratha Spirit* by satellite telephone were unsuccessful.

At 2037 the second mate obtained a telephone number for the police station from the DPA and at 2042, he telephoned them using the satellite telephone. This was the first direct contact between *Karratha Spirit* and any emergency service. The police officer was now able to obtain the necessary information to pass on to the RCC. As a result, it was not until 2055, almost one hour after the accident had occurred, that the RCC was alerted to it.

When the master initiated the 'First Alert' procedure²⁴ at 2020, as specified in the Emergency Response Manual, he believed that the shore management team would contact the RCC and coordinate the response, even though he had already requested a medical evacuation (medivac) through the DPA. However, the purpose of 'First Alert' is, 'To set out the procedure for ship staff and onshore Emergency Response personnel to notify Teekay management of an emergency situation.' Within 30 to 45 minutes of the 'First Alert' notification, Teekay management staff had manned their 'emergency response centre' and contacted the ship for more information. By this time, the WA police had already informed the RCC of the accident.

Neither *Karratha Spirit*'s master nor the chief mate used the most appropriate communication methods, GMDSS, for a ship that was seeking urgent assistance for a medical emergency. The authority best placed to coordinate a medical evacuation, the RCC, was not contacted directly from the ship. Consequently, the RCC officers, who could have provided the assistance required, remained unaware of the accident for almost one hour after it had occurred.

²⁴ TK Standard Operating Practices, SP 0268, 'First Alert – Incident Notification for Personnel/Ship/Environment Procedure', Version 10.

2.7.2 Helicopter evacuation

At about 2015 on 24 December, *Karratha Spirit*'s master requested an urgent helicopter medivac for a casualty on board the ship. However, no helicopter medivac took place.

The evacuation arrangements for the crew of a facility are analysed as part of the formal safety assessment (FSA), a key component of the safety case required before the facility can operate on field. As part of the FSA, an Escape, Temporary Refuge, Evacuation and Rescue (ETRER) analysis was undertaken to demonstrate that *Karratha Spirit* met the emergency evacuation requirements. The FSA was assessed and accepted by NOPSA before the facility came on field.

There are several helicopter operators in the Dampier region that can provide a helicopter at short notice or in an emergency if requested to do so, although these take some time to be configured as a medivac helicopter or air ambulance. Teekay does not have a contract in place to ensure that a helicopter is available on standby but has access to helicopter emergency services through a contractual arrangement with the Legendre Oil Field operator who directly manages all emergencies on the field. However, on 24 December, the platform had been evacuated so the ship's master had made the request for a helicopter medivac through the DPA. The Legendre Oil Field operator was not informed of the accident until about 2200, after the Royal Flying Doctor Service (RFDS) Telemedical Advice Centre (TMAC) determined that the patient was deceased.

The decision to request a medivac lies with the ship's master. Shipping companies can organise a helicopter medivac at the master's request without involving the RCC or the TMAC. However, in this instance, the ship's medivac request was managed by RCC.

The Australian Seafarers Handbook states, under 'Medical Assistance'²⁵, that:

Responsibility for the final decision to effect a medical evacuation lies with the master of the vessel. RCC Australia will seek medical advice concerning the evacuation method from the TMAC if not already provided by the master. Not all patients can be evacuated by helicopter.

Once it had been advised of the emergency, RCC contacted the TMAC for advice. The helicopter medivac would not take place until it was determined through the TMAC that the evacuation was appropriate and would not further harm the patient being evacuated. Once that had been determined, an appropriately equipped medical evacuation helicopter needed to be available and tasked by RCC for the medivac.

In this instance, the TMAC determined that the patient had already succumbed to his injuries and that a medivac would not be necessary. Therefore, no helicopter was tasked for the operation.

Helideck

On 24 December, the master told the DPA communications officer that the helideck was marked as 'not to be used at night' but that 'in an emergency we have to use it'.

²⁵ Australian Hydrographic Service (2004), '*Australian Seafarers Handbook*', First Edition, Australia, p143.

Karratha Spirit's operating limits are specified in the ship's documentation in 'Operating and Integrity Envelopes (*Karratha Spirit*)'²⁶. This document states:

The "integrity envelope" sets the absolute limits for FSO operation within the requirements of HSE, business and reputation. Integrity limits are defined by design basis documentation. The "operating envelopes" set the boundaries for normal operation, including restrictions relating to performance.

The "integrity envelope" sets the maximum limits for FSO operation while connected to the CALM buoy. Integrity limits are defined by design basis documentation.

The "safe operating envelope" set the boundaries for normal operation. The FSO and equipment must be operated within this envelope and any deviation outside the operating envelopes must follow the Management of Change procedure.

The operating limits for the helicopter landing platform (helideck) are specified in the Operating and Integrity Envelopes (*Karratha Spirit*) document as:

The helideck has been designed to accommodate the Sikorsky S76, Puma 330J, Bell 412.

Note: As of October 2004 the Helideck has been downgraded: Helipad suitable for receiving helicopters for 16 m circle 5.3T during daylight hours only.

A review by the ATSB of the ship's HSEQ meeting minutes from January 2007 to November 2008 shows that, 'Helipad unsuitable for Super Puma and night time operations' was noted under 'Safety Committee (Aust teams only) comments/issues' for every meeting. This would have reinforced the master's belief that the helideck could not be used at night.

In submission, Teekay stated that:

The helipad was down graded in 2005. It complies with CAP 437²⁷ and is suitable for use with prescribed aircraft. The previous field operator stated that due to the reduced landing radius it did not want (routine) helicopter landings at night. This did not include emergencies as the helicopters have their own lighting and an assessment on landing would remain with the pilot at the time (as is always).

Winch only is also an option.

The helipad had gone through 2 CAP audits by certified CASA²⁸ auditors where no mention on night time restrictions was recorded. The *Karratha Spirit* received both of these audits as well as having the opportunity to raise this issue with the auditor at the time.

The master believed, based on the information available to him, that *Karratha Spirit*'s helideck had been downgraded and limited to day time operations. He was correct that it could be used for emergencies, at the discretion of the pilot. If the helideck was able accommodate Sikorsky S76, Puma 330J, Bell 412 helicopters as specified and there were no additional operating limits, then the 'Operating and

²⁶ TK Standard Operating Practices, RF 0114, 'Operating and Integrity Envelopes (*Karratha Spirit*)', Version 3.

²⁷ Civil Aviation Authority UK, 'CAP 437 Offshore Helicopter Landing Areas – Guidance on Standards'.

²⁸ Civil Aviation Safety Authority

Integrity Envelopes (*Karratha Spirit*)' document RF 0114 did not provide the master with a clear and unambiguous status of the helideck and it should have been amended accordingly and the ship's master made aware of the helideck status.

2.7.3 Automatic external defibrillator

Immediately following the accident, the crew had been unable to detect the injured IR's pulse and so started performing cardio-pulmonary resuscitation (CPR).

After they had moved him to the ship's hospital, they applied the electrodes from the ship's automatic external defibrillator (AED) to his chest following the computer generated voice prompts given by the unit. The AED prompted them to wait while it checked the injured man's vital signs before instructing the crew to continue CPR. This cycle repeated itself for almost the next two hours, until the doctor advised them that they could cease.

When an AED checks for a patient's vital signs, it is assessing the heart's electrical output to determine if a 'shockable rhythm' is present. If a heart is fibrillating²⁹, an electric shock may return it to its normal cardiac rhythm. However, if the heart has stopped and there is no cardiac electrical output, colloquially known as a 'flatline', an AED cannot be used. Instead, it prompts the operators to continue CPR in an attempt to support life.

On 24 December, some of the crew misunderstood the operation of the AED and were concerned that it may have malfunctioned because they believed that it should have started the injured man's heart. In fact, the AED had not detected a shockable rhythm and, therefore, it did not generate an electric shock to defibrillate the heart.

2.8 Regulatory jurisdiction

In Australia, the *Navigation Act 1912* (Nav Act) regulates ship safety, crewing levels, seafarer qualifications, cargoes and cargo operations and generally applies to trading ships proceeding on overseas or interstate voyages. The Australian Maritime Safety Authority (AMSA) administers the ship safety provisions of the Act. Section 8AA of the Act allows AMSA to declare that a trading ship is covered by the Act upon application to AMSA by the ship owner for such a declaration. Section 8A allows for a similar declaration by AMSA that an offshore vessel is covered by the Act upon application to AMSA by the ship owner.

The *Occupational Health and Safety (Maritime Industry) Act 1993* (OHSMI Act) regulates the health, safety and welfare at work of maritime industry employees employed by the operator of a 'prescribed ship'. This is a ship to which Part II of the Nav Act applies and expressly does not include a ship to which the *Offshore Petroleum and Greenhouse Gas Act 2006* (OPGGSA) applies. Part II of the Nav Act generally applies to a ship with an Australian connection (i.e. the ship is registered in Australia, or engaged in the Australian coasting trade, or the majority of the crew are Australian residents or it is operated by an Australian person or company.) The OHSMI Act is administered by the Education, Employment and Workplace Relations portfolio and AMSA is designated as the Inspectorate under the OHSMI Act.

²⁹ The rapid, irregular, and unsynchronized contraction of the heart's muscle fibres.

Safety in the Australian offshore petroleum industry is regulated by the National Offshore Petroleum Safety Authority (NOPSA) through the implementation of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGSA).

Karratha Spirit was originally built as a trading tanker. The ship's conversion to a floating storage and offloading tanker (FSO) did not alter its basic capability as a tanker but equipment that was specifically required for its role as a FSO was added. In 2006, the ship's classification was changed from a trading tanker to a 'FSO Disconnectible'. Ships like *Karratha Spirit* can operate as either a ship or as an oil storage facility and hence, at different times, can come under different regulatory regimes.

According to Schedule 3 of the OPGGSA, a vessel or structure is taken to be a 'facility' for the purposes of the OPGGSA while that vessel or structure:

- (a) is located at a site in Commonwealth waters³⁰; and
- (b) is being used, or prepared for use, at that site:
 - (i) for the recovery of petroleum, for the processing of petroleum, or for the storage and offloading of petroleum, or for any combination of those activities;

Therefore, *Karratha Spirit* is considered to be a facility while it is moored to the Legendre CALM buoy and undertaking oil exploitation activities. The OPGGSA states³¹ that Commonwealth maritime legislation, specifically the Nav Act, the OHSMI Act and subordinate legislation under these Acts, does not apply in relation to:

- (a) a facility located in the offshore area of a State or Territory; or
- (b) a person at such a facility; or
- (c) a person near such a facility, to the extent to which the person is affected by:
 - (i) such a facility; or
 - (ii) activities that take place at such a facility; or
- (d) activities that take place at such a facility.

Since the OPGGSA overrides the application of Australian maritime safety legislation while *Karratha Spirit* is a facility, safety on board the ship is regulated solely by NOPSA until such time that³²:

... operations cease, and the vessel or structure has been returned either to a navigable form or to a form in which it can be towed to another place.

It is debatable as to exactly when, on 24 December 2008, *Karratha Spirit* ceased to be a facility. At about 1958, when the pickup line struck the IR, oil operations had ceased, the import hose had been disconnected and the ship was no longer moored to the CALM buoy. It can, therefore, be argued that *Karratha Spirit* had been

³⁰ For Western Australia, this is defined in the OPGGSA as including the waters that are beyond the coastal waters, within the outer limits of the continental shelf and that are not within the Joint Petroleum Development Area. Coastal waters are within three miles of the coast unless otherwise defined in the *Coastal Waters (State Powers) Act 1980*.

³¹ *Offshore Petroleum and Greenhouse Gas Storage Act 2006*, Section 640.

³² *Offshore Petroleum and Greenhouse Gas Storage Act 2006*, Schedule 3, Clause 4 (7).

returned to a navigable form and, according to the OPGGSA clause outlined above, it was no longer a facility.

The submissions received from AMSA, NOPSA and the MUA all share the view that *Karratha Spirit* was covered by the OPGGSA at the time of the accident.

In submission, NOPSA stated that:

... the pick up line which struck the IR, was connected to the port side hawser and therefore connected the *Karratha Spirit* to the CALM buoy at the time of the incident and then for a period after the incident.

... the vessel was not in a navigable form (ie it could not steer or be towed) at the time of the incident and therefore the vessel was a facility.

However, the word navigable is not defined in the OPPGSA. Furthermore, the Macquarie Dictionary meaning of the word ‘that may be navigated’ is not prescriptive. Hence, it can be argued that a ship that is intact, seaworthy, properly manned and has its steering, propulsion and navigational equipment operating is capable of being navigated and can therefore be considered ‘navigable’. It can be argued that once the sacrificial lashing holding the hawser pickup line to the mooring winch was cut, the ship was in a navigable form as it was no longer made fast to the CALM buoy and, therefore, was not a ‘facility’ covered by the OPPGSA.

The provisions of the OPPGSA specifically disappplied the Nav Act when *Karratha Spirit* commenced operation as a ‘facility’. For the Nav Act to reapply, *Karratha Spirit* needed to be on a voyage to which the Nav Act applied. *Karratha Spirit*’s master had planned a voyage that would take the ship away from the CALM buoy to steam offshore, outside Australian territorial waters to avoid a cyclone, before returning to the CALM buoy. This voyage was neither an interstate or international voyage and, thus, did not meet the application criteria of the Nav Act. Furthermore, *Karratha Spirit* was not a declared ship under Section 8A or Section 8AA of the Nav Act. Consequently, it would not have come under AMSA’s jurisdiction under these provisions. Therefore it appears that the ship was not covered by any safety regulatory authority or legislation, for the duration of the voyage, once it had disconnected from the CALM buoy despite being Australian registered and a ‘prescribed’ ship as defined by the Nav Act.

The safety of vessels on intrastate voyages between Western Australian ports falls under the jurisdiction of the Department for Planning and Infrastructure (DPI) under the provisions of the *Western Australian Marine Act 1982*. Intrastate voyages are defined as ‘a voyage other than an overseas voyage or an inter-state voyage’³³ as defined in the Nav Act. However, in this instance, *Karratha Spirit* did not enter or depart any Western Australian port on any interstate or overseas voyage and did not come within the 3 mile coastal waters limit or undertake a voyage between ports within the state (an intrastate voyage). Consequently, although it has been suggested by AMSA that the ship would have come under the jurisdiction of the DPI, this seems unlikely.

It is of concern that *Karratha Spirit* appears not to have been subject to any safety regulatory regime once it left the CALM buoy and for the duration of its intended voyage. There should be no ambiguity about the safety regime applicable to every Australian vessel or facility, regardless of its mode of operation, and coverage

³³ *Western Australian Marine Act 1982*, Section 6.

should be seamless and continuous. The Marine Report by the independent inquiry into Offshore Petroleum Safety Regulation recommended³⁴ that:

... AMSA should have a role in assuring continuing marine standards that are not inconsistent with OPGGSA provisions and that AMSA needs defined powers to assist NOPSA in minimising risk in the offshore petroleum.

The same report also stated that:

a modern performance-based Nav Act would not only serve the interests of the Australian maritime industry but it would more effectively complement current Commonwealth offshore petroleum legislation and minimise confusion at interfaces. Such reform could provide a better means of clarifying AMSA's powers over offshore vessels and potentially remove the need for the OPGGSA's disapplication of maritime legislation.

In this instance, the consensus of the regulatory authorities is that *Karratha Spirit* was not in a navigable form at the time of the accident and was therefore under NOPSA's jurisdiction under the OPGGSA. However, the point at which *Karratha Spirit* became 'navigable' is not clearly defined in the OPGGSA and is open to interpretation. Furthermore, after *Karratha Spirit* had departed the CALM buoy it appears that the ship did not come under the jurisdiction of any Australian safety regulatory regime.

2.8.1 Safety management system audits

NOPSA

Most of the time, *Karratha Spirit* remains moored to the CALM buoy, receiving oil, and therefore, it comes under NOPSA's jurisdiction as a facility. Before *Karratha Spirit* could operate as a facility moored at the Legendre CALM buoy, *Karratha Spirit*'s operator was required to prepare a Safety Case and submit it to NOPSA for acceptance. This document included a facility description, FSA and a description of the safety management system (SMS). The safety case documentation did not, and was not required to, include a full copy of the SMS itself.

The FSA process involved identifying and addressing the risks associated with Major Accident Events³⁵ (MAEs). All identified hazards that were not MAEs were required to have their risks reduced to as low as reasonably practicable (ALARP) through the implementation of the ship's SMS. Under the Safety Case, the facility operator is responsible for meeting the FSA requirements and for maintaining an effective SMS.

Karratha Spirit's mooring operations were not included in the FSA because the operator had not identified these operations as possible MAEs. However, mooring operations, and their associated risks, were addressed through the ship's SMS.

Karratha Spirit's SMS detailed the policies and procedures that should be implemented by the facility's operator. NOPSA's acceptance of the SMS was based

³⁴ Offshore Petroleum, Safety Regulation: Marine Issues, Australian Government, 2009. Recommendation R3.

³⁵ An event connected with a facility, including a natural event, having the potential to cause multiple fatalities of persons at or near the facility.

on the integrity of the SMS as described in the Safety Case. Through planned inspections, NOPSA assessed the operator's compliance with its SMS. If the planned inspections showed that the operator was not complying with its SMS, either a recommendation for compliance was made in the inspection report or an Improvement Notice issued. A failure in the SMS is considered by NOPSA to be the operator's responsibility because the SMS had been developed, implemented and reviewed by the operator.

NOPSA undertakes regular safety inspections, at least once per year, in accordance with Schedule 3 of the OPGGSA, to:

monitor whether operators of offshore petroleum facilities are complying with their legal obligations concerning the health and safety of the offshore workforce.

Planned inspections are a critical examination of the facility operator's systems and facilities. They verify the risk management commitments of the operator as specified in its safety case. NOPSA's planned inspections do not involve the inspection of every "nut and bolt" of a facility – rather they operate on a quality assurance basis.

The inspections are a sampled evaluation of the safety management system and its implementation by the operator to manage the risks associated with the facility to a level as low as reasonably practicable.

The information obtained from inspections assists NOPSA to monitor an operator's compliance with the legislation, including their compliance with a Safety Case, Pipelines Safety Management Plans and Diving Safety Management Systems³⁶.

Recognising the importance of sailing away from an Oil or Gas Field, NOPSA has developed an audit/inspection checklist³⁷ for use when conducting planned inspections of FSOs and FPSOs. The checklist items include the policy and decision making criteria for departing a field, the implementation of the policy, monitoring of the implementation of the policy, manning and competency, and auditing. The checklist did not include the specific procedures for departing the field, such as *Karratha Spirit's* import hose and hawser disconnection procedures. Consequently, these detailed procedures were not reviewed.

AMSA

When operating as a facility, *Karratha Spirit* is outside AMSA's jurisdiction and it does not need to meet the requirements of the Nav Act or OHSMI Act at that time. However, the ship's operator had voluntarily recognised the need for *Karratha Spirit* to periodically undertake interstate or international voyages, and had decided to continue to meet AMSA's requirements.

As the flag State authority, AMSA issued *Karratha Spirit* with a Safety Management Certificate (SMC) under the International Safety Management Code (ISM Code), after it had verified that the ship was operated in accordance with an approved SMS. To maintain a SMC, a number of audits and reviews are required,

³⁶ NOPSA Bulletin, *What are Planned Inspections?* In, 'Health and Safety under the Offshore Petroleum and Greenhouse Gas Storage Act - What operators and workers need to know.' Q1, Q4 and Q11.

³⁷ NOPSA Inspection and Audit Form, FM 0387: *Readiness to Sail Away Checklist*. Revision 1, May 2008.

including the master's annual review, a formal annual internal audit by the ship's operator and an external audit by AMSA twice every 5 years in accordance with the ISM Guidelines³⁸, once for renewal of the SMC and once as an intermediate verification audit.

The ISM Guidelines allow for more intermediate audits to be undertaken:

In certain cases, particularly during the initial period of operation under the safety management system, the Administration may find it necessary to increase the frequency of the intermediate verification. Additionally, the nature of non-conformities may also provide a basis for increasing the frequency of intermediate verifications

Karratha Spirit had a mature SMS and AMSA had no reason to increase the number of intermediate audits and the last time that AMSA performed an ISM Code audit of *Karratha Spirit*'s SMS was in September 2006. *Karratha Spirit* passed its audit and its certification remained valid.

Memorandum of Understanding (MoU)

NOPSA's site inspections do not cover compliance with the Nav Act or the OHSMI Act so, in order for *Karratha Spirit* to comply with its maritime obligations, AMSA needs to conduct its own audits and inspections.

In recognition of the differing needs of AMSA and NOPSA, the two authorities have implemented a Memorandum of Understanding (MoU) that states, in part:

The parties may jointly conduct audits and inspections of facilities for which both parties have a direct regulatory responsibility with the objective that, as far as reasonably practicable, duplication or overlap of audits and inspections is minimised.

To achieve this aim, NOPSA allows AMSA surveyors to accompany NOPSA inspectors when they undertake a site inspection. However, AMSA has no legal jurisdiction over the facility during these inspections and is only on board the facility at NOPSA's invitation. AMSA has no regulatory role in relation to offshore facilities and therefore has no power to conduct regular audits and inspections. However, an MoU is not a binding agreement and if there is any failure in the application of the MoU, then AMSA would be unable to effectively fulfil its regulatory obligations for *Karratha Spirit* as a ship and, when the ship leaves the CALM buoy, it could possibly be in breach of the Nav Act.

In the years before the accident, AMSA and NOPSA undertook one joint inspection of *Karratha Spirit*, in October 2007, to allow AMSA to complete a flag State inspection of the ship. During the same period, AMSA separately conducted a number of other inspections and audits while the ship was berthed at a WA port and these were not done under the MoU with NOPSA.

Effectiveness of the audits

The ATSB investigation found that a discrepancy existed between the procedure for connecting and disconnecting the mooring hawsers and the shipboard practice.

³⁸ IMO Resolution A.913 (22), *Revised Guidelines on Implementation of the International Safety Management (ISM) Code by Administrations*, 2001.

Furthermore, *Karratha Spirit*'s master had completed an annual review of the ship's SMS and the ship's operator had carried out annual audits of the SMS and none of these reviews or audits had identified the discrepancy.

NOPSA does not undertake the audits necessary for maritime compliance and AMSA is only able to do so, while the facility is on station, with NOPSA's cooperation. NOPSA had carried out annual occupational health and safety inspections on board the ship and AMSA had carried out the necessary third party audits of the system to meet its certification requirements. However, none of these audits or inspections had identified the discrepancy between the mooring hawser procedures and actual shipboard practices or that the ship's internal review processes had not identified the discrepancy.

3

FINDINGS

3.1 Context

On 24 December 2008, an integrated rating was fatally injured on board *Karratha Spirit* while the crew were in the process of disconnecting the ship from its CALM buoy to evade a tropical cyclone.

At about 1958, when an integrated rating cut the lashing that had attached the end of the last three turns of an 80 mm line onto a winch drum, the 80 mm line rapidly unwound from the drum striking the integrated rating on the head and throwing him under the drum. He died as a result of his injuries.

From the evidence available, the following findings are made with respect to the accident on board *Karratha Spirit* and should not be read as apportioning blame or liability to any particular organisation or individual.

3.2 Contributing safety factors

- The integrated rating had placed himself in a dangerous position when he stepped between the ‘cheeks’ of the winch drum to cut a lashing that was securing the heavy 80 mm mooring hawser pickup line to the winch drum.
- The 80 mm pickup line should have been connected to a lighter 32 mm messenger line, which should also have been stored on the winch drum, using a sacrificial lashing. The absence of the messenger line meant that the sacrificial lashing could not be cut in a safe place, away from the winch drum.
- The master and crew had followed the steps in the import hose disconnection procedure but the procedure did not provide sufficient explicit and unambiguous guidance to prevent the import hose forming a loop under the mooring hawsers while disconnecting it from the manifold. Furthermore, the master’s efforts to regain control of the operation resulted in the lines coming under tension, making the hawser disconnection more difficult and increasing the risk.
- The fact that the master had taken command of the operation would suggest to the crew that he understood it. With their limited experience of the operation, the crew would be less likely to question the master’s decisions or challenge his operational command. Consequently, the crew did not alert him to the increasing load on the pickup lines, believing that he was aware of it and had control of the developing situation.
- The master’s original intention had been to learn about the disconnection operation. Had he remained an observer and not been in control of the operation, and made that role clear to the crew on the forecastle, he would not have needed to make decisions under pressure that he was not adequately prepared for. He would have been able to provide an overview of the operation and possibly question the practices that, in hindsight, were proven to be highly dangerous.
- The master had not taken part in any briefing or toolbox meetings with the crew prior to taking over control of the task. Consequently the master and crew did not have a ‘shared mental model’ of the disconnection process.

- The ship's procedures for connecting and disconnecting from the CALM buoy did not provide explicit, succinct and unambiguous guidance and there were differences between the procedures and the actual shipboard practices that increased the level of risk associated with those operations. [*Minor safety issue*]
- The procedures for connecting and disconnecting the import hose and disconnecting from the CALM buoy in place on board *Karratha Spirit* were signed off as being satisfactory and reflecting shipboard practice, but they had not been effectively reviewed on board the ship. Consequently, the ambiguities in the procedures and the discrepancies between the procedures and the ship's practices were not identified during any shipboard review or audit and were not made known to the ship's managers through any review process. [*Minor safety issue*]
- The Job Hazard Analysis (JHA) for disconnecting from the CALM buoy did not provide an accurate assessment of all of the hazards and associated risks in performing the task. In addition, the crew did not use it to assess the risks associated with undertaking an unfamiliar operation and it was reviewed without any involvement from the crew. Consequently, the JHA was not an effective means for assessing and controlling the risks associated with the operation of disconnecting from the CALM buoy. [*Minor safety issue*]
- NOPSA does not undertake the audits necessary for maritime compliance and AMSA is only able to do so for most of the time, while the facility is on station, with NOPSA's cooperation. NOPSA had carried out annual occupational health and safety inspections on board the ship and AMSA had carried out the necessary third party audits of the system to meet its certification requirements. However, none of these audits or inspections had identified the discrepancy between the mooring hawser procedures and actual shipboard practices or that the ship's internal review processes had not identified the discrepancy. [*Minor safety issue*]

3.3 Other safety factors

- Neither *Karratha Spirit*'s master nor the chief mate used the most appropriate communication methods for a ship that was seeking urgent assistance for a medical emergency requiring helicopter evacuation. The authority best placed to coordinate a medical evacuation was not contacted directly from the ship. Consequently, the Rescue Coordination Centre who could have provided the assistance required, remained unaware of the accident for almost one hour after it had occurred.
- The Telemedical Advice Centre (TMAC) determined that the patient was deceased and that a medivac would not be necessary. Therefore, no helicopter was tasked for the operation.
- *Karratha Spirit*'s SMS operating limits document did not provide the master with a clear and unambiguous status of the helideck's normal operating limits. The master intended to use the helideck for an emergency helicopter medivac.
- In this instance, the consensus of the regulatory authorities is that *Karratha Spirit* was not in a navigable form at the time of the accident and was therefore under NOPSA's jurisdiction according to the OPGGSA. However, the point at which *Karratha Spirit* became 'navigable' is not clearly defined in the OPGGSA and is open to interpretation. Consequently, during some operations, it is

possible that the ship would not come under the jurisdiction of any Australian safety regulatory regime. *[Significant safety issue]*

- On 24 December, some of the crew misunderstood the operation of the automatic external defibrillator (AED) and were concerned that it may have malfunctioned because they believed that it should have started the injured man's heart. In fact, the AED had not detected a shockable rhythm and, therefore, it did not generate an electric shock to defibrillate the heart.

4 SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

4.1 Teekay Shipping Australia

4.1.1 Safety management system procedures

Minor safety issue

The ship's procedures for connecting and disconnecting from the CALM buoy did not provide explicit, succinct and unambiguous guidance and there were differences between the procedures and the actual shipboard practices that increased the level of risk associated with those operations.

Action taken by Teekay Shipping Australia MO-2008-013-NSA-061

Teekay Shipping Australia has rewritten the procedures for connecting and disconnecting the import hose and for mooring at and disconnecting from the CALM buoy, including appropriate photographs and diagrams.

ATSB assessment of response/action

The ATSB acknowledges the safety action taken by Teekay Shipping Australia to address this safety issue.

4.1.2 Safety management system review and familiarisation

Minor safety issues

The procedures for connecting and disconnecting the import hose and disconnecting from the CALM buoy in place on board *Karratha Spirit* were signed off as being satisfactory and reflecting shipboard practice, but they had not been effectively reviewed on board the ship. Consequently, the ambiguities in the procedures and the discrepancies between the procedures and the ship's practices were not identified during any shipboard review or audit and were not made known to the ship's managers through any review process.

The Job Hazard Analysis (JHA) for disconnecting from the CALM buoy did not provide an accurate assessment of the all of the hazards and associated risks in performing the task. In addition, the crew did not use it to assess the risks associated with undertaking an unfamiliar operation and it was reviewed without any involvement from the crew. Consequently, the JHA was not an effective means for assessing and controlling the risks associated with the operation of disconnecting from the CALM buoy.

Action taken by Teekay Shipping Australia MO-2008-013-NSA-062

The ATSB has been advised that the following safety actions have been taken by Teekay Shipping as a result of the accident:

Inadequate Supervision and Adherence to Procedures

- The importance of Risk Assessment and strictly adhering to documented procedures to be emphasized through a concentrated training campaign for the entire staff on both FSOs.
- Develop an induction package that highlights high risk operational tasks to be viewed by unfamiliar facility personnel prior to task being undertaken.
Trainer to ascertain facility personnel's understanding.
Familiarisation to be recorded in current competency matrix.
Drills to be undertaken on irregular high risk tasks (i.e. disconnection drill prior to cyclone season).
- The Management of Change process and parameters to be highlighted onboard the FSOs during an extraordinary HSEQ safety meeting.
- Conduct an operational audit of all FSO specific practices to ensure validity, compliance and alignment of procedures

Loss of situational awareness

- The FSOs are to develop documented procedures that persons off watch may be called at any time for priority operations.
- Shore management to develop a means of ensuring facility personnel are effectively familiarised by experienced personnel prior to identified high risk tasks being undertaken.
- Such familiarisation is to be recorded in a manner that the Master (or designate) can identify the amount of experience the FSO has onboard, at any one time, for any one high risk task.
- Shore management in consultation with Master is to review competency matrix and identify task experience shortfalls, as per FSO training matrix and competency/induction matrix.
- Interview the Master, highlighting failures. Provide relevant training.
- Raise awareness regarding safe mooring practices and the dangers of being present within snap back zones.
- Communicate this incident as an extraordinary safety meeting to both FSOs to extract learning from the incident.

- Use the lessons learnt from incident to raise awareness during seafarer conferences, and ship visits.

ATSB assessment of response/action

The ATSB acknowledges the safety action taken by Teekay Shipping Australia to address this safety issue.

4.2 The Australian Maritime Safety Authority

4.2.1 Jurisdiction

Significant safety issue

In this instance, the consensus of the regulatory authorities is that *Karratha Spirit* was not in a navigable form at the time of the accident and was therefore under NOPSA's jurisdiction according to the OPGGSA. However, the point at which *Karratha Spirit* became 'navigable' is not clearly defined in the OPGGSA and is open to interpretation. Consequently, during some operations, it is possible that the ship would not come under the jurisdiction of any Australian safety regulatory regime.

Action taken by the Australian Maritime Safety Authority MO-2008-013-NSA-063

The ATSB has been advised that the Australian Maritime Safety Authority is currently undertaking a review of the *Navigation Act 1912*.

ATSB assessment of response/action

The ATSB acknowledges the safety action taken by the Australian Maritime Safety Authority to address this safety issue.

4.3 National Offshore Petroleum Safety Authority

4.3.1 Oversight

Minor safety issue

NOPSA does not undertake the audits necessary for maritime compliance and AMSA is only able to do so for most of the time, while the facility is on station, with NOPSA's cooperation under an MoU. NOPSA had carried out annual occupational health and safety inspections on board *Karratha Spirit* and AMSA had carried out the necessary third party audits of the SMS to meet its certification requirements. However, none of these audits or inspections had identified the discrepancy between the mooring hawser procedures and actual shipboard practices or that the ship's internal review processes had not identified the discrepancy.

Action taken by the National Offshore Petroleum Safety Authority MO-2008-013-NSA-064

In response to the ATSB draft report, the National Offshore Petroleum Safety Authority advised the ATSB that with regards to the Safety Advisory Notice:

The Safety Authority has sought ongoing support from AMSA in the provision of marine surveyors to assist the Safety Authority in its inspection of facilities (that can become vessels upon exiting the offshore petroleum regime). AMSA have confirmed its ongoing willingness to assist. The Authority has reviewed and is using its 'sail-away preparedness' and 'cyclone response preparedness' checklists in inspections of selected facilities.

The Authority has increased its target frequency for inspections of normally occupied facilities (including FPSOs and FSOs) from once a year to twice a year, and is actively addressing the consequential requirement for additional OHS Inspectors.

ATSB safety advisory notice MO-2008-013-SAN-066

The Australian Transport Safety Bureau advises that the National Offshore Petroleum Safety Authority (NOPSA) should consider the safety implications of this safety issue and undertake further action where considered appropriate.

4.3.2 Jurisdiction

Significant safety issue

In this instance, the consensus of the regulatory authorities is that *Karratha Spirit* was not in a navigable form at the time of the accident and was therefore under NOPSA's jurisdiction according to the OPGGSA. However, the point at which *Karratha Spirit* became 'navigable' is not clearly defined in the OPGGSA and is open to interpretation. Consequently, during some operations, it is possible that the ship would not come under the jurisdiction of any Australian safety regulatory regime.

Action taken by the National Offshore Petroleum Safety Authority MO-2008-013-NSA-065

In response to the ATSB draft report, the National Offshore Petroleum Safety Authority advised the ATSB that:

The ATSB is no doubt also aware of the reports prepared for the Australian Government by Kym Bills and David Agostini in June 2009 concerning Offshore Petroleum Safety Regulation: Better practice and the effectiveness of the National Offshore Petroleum Safety Authority and Marine Issues. The Department of Resources Energy and Tourism has drafted a Response for Consultation, addressing the two reports and including a response to the June 2008 Review of NOPSA Operational Activities. The Government has already acted on some of the recommendations from the reports. Details and links to all the documents are available from the Department's website.

The Safety Authority is actively engaged with the Department on the development of these responses, including several which have some bearing on the Significant

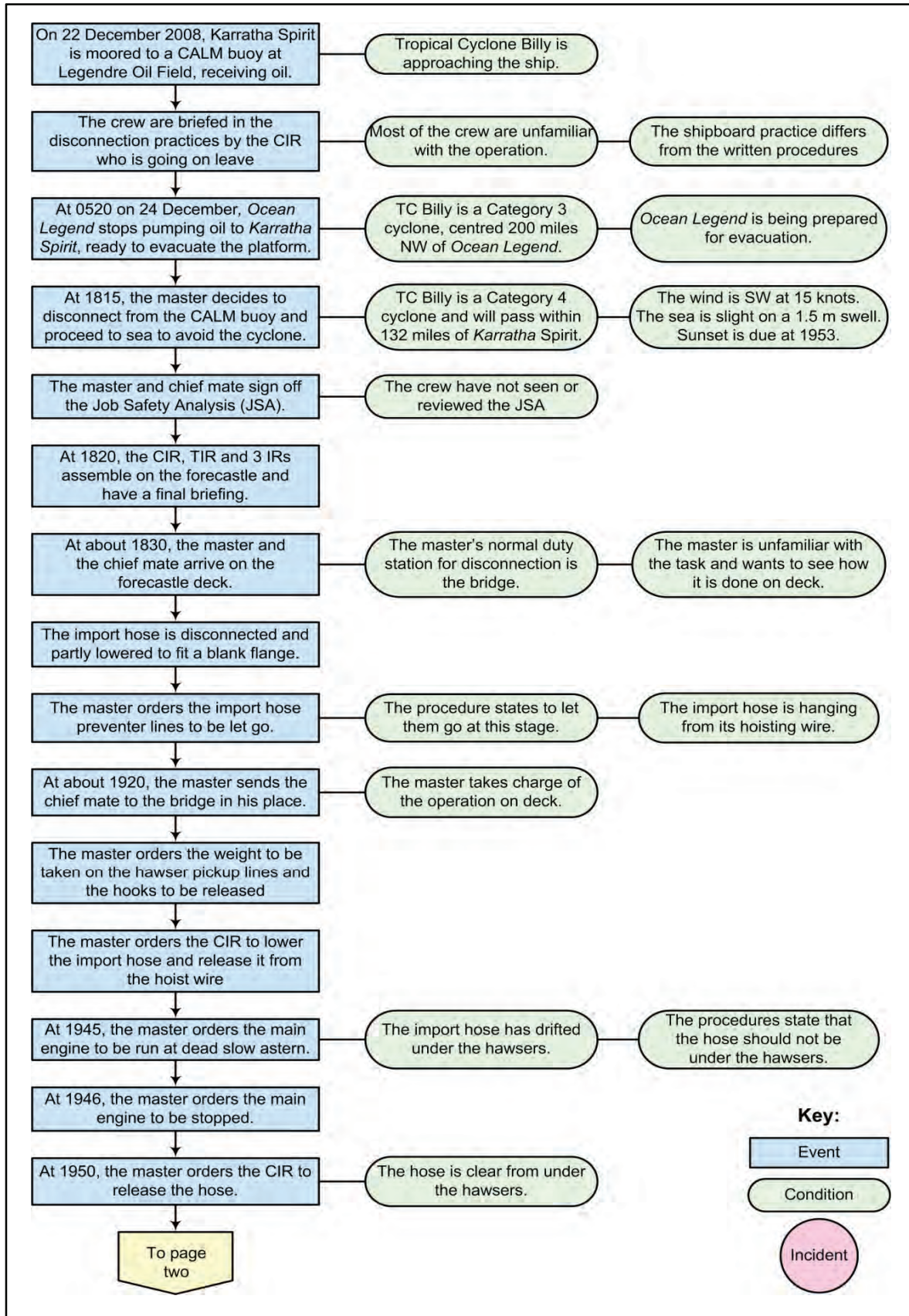
Safety Issue raised in the ATSB report. For instance, consideration is being given to amending the Offshore Petroleum and Greenhouse Gas Storage Act 2006 to extend the offshore OHS regime boundary 500m from the point of departure and to provide OHS Inspectors with powers appropriate to investigation of OHS incidents that occur on a facility that then becomes a vessel. A previous amendment to the Act has created a warrant that may be issued by a Magistrate and executed by an OHS Inspector to gain entry to, and seize evidential material from, such a vessel.

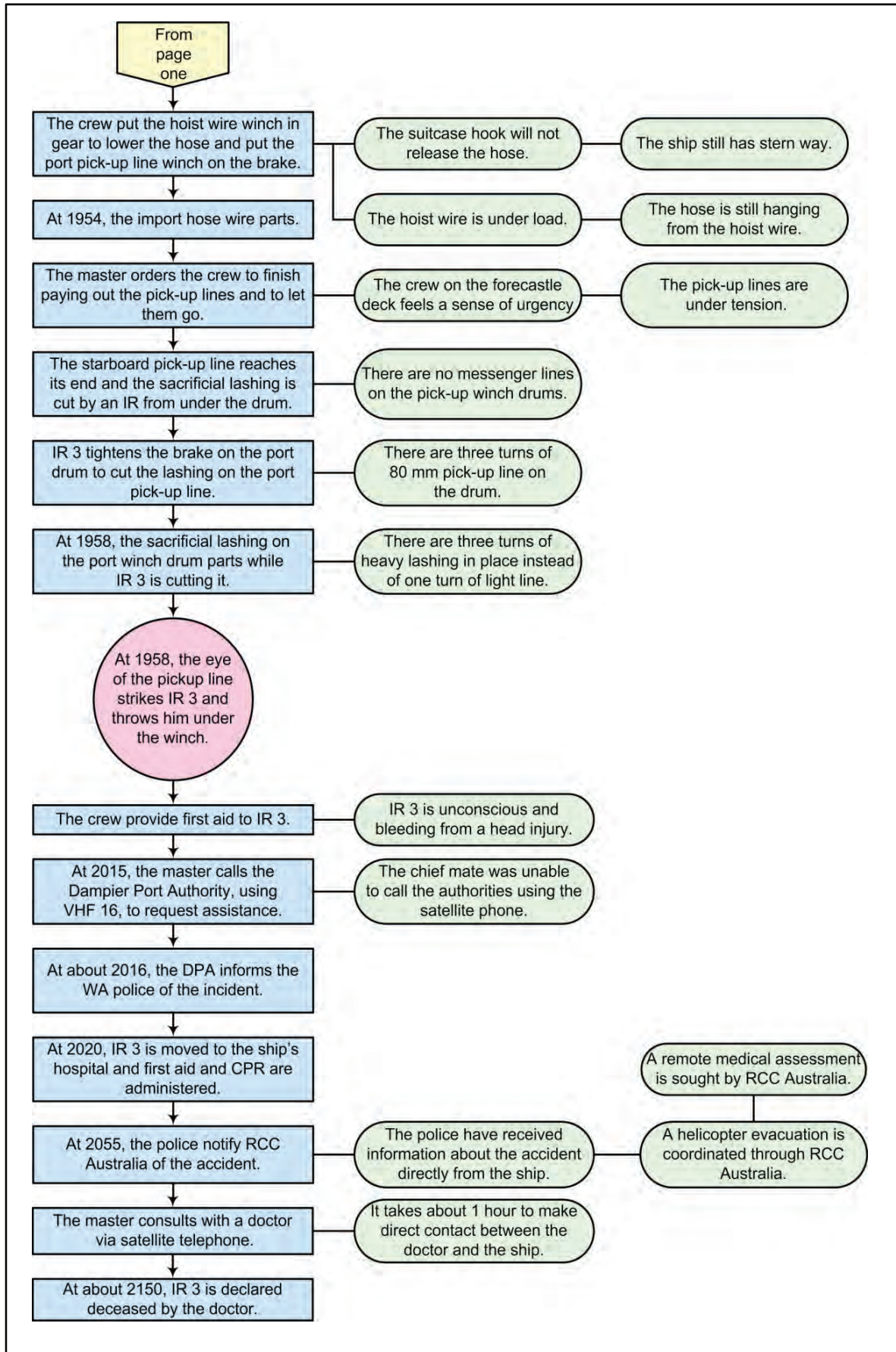
The OHS laws for vessels that exit the OHS regime are being considered by the Government as part of a complete review of the Navigation Act. The Safety Authority will provide operational relevant input to this review as required.

ATSB safety recommendation MO-2008-013-SR-067

The Australian Transport Safety Bureau recommends that the National Offshore Petroleum Safety Authority (NOPSA) should undertake further action to address this safety issue.

APPENDIX A: EVENTS AND CONDITIONS





APPENDIX B: SHIP INFORMATION

Karratha Spirit

IMO Number	8613736
Call sign	VNFO
Flag	Australia
Port of Registry	Sydney
Classification society	American Bureau of Shipping (ABS)
Ship Type	Floating storage and offloading tanker (FSO)
Builder	Hyundai Heavy Industries, Korea
Year built	1988
Owners	Teekay Corporation
Ship managers	Teekay Shipping Australia
Gross tonnage	59 289
Net tonnage	35 989
Deadweight (summer)	106 672 t
Summer draught	14.67 m
Length overall	257.00 m
Length between perpendiculars	234.02 m
Moulded breadth	42.68 m
Moulded depth	21.52 m
Engine	1 x B & W 6S60 MC
Total power	10 165 kW
Crew	17

APPENDIX C: SOURCES AND SUBMISSIONS

Sources of information

Australian Maritime Safety Authority (AMSA)
Bureau of Meteorology (BoM)
Dampier Port Authority (DPA)
Karratha Spirit's master and crew
Maritime Union of Australia (MUA)
National Offshore Petroleum Safety Authority (NOPSA)
Teekay Shipping Australia
Western Australia Police

References

Australian Hydrographic Service (2004), *'Australian Seafarers Handbook'*, First Edition, Australia.

Cannon-Bowers, JA, Salas, E, Converse, S A (1993), *'Shared mental models in expert team decision making'*. In Mathieu, J, Heffner, T, Goodwin, G, Salas, E, Cannon-Bowers, JA. *The influence of Shared Mental Models on Team Process and Performance*. Journal of Applied Psychology, Vol 85, No. 2, American Psychological Association Inc.

Civil Aviation Authority UK, *'CAP 437 Offshore Helicopter Landing Areas – Guidance on Standards'*.

Coastal Waters (State Powers) Act 1980.

IMO Resolution A.913 (22), Revised Guidelines on Implementation of the International Safety Management (ISM) Code by Administrations, 2001.

International Convention for the Safety of Life at Sea, 1974, as amended (SOLAS).

Navigation Act 1912

NOPSA Bulletin, What are Planned Inspections? In, *'Health and Safety under the Offshore Petroleum and Greenhouse Gas Storage Act - What operators and workers need to know*.

NOPSA Inspection and Audit Form, FM 0387: *Readiness to Sail Away Checklist*. Revision 1, May 2008.

Offshore Petroleum and Greenhouse Gas Storage Act 2006

Offshore Petroleum, Safety Regulation: Marine Issues, Australian Government, 2009.

Petroleum (Submerged Lands) (Management of Safety on Offshore Facilities) Regulations 1996

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

The final draft of this report was sent to the master and directly involved crew members, the Australian Maritime Safety Authority (AMSA), the Maritime Union of Australia (MUA), the National Offshore Petroleum Safety Authority (NOPSA), Teekay Shipping Australia, Teekay Shipping's P&I lawyer, the Dampier Port Authority communications officer and the Western Australia Police in Karratha.

Submissions were received from AMSA, MUA, NOPSA, Teekay Shipping Australia, the Dampier Port Authority communications officer, the Western Australia Police in Karratha, Teekay Shipping's P&I lawyer and *Karratha Spirit's* master, chief officer, one Chief Integrated Rating and one other integrated rating. The submissions have been included and/or the text of the report was amended where appropriate.

Independent investigation into the fatality on board the Australian registered floating storage and offloading tanker *Karratha Spirit* off Dampier, Western Australia on 24 December 2008.