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REPORT ON INVESTIGATION OF MARINE ACCIDENT MV STAR JAVA - IMO NO 9310513 OCCUPATIONAL ACCIDENT IN SQUAMISH 18.AUGUST 2008

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This report has been translated into English and published by the Accident Investigation Board Norway (AIBN) to facilitate access by international readers. As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

AIBN has compiled this report for the sole purpose of improving safety at sea. The object of a safety investigation is to clarify the sequence of events and root cause factors, study matters of significance for the prevention of maritime accidents and improvement of safety at sea, and to publish a report with eventually safety recommendations. The Board shall not apportion any blame or liability. Use of this report for any other purpose than for improvements of the safety at sea should be avoided.

Photo of ferry on the Norwegian west coast: Bente Amandussen

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NOTIFICATION OF THE ACCIDENT

The accident on board MV *Star Java* occurred alongside the quay in Squamish in Canada on 18 August 2008 at 1445 local time. The ship notified the Norwegian Maritime Directorate on 20 August. The Norwegian Maritime Directorate then notified the Accident Investigation Board Norway (AIBN) by e-mail on 21 August 2008. The ship had also notified the Transport Safety Board of Canada (TSB) of the accident.

On the same date, AIBN contacted the owners in Bergen in order to obtain more information. The ship was scheduled to depart from Vancouver on 22 August at 0200 hrs to sail to Yokohama in Japan. Estimated time of arrival at the destination was 3 September 2008. AIBN contacted TSB on 22 August and was informed that TSB would not investigate the accident. On the same day, AIBN informed TSB, the owners and the Norwegian Maritime Directorate that AIBN would instigate an investigation pursuant to the provisions of the Norwegian Maritime Code of 24 June 1994 (the Maritime Code) chapter 18.

Two of AIBN's accident investigators travelled to Japan and boarded the ship on 3 September 2008 when it arrived in Yokohama. The accident investigators accompanied the ship to Shimitzu, and disembarked on the following day. The inspectors conducted technical investigations and interviews with the personnel involved.

SUMMARY

After having taken on board cargo from several ports in the area of Vancouver Island in Canada, MV Star Java arrived at Terminal Berth No 2 in Squamish on the morning of 17 August 2008 and started taking on board woodpulp. Loading was completed the following day at 1300. On the orders of the ship's chief mate, the deck crew started to secure and make ready one of the ship's gantry cranes prior to departure for the next port that afternoon.

While working to secure the crane, the ship's boatswain was crushed between the end stop for the crane's trolley and the railings up on the walkway as the crane's outriggers were swung in. None of the other persons who were up on the crane at the time of the accident observed the incident, but the ship's management was notified as soon as it became clear that the boatswain had been crushed and first aid measures were implemented immediately. The ship's

management also called for medical personnel from ashore, who arrived quickly. Despite the steps taken, it was not possible to save the boatswain's life.

In accordance with its terms of reference, the AIBN has conducted a safety investigation in an attempt to clarify the course of events and identify the underlying causes of the accident with a view to making safety recommendations that may prevent similar accidents in the future. The investigation of the accident on board MV *Star Java* has therefore been limited to matters surrounding the actual accident that occurred in one of the ship's cranes in connection with securing work. Focusing on these matters, the Accident Investigation Board has identified safety issues concerning the design of the crane not providing for the safety of personnel to a sufficient extent. Safety issues have also been found to exist in the form of inadequate risk assessment and hence inadequate procedures for work process organisation, leadership and communication when the ship's cranes are being secured.

The Accident Investigation Board submits three safety recommendations in this report. These are addressed to the crane manufacturer with respect to the design of the gantry crane, the shipping company with respect to work organisation, supervision and communication during securing of the ship's cranes and the authorities with respect to rules and regulations for the design of cranes in general.

1. FACTUAL INFORMATION

1.1 Details of the ship and the accident

Details of the ship

Name of ship	:	*MV Star Java*
Call sign	:	LAJS6
IMO number	:	9310513
Owner/shipping company	:	Grieg Shipping AS, P.O. Box 234 Sentrum, NO-5804 Bergen
Responsible for ISM	:	Grieg Shipping Group AS, Org. system No 932350467, P.O. Box 781 Sentrum, NO-5807 Bergen
Type of ship	:	Open hatch bulk carrier
Year / place built	:	2006 / Tamano, Japan
Flag state	:	Norway (NIS)
Class society	:	DNV
Control authority for periodic inspection incl. the ISM system	:	DNV
Port of registry	:	Bergen
Hull material	:	Steel
Length overall	:	198.00 metres
Breadth	:	31.06 metres
Gross tonnage	:	32,679
Engine power	:	10,520 KW / 14,108 BHP
Contracted speed	:	16 knots

Details of the accident

Time and date	:	1450 – 1455, 18 August 2008
Place of accident	:	Squamish Terminals Berth No 2, Canada
Persons on board	:	19 crew members and 11 others[1]
Personal injuries/deaths	:	1 dead (boatswain/able seaman)
Damage to the ship	:	Walkway railings on the after girder, starboard side, on gantry crane no 1 bent by approx 15 degrees

1.2 Course of events

After having taken on board cargo from several ports in the area of Vancouver Island in Canada, MV Star Java arrived at Terminal Berth No 2 in Squamish, Canada, on the morning of 17 August and started taking on board woodpulp. Loading was completed at about midnight. Some cargo remained to be taken on board on 18 August and loading was resumed at 1230 that day. Loading of woodpulp into hold no 4 using gantry crane[2] no 1 was completed at 1242.

At 1425, the chief mate instructed the crew on deck to start securing gantry crane no 1.The boatswain and the deck cadet, who were working in hold no 2 at the time, came up on deck and went up into the crane to start the work.

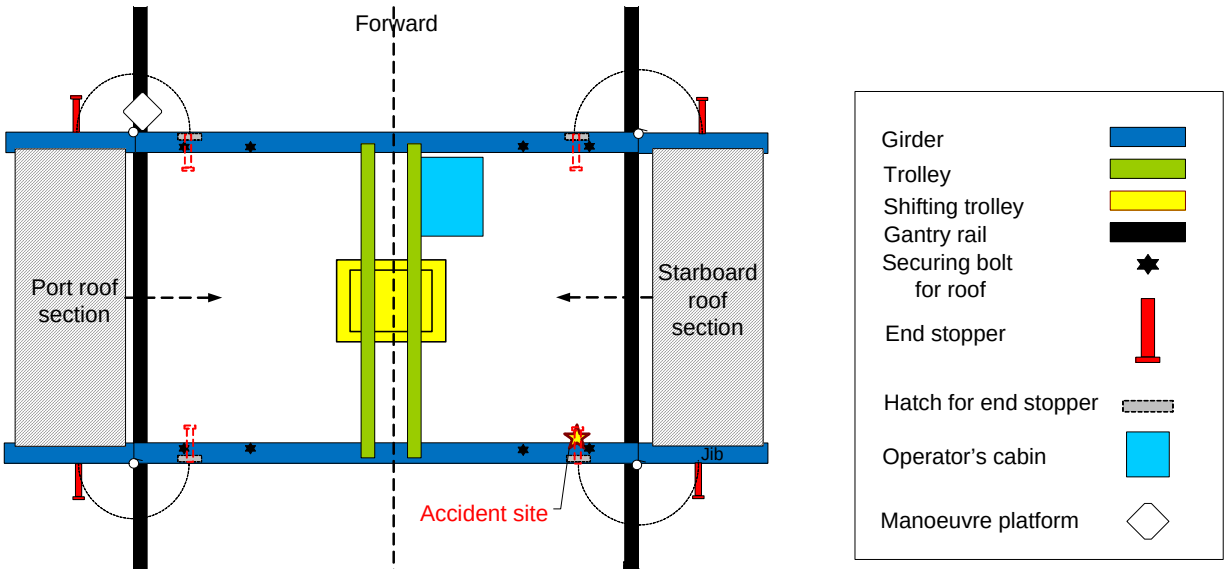

Figure 1: Simplified drawing of the gantry crane seen from above.

The boatswain was operating the trolley from the operator's cabin located under the trolley at the forward edge. The trolley was attached to the sliding roof on the port side. The sliding roof was pulled towards the centre of the crane with the trolley. When the roof section was in right position, the cadet and boatswain

[1] Nine stevedores, one supercargo and one first aider from the facilities ashore.
[2] Overhead travelling crane

secured it to the permanent roof structure with the four securing bolts (see figure 1). The electrician now came up and took over the operation of the trolley. The starboard sliding roof was attached to the trolley and run in towards the centre. The boatswain secured the roof section with the two securing bolts on the forward girder. The deck cadet secured the roof section with the two securing bolts on the aft girder.

The trolley was run to the centre position, whereupon the boatswain secured it at the forward end. He then went to the aft girder to show the deck cadet how to secure the aft end of the trolley. The electrician secured the shifting trolley at the centre of the trolley. When this part of the securing work had been completed, the boatswain, the electrician and the cadet stayed up on the crane. At 1430 the chief mate and the able seaman began to close the hatch of hold no 4. Gantry crane no 1 was used for this work. After the hatch was closed the chief mate went to the deck office and the seaman went to the manoeuvre platform to swing in the jibs.

As the view from the manoeuvre platform up to the forward and aft girders, where the rest of the securing work was to be carried out, is restricted, the seaman called up the electrician on his UHF radio and asked for the go-ahead to start the operation of swinging in the jibs. The boatswain, as well as the seaman and the electrician, had UHF radio communication. The electrician confirmed, by personal inspection, that both the cadet and the boatswain were in safe positions and gave the signal to go ahead. Having received the go-ahead signal, the seaman released the securing pistons for the jibs and started to swing in the jibs. The electric sensors confirmed that the sliding roof sections had been pulled in and secured, and the four jibs were set in motion.

Figure 2: Accident site on top of the aft girder on starboard side, in gantry crane no. 1.

At the time when the operation to swing in the jibs began, the electrician was on the trolley. The boatswain and the cadet were near the centre of the aft girder. Having given the go-ahead to start the operation to swing in the jibs, the electrician

advised the boatswain that the hatches in the protective walls near the outer securing bolts, must be opened. The electrician moved forward on the forward girder and opened the hatches on both sides. He then left the crane superstructure and moved out onto the forward girder to observe the jibs during the closing process.

The boatswain told the cadet to open the hatch for the end stop at the port side of the aft girder. On his way towards the hatch the cadet saw that the boatswain was checking the work that he (the cadet) had done to secure the trolley. The cadet opened the port hatch and then checked that the sliding roof section was properly secured by the outer securing bolt, before moving inboard again, towards the centre of the girder. On his way in along the girder he saw the boatswain standing by the outer securing bolt at the aft end of the starboard sliding roof section (see figure 1). The cadet spoke to the boatswain, but received no answer. So he walked out towards the boatswain and saw that he had been struck by the end stop on the starboard aft jib. He shouted that the boatswain was trapped by the end stop. The seaman down on the manoeuvre platform heard the deck cadet cry out, realised that something was wrong and started to swing the jib back out.

The electrician also heard the deck cadet's shout and went into the crane to find out what had happened. He saw that the boatswain was trapped by the end stop. As he ran towards the site of the accident, he used his UHF radio to report that there had been an accident and to summon help.

The electrician's call on the UHF radio was received by the mate, who was on deck to oversee the transfer of three containers from hold no 8 to hold no 11, and by the chief mate and the captain, both of whom were in the office, in a meeting with a supercargo. They all ran to the site of the accident.

The time of the accident is estimated to be between 1445 and 1450. The ship's mate, who was responsible for first aid and who received the electrician's warning over the UHF radio, and the first aider from the facilities ashore, who was already on board, arrived at the site of the accident quickly and took over the treatment of the boatswain. At the request of the captain, the supercargo called for medical assistance from ashore. Medical personnel and the police came on board at approximately 1520. The ambulance arrived at 1530. Despite rapid treatment by the ship's crew and the availability of external medical expertise, the boatswain's life could not be saved. At 1617 the captain was informed by the supercargo that the boatswain had deceased.

1.3 Shipping company and fleet

MV *Star Java* is owned by Grieg Shipping AS. Grieg Shipping AS is part of the Grieg Shipping Group with offices in Bergen and Oslo and branch offices in the USA, China and the Philippines. The company currently operates a fleet of 23 open hatch[3] bulk carriers equipped with gantry cranes. The ships and the cranes are designed for transporting forestry products such as woodpulp and paper. The ships operate on long-term contracts for Star Shipping. The design of the cranes on all the

[3] An open hatch carrier is a ship with rectangular cargo holds on which the hatchways are as wide as the cargo holds.

ships makes them very suitable for loading and offloading in places with little developed infrastructure. Typically therefore, the vessels operate in places on the west coast of Canada where small communities have grown up around the forestry industry. The shipping company's vessels were built in the period between the mid-1980s and 2006. The company also has the next generation of ships under construction, in the form of four new open hatch bulk carriers, also equipped with gantry cranes. All of the company's ships are manned by crews from the Philippines. The company is certified under the International Safety Management (ISM) Code and had a valid Document of Compliance (DOC) at the time of the accident.

The shipping company has been forthcoming and has helped to facilitate the Accident Investigation Board Norway (AIBN)'s safety investigation after the accident on board MV *Star Java.*

1.4 The Ship

MV *Star Java* is the shipping company's newest open hatch bulk carrier. MV *Star Java* was built by Mitsui Engineering & Shipbuilding, Tamano Works in Japan in 2006 and has an overall length of 198.00 metres. The ship has 11 holds with a total storage capasity of 61,489 m^3 and a deadweight tonnage[4] of 44, 692 tonnes. The ship is fitted out with two gantry cranes (see Figure 3) and mainly carries forestry products from North America and Canada to the East, and various types of general cargo on the return voyage.

All the ship's certificates as required by the authorities, and its class certificate, were valid at the time of the accident.

Figure 3: Gantry cranes (the photo is from *Star Isfjord*).

1.5 Organisation of work on board

MV *Star Java* has a crew of 19 Filipino seamen. The deck crew consists of the captain, three deck officers and seven other crew members, including one cadet. The engine room complement consists of the chief engineer, two engine officers, one electrician and two other crew members. In addition, there are two crew members who take care of provisioning and catering. The work of the deck crew on

[4] Describes the ships loading capacity

board is organised along traditional lines with a 3-watch system at sea, 4 hours on and 8 hours off, twice per 24 hours. Each watch consists of a watch-keeping navigator and one deck crew member. The rest of the deck crew are on day duty. In port, the sea watches are discontinued and replaced by a system of 6-hour watches, whereby watch-keepers have 6 hours on and 6 hours off. There are one deck officer and two deck crew on each watch. The rest of the deck crew work days and assist with loading and unloading operations as required. The vessel is classed to operate with its engine room unmanned (E0), which means that the engine room crew work days and are organised in E0 watches when the engine room is unmanned.

The crew on board is recruited through a recruitment agency in the Philippines[5]. The shipping company has a high rate of returning crew. Many members of the ship's crew have sailed with the company for a long time, and their level of experience with the type of ship and crane equipment is thus generally high. When new personnel is taken on board, a familiarisation programme is completed, which includes the ship's crane equipment. Special training is also conducted for personnel who are involved in the operation and securing of the ship's cranes. As far as training in the securing of cranes is concerned, the procedures in the shipping company's safety management system refer to the crane manufacturer's operating procedures. For the most part, training on board is in the form of on-the-job training, whereby inexperienced crew members learn from their more experienced colleagues.

Those members of the crew who were directly or indirectly involved in the accident have/had the following background and responsibilities on board.

The captain (55 years old) is very experienced in this type of ship. He had been captain on board *Star Java* since the vessel was delivered from the yard in November 2006. He had previously served on board one of *Star Java's* sister ships and has been with the company for 15 years altogether.

The chief mate (31 years old) is in overall charge of the work of the deck crew and reports to the ship's captain. Among other things, this includes responsibility for loading and unloading operations, the safety of the deck crew and responsibility for operating and securing the vessel's cranes. The chief mate had been on board *Star Java* since May 2008. He has previous experience from several of the company's other ships that are equipped with gantry cranes.

The first mate (33 years old) was the deck officer on watch. Among other things, he is responsible for first aid and medical matters on board. The first mate had been on board *Star Java* since March 2008.

The boatswain (57 years old) who died in the accident was a very experienced seaman. He had been with the shipping company since 1989 and joined the *Star Java* in May 2008. The boatswain organises the day-to-day work of the deck crew and reports to the chief mate. Among his other tasks, the boatswain has special responsibility for ensuring that the cranes are secured before the ship puts to sea. The boatswain is also charged with making sure that the deck crew use and operate equipment and machinery on deck correctly and safely.

[5] Seabound Maritime Services Inc. Manilla, the Philippines

The electrician (26 years old) had a special responsibility for the maintenance of the ship's gantry cranes and reports to the chief engineer. The electrician is also expected to take part in the securing of the cranes. He had been on board *Star Java* since January 2008. This was his first voyage as an independent electrician, but he had previously been on board one of *Star Java's* sister ships, in addition to one of the company's other ships.

The able seaman (44 years old) had long experience in the company and thus much experience with gantry cranes. He had been on board *Star Java since* June 2008. One of the seaman's duties is to take part in the securing of the ship's cranes.

The deck cadet (18 years old) was in his first job at sea on board *Star Java*. He came on board in June 2008. One of the deck cadet's duties is to take part in the securing of the ship's cranes.

The organisation of the work of securing the ship's cranes is mentioned in several specific instructions in the shipping company's safety management system. The crane manufacturer's operating procedures are referred to in respect of the securing of cranes on board the individual ships. The manufacturer's operating procedures for the cranes on board MV *Star Java* place little emphasis on the safety of personnel regarding securing operations. Personal safety is discussed in section 1.1, and relevant for the securing operations, it states that the crane must not be operated and no part of the crane moved if anyone other than the crane operator is in or on the crane. According to this procedure there must therefore not be any personnel up on the girders when the jibs are being manoeuvred. Personnel who have secured the sliding roof sections are required to climb down to the deck before the jibs are swung in.

1.6 Crane design

MV *Star Java* is equipped with two of the shipping company's newest type of gantry cranes, produced by Mitsui Engineering and Shipbuilding Co. Ltd. The cranes are used both for handling cargo and for lifting and moving the large hatch covers. The crane structure consists of four legs, one in each corner, held together by girders (see Figure 1). The crane has a lifting capacity of 68 tonnes. To facilitate access to the highest parts of the cranes, exterior and interior ladders are provided, which lead up onto the girders. There is also a walkway with railings up on the girders.

The whole crane arrangement can be moved fore and aft on rails and placed over the hold to be loaded or unloaded. Up on the girders there is a trolley that can be moved thwartships. The trolley in turn contains a shifting trolley, which can be moved forward and aft and is used to hoist and lower the load. The cranes extend from one side of the ship to the other and they can also be lengthened over the ship's side, using two jibs on either side of the crane that can be swung out. In this way the crane can operate and handle loads up to eight metres from the ship's side. To prevent the trolley from being run past the ends of the girders the jibs are fitted with end stops that form a physical barrier for the trolley when the jibs are swung in. To protect the cargo during loading and offloading, the crane is fitted with a permanent roof and additional sliding roof sections are extended over the jibs. Up on the girders, the crane is equipped with continuous protective walls. The crane is

also equipped with 'skirts' that can be pulled down from the girders to the hatch frames on the holds, so that loading and unloading operations are virtually unaffected by wind and weather.

1.7 Securing of cranes

When the cranes have been in use they have to be readied and secured before the ship puts to sea again. The first phase in readying the cranes involves pulling back and securing the sliding roof sections over the jibs, if these have been used.

The sliding roof sections are pulled back using the trolley. The trolley is attached to the roof structure and the sliding roof sections are pulled in under the crane's permanent roof. The sliding roof securing arrangements consist of four bolts, one at each corner, which are screwed into place manually. To prevent the jibs from being swung in while the roof sections are extended, electric sensors are fitted to the securing bolts that prevent the jibs from being moved until all the securing bolts are in place. Once the securing bolts are screwed home, the two outermost bolts are further secured against loosening by fastening a chain to the T-shaped securing bolts.

The next phase of the work of preparing the crane for the sea voyage starts once the sliding roof sections are secured. At this point the trolley is parked in its middle position and secured with bolts. The trolley is automatically secured against being run past the end of the girders when the jibs are swung in. A device mounted at right angles to each jib works as an end stop for the trolley when the jib is swung in. These end stops (see figure 1 and 2) come in through hatches in the crane's forward and aft protective walls, under the outermost securing bolts for the sliding roof and at a height of about one metre above the girders (walkway). The two outermost securing bolts for each sliding roof section are located in the area where the end stops for the trolley come in when the jibs are swung in.

During loading and offloading the jibs are secured in the swung out position using hydraulic securing pistons that have to be released before the jibs can be swung back in. Swinging in of the jibs is done from a manoeuvre panel on a platform down on the cranes forward port leg. After the jibs have been swung in, they are secured to the forward and aft girders with securing bolts.

Finally the gantry cranes are run all the way to the aft of the deck and parked. Moving the cranes fore and aft is carried out from the manoeuvre platform down on the leg of the crane.

1.8 Construction of the stop function for the trolley (end stops)

The end stops for the trolley are devices mounted at right angles to the four jibs. When the jibs are swung in, the end stops are rotated in at the same time, through the crane's forward and aft protective walls at a height of about one metre above the walkway on the girders, directly beneath the T-shaped securing bolts for the sliding roof sections. Figure 2 shows the end stop on its way in through the hatch. The T-shaped securing bolt for the sliding roof section is directly above the end stop for the trolley.

Before the jibs can be swung in, the hydraulic securing pistons have to be released. This is done from the manoeuvre platform down on the port leg of the crane and takes approx 3 seconds. Release of the hydraulic securing pistons makes a noise that is quite audible on the walkway up on the crane. About 58 seconds elapse, from starting to swing in the jibs until the end stops come into view inside the enclosed crane. A further 10 seconds elapse, from the time that the end stops for the trolley first come into view in the hatches in the forward and aft walls until the jibs are fully swung in. The swinging in of the jibs is barely audible.

Electrical sensors are fitted to the securing bolts for the sliding roof sections so that the jibs cannot be moved before the roof has been secured.

1.9 Changes in crane design within the Grieg shipping fleet (from the 1980s to 2006)

In step with the market's requirement to be able to carry out loading and offloading operations in all weather conditions, the shipping company, in collaboration with the crane manufacturer, has contributed to the continuous development of ship and crane design. The first generations of cranes were completely open and the jibs were manoeuvred from manoeuvre stations on each individual jib, high up on the gantry. Newer generations of cranes were designed with permanent roofs above the crane. Later additions were sliding roof structures, 'skirts' that could be pulled down and weatherproof walls at the forward and aft ends of the crane. Today's cranes can be weatherproofed in such a way that the cargo can be loaded and offloaded without being exposed to wind and weather. On the latest generations of cranes, manoeuvre panels for the jibs has been moved from the original locations high up on each of the four individual jibs, to a manoeuvre station located lower down on one of the legs of the crane.

The first generation of gantry cranes were completely open, without any form of roof or walls to protect the cargo against wind and weather. This was the normal crane design until 1985/86. Figure 4 shows the gantry cranes on MV *Star Atlantic*.

Figure 4: Open gantry crane.

All control of the jibs, the trolley and the shifting trolley is done from high up on the girders. Manoeuvre panels for the forward jibs are located on the forward girder out near the end stops, whilst manoeuvre panels for the aft jibs are correspondingly

placed on the aft girder. The jibs are manoeuvred one by one and the manoeuvre positions provide a very good overview.

Gradually, the need emerged to protect the cargo against rain during loading and offloading operations. From 1985/86 onwards, most cranes were delivered with roofs. Figure 5 shows the gantry cranes on MV *Star Frazer*.

Figure 5: Partially enclosed gantry crane.

In addition to permanent roofs, the current generation of cranes have sliding roofs on the starboard and port sides, which can be extended over the jibs. In addition, the upper parts of the cranes are protected by fixed walls (from the girders and up to the roof) at the forward and aft ends. This is the most usual design for cranes delivered after 1994/95. Figure 6 shows gantry crane no 2 on MV *Star Java*, looking aft.

Figure 6: Enclosed gantry crane.

On the current generation of cranes the operation of the jibs has been moved down to a manoeuvre platform on the port forward leg of the crane. On the first generation of gantry cranes the four jibs were manoeuvred individually.

On the most recent generation of gantry cranes the jibs can be operated individually, two at a time, or all four at the same time. The control panel is arranged so that the spring-loaded push buttons for operating the jibs have to be held in while the jibs are being swung out or in. The jibs stop moving immediately, when the manual pressure on the buttons is released.

1.10 Current regulations

Personal safety matters are governed by the HSE Regulations[6]. For ships that are required to have a safety management system, it is the shipping company that is responsible for setting up such a system, that covers safety matters in the above mentioned HSE Regulations. The regulations require, among other things, that hazards on board be identified. When a hazard is identified, the risk posed by the hazard must be assessed. Risk assessment must be undertaken regularly. The results of the risk assessment must be recorded in writing. If risks to employees' health and safety are discovered, the measures necessary to remove or reduce the risks must be implemented.

The requirements for a safety management system are regulated by the ISM Regulations[7]. These regulations are applicable to Norwegian cargo ships with a gross tonnage of 500 or more, among others. In accordance with section 2 of the regulations, every shipping company must have a safety management system that covers both its organisation on land and the individual ships in compliance with the ISM Code.

The rules concerning the design, production and use of cranes on Norwegian ships are laid down in the Regulations on loading and offloading equipment[8]. The regulations contain detailed requirements and the material focus is on the design, strength, testing, inspection and use of cranes. The regulations contain different requirements for approval, depending on whether the crane is manufactured in Norway or abroad. Cranes manufactured in Norway must be certified by a competent person or a workshop approved by the Norwegian Maritime Directorate, while cranes produced outside Norway may be certified by the crane manufacturer. Cranes produced abroad may be certified by the crane manufacturer, if the ship's master or the shipping company believes the workshop in question has the necessary test equipment and personnel with adequate qualifications in the area.

1.11 The shipping company's safety management system

The shipping company had established a safety management system[9] in line with IMO's ISM Code[10]. The system was established with three levels:

Level 1 covers the overall objectives and strategies, including descriptions of the organisation and its activities.

Level 2 covers overriding procedures for the shipping company's activities.

Level 3 covers, amongst other things, operations manuals specific to particular vessels, instructions (including job instructions for ships' crews), HSE documentation, training and practice manuals, and various checklists.

[6] Regulations no 8 of 1 January 2005 relating to the working environment, safety and health of employees on board ships

[7] Regulations no 306 of 14 March 2008 relating to safety management systems on Norwegian ships and mobile facilities

[8] Regulations no 4 of 17 January 1978 relating to shipboard loading and offloading appliances

[9] Safety, Security and Quality Management System (SSQM-System)

[10] International Safety Management Code (IMO Res. A 741(18))

The shipping company's safety system is generic and the procedures cover all of the company's vessels. The ship's cranes are referred to in several specific instructions in the shipping company's safety management system. The familiarisation programme for newly hired personnel, and the special training of personnel who are involved in the operation and securing of the ship's cranes, are described in dedicated procedures and checklists.

The shipping company and the captain are responsible for continuous improvement of the safety management system, among other things by conducting internal safety audits to verify that safety and pollution prevention activities comply with the safety management system. SAFIR[11] reports about accidents, near-accidents, non-conformities and hazardous situations are important elements in the shipping company's continuous improvement of matters relating to health, safety and the environment. These reports are sent to the shipping company for analysis. The shipping company assesses the need for corrective measures to be implemented, and decides whether to inform the company's other ships about the incident.

The shipping company carries out regular audits of the safety management system (management reviews). The ship's captain is responsible for reviewing the safety management system on board, and for reporting any shortfalls to the land-based management (captain's review). One of the main points of this review is to ensure that practical work execution on board is in line with the procedures.

Health, safety and environment conditions on board are also addressed through the ship's safety delegate system. Monthly PEC (Protection and Environment Committee) meetings are held, attended by the safety delegates and the ship's management. Accidents, near-accidents and incidents that the land organisation has reported from the shipping company's other ships, are discussed and followed up at these meetings. Monthly open meetings are held, at which anyone on board can raise questions of safety. The ship's officers also have weekly meetings, among other things for the purpose of following up HSE matters. The ship submits annual reports on the work of the PEC. The work of the PEC and experience from the PEC meetings are also important tools for the captain in his review of the safety management system.

1.12 Supervision by the authorities

MV *Star Java* is registered in the Norwegian International Ship Register (NIS). The Norwegian authorities have delegated all periodic official inspections of ships registered in the NIS to five accredited classification societies[12]. To ensure that the arrangement works as intended, the Norwegian Maritime Directorate conducts audits of the class societies. Details of the scheme are set out in agreements between the Norwegian Ministry of Trade and Industry and the respective class societies.

In respect of MV *Star Java* and the shipping company Grieg Shipping AS, the NIS agreement states that DNV (Det Norske Veritas) shall carry out an initial inspection

[11] Safety Improvement Report
[12] Det norske Veritas (DNV), American Bureau of Shipping (ABS), Lloyds, Germanischer Lloyd (GL) and Bureau Veritas (BV)

as well as subsequent periodic inspections of the ship and its equipment, with the exception of loading and offloading equipment. With that exception, DNV has carried out the inspections and issued the relevant certificates relating to the ship and its equipment.

On behalf of the Norwegian Maritime Directorate, DNV is also the supervisory authority for the shipping company's, and the ship's, safety management systems. By virtue of its supervisory role, DNV conducts verification and approval of the shipping company's safety management system, both ashore and on board the vessels. DNV is required to check that the company and the management on board operate in accordance with approved safety management systems. With respect to ISM certificates, DNV issued a temporary Safety Management Certificate (SMC) when the ship was delivered. The Document of compliance (DOC) was issued to Grieg Shipping Group AS on 10 June 2007. DNV Vancouver conducted a Safety Management Renewal (audit) on board the ship on 19 April 2007. On 14 June 2007, DNV then issued the full-time certificate, which is valid until 19 April 2012.

The manufacturer, Mitsui Engineering & Shipbuilding Co. Ltd, tested and certified the gantry cranes on board MV *Star Java* on 16 October 2006. Despite there being no requirement to that effect, a representative from the International Cargo Gear Bureau Inc[13] was present during the tests.

2. ANALYSIS

2.1 Introduction

The accident occurred while the boatswain was up in gantry crane no 1, on the walkway on the starboard side of the aft girder and below the outer securing bolt for the sliding roof section, as the jibs were swung in. The electrical sensors on the securing bolt for the starboard sliding roof section had confirmed that the roof had been secured. If this had not been the case, it would not have been possible to start swinging in the jibs and, consequently, there would have been no need to check the securing devices. It has not been possible to ascertain why the boatswain was in the area of the outer securing bolt up until the time when he was hit by the end stop. After having opened the hatch for the end stop, he may have given his attention to checking the chain to be attached to the T-shaped securing bolt in the aft corner of the starboard sliding roof section. This is based on where the boatswain was hit and the position in which he was found, among other things. As brought forward from the company and the crew on board the boatswain was a highly responsible and conscientious seaman. In the light of the fact that the securing work in the aforementioned area had been carried out by an inexperienced cadet, it can be assumed that he was preoccupied with checking/attaching the aforementioned chain.

Once the accident occurred, it had the worst possible outcome. This is linked to the design and position of the end stops installed on the jibs to secure the trolley. These end stops move in through the crane's forward and aft protective walls and pass the girders, and hence the walkway, at a height of approx. one metre just below the

[13] Internationally recognised form for inspection and certification of cranes

outer securing bolt for the sliding roof. Because of this, the Accident Investigation Board considers it necessary to look more closely at the actual design of the crane.

The fact that the boatswain was standing by the outer securing point at the time that the operator started to swing in the jibs, suggests that there are reasons for looking more closely at the organisation, supervision and communication routines relating to the securing of the cranes.

The analysis also includes an assessment of whether the safety management system, current regulations and supervisory arrangements are adequate with a view to preventing this type of accident.

2.2 Design of trolley stop function (end stops)

The end stops for the trolley have the same design in the latest generation of gantry cranes as in previous generations of cranes. This means that the design of the end stops has not changed in step with the development whereby the cranes have become increasingly enclosed. In the newest cranes with end walls, the end stops will not be visible from the walkway on the girders until they appear inside the enclosed cranes. Approx. 10 seconds elapse from the time that the end stops for the trolley come into view in the hatches in the forward and aft walls until the jibs have been fully swung in. The swinging in of the jibs is hardly audible.

Insofar as it is possible to move around the area, the end stops for the trolley appear to be a safety problem with respect to moving across the walkway in the area of the outer safety bolts.

2.3 Change in crane design within the Grieg shipping fleet (from the 1980s until 2006)

The first generation of gantry cranes was completely open, and the manoeuvring and securing of jibs, trolley and shifting trolley took place up on the cranes' girders. When the jibs are swung in, the end stops moves across the girders at a height of approx. 1 metre above the girders, but because the crane structure is open and provides a clear overview, this technical solution does not represent any significant safety problem in the first generation of gantry cranes.

Subsequent generations of cranes have become more enclosed. In addition, the manoeuvre station for the jibs has been transferred down on the forward port crane leg, while the roof sections, trolley, shifting trolley and jibs are secured up on the crane.

It is not possible to see the walkway on the forward girder or the walkway on the starboard side of the aft girder from the manoeuvre platform down on the crane leg (see figure 7). Depending on the shifting trolley's position it may also be impossible to see the walkway on the starboard side of the aft girder.

Figure 7: View from the manoeuvring platform.

In the Accident Investigation Board's opinion, the transfer of the manoeuvre panel to the fore port crane leg, combined with the top of the crane being increasingly enclosed, has contributed to reducing the overview of the securing operation as a whole and hence reduced the safety of the personnel involved.

2.4 Organisation of the work on board

Based on the ship's established watch systems, the size of the crew and the ship's sailing pattern during the period prior to the accident, the Accident Investigation Board does not regard fatigue[14] as a contributory cause of the accident. This is confirmed by the interviews with the personnel involved.

On the day of the accident, the chief mate had instructed the deck crew to secure gantry crane no 1. The work was carried out by the boatswain, electrician, able seaman and deck cadet. Pursuant to the job instructions, it is the chief mate who has overriding responsibility for securing the cranes. However, he did not participate in the practical work. According to the job instructions, the boatswain must ensure that the cranes are secured before a sea voyage, and other personnel involved must participate in securing the cranes. During the operation of swinging the jibs back in to make the crane ready, there were personnel present up on the crane.

The technical development whereby the cranes become increasingly enclosed, and the centralisation and transfer of the manoeuvre panels have gradually led to greater requirements for organisation, supervision and communication in connection with the securing of cranes. The Accident Investigation Board apprehends that the work to secure the crane must be looked at in the light of technical crane developments. Since neither the boatswain, nor the electrician, able seaman or deck cadet, were in a clear position of leadership with respect to the securing operation, the work was carried out in what appears to be a disorganised manner. Information obtained through interviews with those who were involved in securing the crane also suggests that the work was carried out haphazardly and that nobody knew who was leading the operation. The Accident Investigation Board has not been able to find any procedures or work descriptions in the shipping company's safety management system that adequately clarify what organisation, supervision and lines of

[14] Wearing out, tiredness

communication need to be in place in order to carry out securing operations in a safe manner.

The fact that the shipping company has chosen to carry out the operation of securing the cranes in a manner that in practice differs from the one described by the crane manufacturer in its operating procedure, underlines the need for clear organisation, leadership and communication.

These challenges do not seem to have been adequately understood in the general context of ensuring personnel safety. The accident occurred even though the operation of securing the cranes was to some extent carried out by experienced personnel, all of whom had completed the familiarisation programme and undergone training in accordance with the safety management system.

The Accident Investigation Board holds the view that, on the basis of developments in crane design and the fact that the chosen practice for carrying out the securing operation differs from the one specified by the crane manufacturer, the shipping company has not identified the increased safety problem. The Accident Investigation Board cannot see that the shipping company has conducted any risk assessment of the changed conditions and, based on such a risk assessment, implemented the measures necessary to remove or reduce the risks.

2.5 Current regulations

Both the ISM Regulations and the HSE Regulations describe the shipping company's responsibility with respect to establishing safety barriers to eliminate or reduce identified risks. The two sets of regulations differ somewhat in that the ISM Regulations require barriers to be established, if necessary, against identified hazards, while the HSE Regulations require hazards to be identified and barriers to be established if necessary. In other words, the HSE Regulations are more offensive in that they require hazards to be identified. In this context the Accident Investigation Board would emphasise the importance of the industry being familiar with the HSE Regulations.

In the Accident Investigation Board's opinion, the Regulations relating to the design and construction of cranes are technical regulations, that deal only to a limited degree with matters relating to personal safety, except insofar as they provide for protection against failure in connection with loading and offloading operations. The regulations do not require risk assessments of operational conditions relating to the operation of the crane as early as in the design phase. Personal safety in connection with the operation of the crane is, as per today, generally regulated by the ISM Regulations and the HSE Regulations. However, none of the above mentioned regulations applies to the development of crane designs. This may cause the crane manufacturers to expect that personal safety in connection with crane operations will be ensured by organisational barriers.

The Accident Investigation Board finds it strange that the requirements of the Regulations on loading and offloading appliances are different and more lenient in the case of cranes produced abroad than in the case of cranes produced in Norway.

2.6 The shipping company's safety management system

With respect to procedures for operating and securing the specific gantry cranes on board each individual vessel, the shipping company's safety management system refers to operating procedures prepared by the crane manufacturer. In the case of *Star Java*, the operating procedures are collected in a total of eleven folders from the crane manufacturer. In the Accident Investigation Board's opinion, the manufacturer's operating procedures, only to a small extend focus on personal safety in connection with the various securing operations.

In the shipping company, it is a long-standing tradition to secure the cranes in a similar way that was done on board MV *Star Java*. This work practice is not in accordance with the crane manufacturer's operating procedure for securing the crane. In the Accident Investigation Board's opinion, the lack of conformity between the chosen work practice, and the existing procedures for securing the cranes, has not been identified by the shipping company's system for continuous improvement.

The Accident investigation Board feels that the failure to identify the non-conformity during reviews by the shipping company and the captain may be related to the fact that crane design has developed gradually over an extended period. New crew members are trained through receiving on-the-job instruction from more experienced crew. To some extent the failure to identify the non-conformity between procedures and work practice can also be explained by the fact that many of the shipping company's employees had many years' experience, in some cases dating back to the days of open cranes, and by the fact that the shipping company has not previously experienced any serious accidents in connection with the securing of cranes.

2.7 Supervision by the authorities

Documentation shows that, in connection with certification, the gantry cranes were tested under load in accordance with the Regulations relating to shipboard loading and offloading appliances. However, in the extensive crane documentation there is nothing to indicate that the cranes were assessed with respect to personal safety in connection with the certification. In the Accident Investigation Board's opinion, based on the current requirements, the supervisory activity/inspection of the crane arrangement cannot be expected to identify such unfortunate solutions as the design of the end stops for the trolley represent in this case. These are matters to be addressed by the users, that is to say the crew and the shipping company, through their HSE and other work on board. An amendment to the Regulations relating to shipboard loading and offloading appliances, to the effect that the manufacturer is required to incorporate operational safety in its crane design, could also help to prevent such unfortunate solutions.

Nor can the Accident Investigation Board see that supervision in the form of ISM audits should be able to identify and react to <u>all</u> matters relating to the practical implementation of work tasks on board. This form of system-oriented supervision is expected to assess whether instructions and work procedures have been prepared in all areas where this is necessary. Among other things, this supervisory activity is

based on a random selection of established procedures which are then compared with actual work practice.

The Accident Investigation Board regards it as natural and right that that the crew and the shipping company, through the captain's and management reviews, are best suited to ensuring that the procedures are appropriate and complied with, and will not recommend any changes in today's supervisory activities on the basis of the accident on board MV *Star Java*.

3. CONCLUSION

3.1 Design of trolley stop function (end stops)

The Accident Investigation Board`s opinion is that, for future cranes, alternative design solutions should be sought for the stop function (end stops).

3.2 Change in crane design within the grieg shipping fleet (from the 1980s until 2006)

In the Accident Investigation Board's opinion, the transfer of the manoeuvre position, combined with the fact that personnel are still present up on the crane during securing operations, has intensified the need for organisation, supervision and communication. This problem is addressed in the Accident Investigation Board's evaluation of the organisation of the work on board.

3.3 Organisation of the work on board

Based on the changes to the crane design and the fact that the chosen practice for carrying out the securing operation differed from the one specified in the crane manufacturer's operating procedure, the Accident Investigation Board cannot see that Grieg Shipping has identified and implemented necessary measures to deal with the increased safety problem. In the Accident Investigation Board's opinion, the shipping company should have conducted a risk assessment of the aforementioned conditions and, based on such a risk assessment, implemented the necessary measures to remove or reduce the risks. The Accident Investigation Board has not been able to find any procedures or work descriptions in the owner's safety management system that, based on the practical approach that the shipping company has elected to use, adequately clarify what organisation, supervision and lines of communication need to be in place in order to carry out securing operations in a safe manner.

3.4 Current rules and regulations

Provided that they are understood and complied with, the Accident Investigation Board regards the regulations relating to personal safety on board Norwegian ships, i.e. the ISM Regulations and the HSE Regulations, to be adequate enough to prevent accidents of the kind that occurred on board *Star Java* on 18 August 2008.

The Accident Investigation Board notes that there are no requirements for risk assessments relating to the operation of the crane to be conducted as early as in the

design phase. This may result in effective operational safety barriers not being incorporated into the crane design and hence personal safety will depend to great an extent on the organisational aspects of crane operations. The Accident Investigation Boards consider this as a safetyproblem and is of the opinion that the basis for secure operations should be dealt with already in the phase of design.

The Accident Investigation Board finds it strange that the requirements of the Regulations relating to shipboard loading and offloading appliances are different and more lenient in the case of cranes produced abroad than in the case of cranes produced in Norway.[15] However, the Accident Investigation Board cannot see that this has been of any consequence for the accident in question.

3.5 The shipping company's safety management system (SMS)

The shipping company's safety management system, in general, and its improvement system, in particular, was not able to identify the non-conformity between operating procedures and work practice for securing the crane. In the Accident Investigation Board's opinion, this has to do with the fact that crane design has been developed gradually and over an extended period. The failure to identify the non-conformity can be explained by the above, combined with the fact that the shipping company has many permanent crew members, some of whose lengthy experience includes serving in ships with open cranes, and the fact that the shipping company has not previously experienced any serious accidents in connection with the securing of cranes.

3.6 Supervision by the authorities

In the Accident Investigation Board's opinion, matters relating to personal safety on board should first and foremost be addressed by the users, that is to say by the crew and the shipping company, through their HSE and other work on board. The supervisory authority is responsible for auditing the ships' and the shipping companies' safety management systems. Among other things, such supervision is based on random selection of established procedures to check that they tally with work practice. The Accident Investigation Board understands that an audit will not

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[15] Comments received from the Norwegian Maritime Directorate in connection with the hearingprosess: "*Section 4(3)* of *Regulations no 4 of 17 January 1978 relating to loading and unloading appliances on ships.* Section 4 concerns '*Requirement for approved workshop and manufacturer';* moreover subsection 3 of the same section states: '*Foreign workshops and manufacturers: Abroad, the workshop is deemed to be an approved workshop, qualified workshop or authorised manufacturer of equipment if the ship's master or the shipping company finds that the workshop has the necessary test equipment and personnel with sufficient qualifications in the field.*'

As we see it, *section 4(3)* of the above-mentioned Regulations must be seen in conjunction with *section 1(4)* of the same Regulations.

The original intention must therefore be interpreted as being that the Norwegian Maritime Directorate accepts competent persons / workshops / manufacturers from countries that have regulations that are based in full on ILO Convention 152. *Section 4(3)* must therefore be interpreted to mean that the shipping company / ship's master shall ensure that the competent person / workshop / manufacturer (abroad) meets the requirements stipulated by ILO Convention 152 for such competent persons / workshops / manufacturers. This is not clear as the regulations are currently worded, and this should therefore be changed / specified in revised regulations!".

necessarily identify non-conformities between an established procedure and actual work practice.

3.7 Implemented measures

The shipping company uses the reporting and improvement system SAFIR as part of its safety management system. On the basis of the accident on board MV *Star Java* on 18 August 2008 and the accident report in SAFIR, the shipping company has conducted a risk assessment of the work of securing the gantry cranes and implemented improvement measures. On all the shipping company's ships, the areas where the end stops pass over walkways on the girders are marked as dangerous (see figure 8). On those of the shipping company's ships that have the newest generation of enclosed cranes, an audio alarm is being installed, which is activated when the jibs are swung. The shipping company has discussed the accident on *Star Java* as a separate topic during its annual 'Officers conference' which is attended by all the company's officers who are at home on leave.

Figure 8: Accident site after marking.

4. SAFETY RECOMMENDATIONS

The shipping company has already implemented several measures to prevent similar accidents in the future. In addition, the investigation into this marine accident has identified areas in which the Accident Investigation Board finds it necessary to make safety recommendations for the purpose of improving safety at sea.[16]

Safety recommendation Marine no. 2009/01T

The fact that the end stops move through the crane's protective walls without a sound, passing a walkway which may be occupied by personnel, is regarded as a safety problem. The AIBN recommends that the crane manufacturer seek alternative solutions for new cranes.

[16] The investigation report is submitted to the Ministry of Trade and Industry, which takes necessary measures to ensure that due consideration is given to the safety recommendations.

Safety recommendation Marine no. 2009/02T
Personnel safety has been reduced by the development towards increasingly enclosed cranes and centralisation and transfer of the manoeuvre panels, combined with the choice of operational solutions whereby personnel are present up on the crane during the securing operation. The AIBN recommends that the shipping company, on the basis of a risk assessment of the crane securing operation, reviews its procedures with particular focus on organisation, supervision and communication.

Safety recommendation Marine no. 2009/03T
The Regulations relating to shipboard loading and offloading appliances do not, already in the design phase, require risk assessments relating to the operation of the crane to be carried out. This may result in effective operational safety barriers not being incorporated into the crane design and hence personal safety will largely depend on the organisational aspects of crane operations. The AIBN recommends that the Norwegian Maritime Directorate review the above-mentioned regulations and consider whether they should include a functional safety requirement that would make it mandatory, already in the design phase, to conduct risk assessments relating to crane operation.

Accident Investigation Board Norway

Lillestrøm, 30. March 2009

Appendix A

RELEVANT ABBREVIATIONS

BHK	:	Brake horse power
DNV	:	Det Norske Veritas
DOC	:	Document of Compliance
HSE	:	Health, safety and the environment
IMO	:	International Maritime Organisation
ISM	:	International Safety Management
NHD	:	Ministry of Trade and Industry
NIS	:	Norwegian International Ship Register
MV	:	Motorvessel
PEC	:	Protection and Environment Committee
SAFIR	:	Safety Improvement Report
AIBN	:	Accident Investigation Board Norway
SMC	:	Safety Management Certificate
SMS	:	Safety Management System
SSQM-System	:	Safety, Security and Quality Management System
TSB	:	Transport Safety Board of Canada
UHF	:	Ultra High Frequency