



Accident Report

S Venus

Crane Failure at No. 10 Berth,
Tauranga on 17 August 2004



REPORT NO.: 04 3532

VESSEL NAME: *S VENUS*

Casualty Details:

Date of Casualty: 17 August 2004

Time of Casualty: 2257 hours New Zealand Standard Time (NZST)

Casualty Type: Crane Failure

Casualty Location: No. 10 Berth, Tauranga

Weather Forecast Area: Plenty

Investigator: Hei Cheung, MSI, Tauranga



REPORT NO.: 04 3532

VESSEL NAME: *S VENUS*

Vessel Details:

Ship Name:	<i>S Venus</i>
Built:	1983
Ship Category:	Bulk Carrier
Certified Operating Limit:	International
Overall Length (m):	189.73
Maximum Breadth:	27.60
Gross Tonnage:	22 221
Flag:	Panama
Ship Operator:	Pan Ocean Shipping Co. Ltd
Classification Society:	Korean Register of Shipping



SUMMARY

On 17 August 2004 at approximately 2255 hours New Zealand Standard Time (NZST), the jib of the No. 2 hydraulic crane on **S Venus** collapsed and fell onto the No. 2 after hatch cover, whilst the vessel was loading logs at Mt Maunganui, New Zealand.

Examination of the three No. 2 crane starboard heel jib pin retaining bolts, revealed they had been pre-fatigue cracked for approximately half their diameter before failure occurred. The three retaining bolts on the No. 2 crane port heel jib pin, showed that they too were pre-fatigue cracked and that two of the bolts appeared to have failed under tension.

The retaining bolts of the ship's other cranes were inspected by the Maritime Safety Authority. Some of these were found to be either broken or loose with signs of cracking.

Amongst other recommendations put forward by the Maritime Safety Authority, is a recommendation that the manufacturer's of ship's cranes conduct, as a matter of urgency, a full stress analysis on the retaining bolts of the jib heel pin to determine their adequacy. Subject to the results of that analysis to advise ship owners/operators on whether any remedial work that may need to be done to modify or upgrade the heel retaining bolts to meet operating stress requirements.



KEY EVENTS

- 1.1 On 16 August 2004, at approximately 1948 hours New Zealand Standard Time (NZST), **S Venus** arrived from Napier and berthed port side to Mt. Maunganui Wharf, No. 10 berth, to load logs.
- 1.2 At approximately 2254 hours, on 17 August, a crane driver, employed by International Stevedore Operations (ISO), was driving the ship's No. 2 hydraulic crane to load logs into No. 2 cargo hold. After lifting a sling of logs, weighing about 23 tonnes, from the wharf, he slewed the jib of the crane and logs over the ship's bulwark rail and the No. 2 hatch coaming, with the intention of placing the logs in the forward starboard corner of the hatch square.
- 1.3 The crane driver stated *"As soon as I came over the square (of the hatch), I lowered the sling (logs) to within 1 or 2 metres of the stow for safety, in case the logs fell. The digger driver (who was driving a digger to stow logs inside number No. 2 cargo hold) had told me to place it in the forward starboard corner. When the sling was over amidships, it stopped itself. I was in the middle of the slewing when it stopped. Then there was a single bang, followed by several bangs and the jib fell to starboard. The sound seemed to come from the back of the cab. I jumped up, I let go the levers and they went to neutral."*
- 1.4 The jib became detached from the heel pin bearings and, in consequence, the logs dropped and landed onto the cargo of logs already stowed in the forward starboard corner of No. 2 hatch square. The crane jib continued to slew to starboard until it struck the starboard bulwark rail and landed on No. 2 after hatch cover (See Appendix 3).
- 1.5 The crane driver left the crane driver's cab through the after door and went down to the deck. The digger driver, who was in No. 2 hold, was tracking out of the way of the swung logs and was heading for the after end of the hold on port side, when the jib of the crane fell down. When he realised what had happened, he immediately climbed out of the cargo hold. There was no injury to any of the stevedores or ship's crew.



Key Conditions

- 2.1 **S Venus**, IMO number 8323111, is a bulk carrier, registered in Panama, with a gross tonnage of 22 221 tonnes, a length overall of 189.73 metres and a maximum breadth of 27.60 metres. The vessel is classed with the Korean Register of Shipping (KRS) and is managed by Pan Ocean Shipping Co. Ltd. Seoul, Korea.
- 2.2 The vessel was built by Imabari Shipping Co. Marugame, Japan, in 1983. It is fitted with four Mitsubishi hydraulic deck cranes.
- 2.3 A Certificate of Test and examination of the ship's cranes, certified that the Safe Working Load (SWL) of each crane was 25 tonnes, at an allowable maximum radius of 22 metres. The proof load applied was 30 tonnes. The last proof load test was carried out on 25 April 2002 and the last annual survey was carried out on 23 June 2004 by a KRS surveyor in Korea.
- 2.4 The two jib arms of each deck crane, were connected to jib heel swivel bearings/housings, using four 36mm x 160mm nuts and bolts on each side. A thrust plate was used to retain the bush (installed inside the jib heel swivel bearing) onto a 230 mm diameter heel pin/shaft. It was held in place by three 20mm diameter and 45mm long retaining bolts. These were fitted on each side of the crane, at a point just above the crane's slewing table. The retaining bolts were prevented from working loose by a locking plate. The retaining bolts, the locking plate and the thrust plate were all located inside a steel cover that was bolted to the bearing housing, using six 12 mm x 30 mm long bolts.
- 2.5 At approximately 1530 hours on the day of the accident, one of the surveyors from Cargo & Marine Services told the local investigating Maritime Safety Inspector (MSI) from the Maritime Safety Authority (MSA), that **S Venus**, was loading logs at No. 10 berth. He asked the MSI whether he knew if anyone had inspected the vessel's Mitsubishi cranes.
- 2.6 After checking the Asia Pacific Computerized Inspection System (APCIS), the MSI advised the Surveyor that the vessel had undergone a Port State Control (PSC) inspection on 2 August 2004, in New Plymouth, New Zealand. He ascertained that the local MSI at New Plymouth had inspected the cranes visually whilst they were being used to work cargo. No deficiencies had been observed at that time.
- 2.7 The investigating MSI drew the attention of the Master of **S Venus** to a copy of the *Mitsubishi Heavy Industries (MHI), Ltd. Technical Information (No. D-42004) of Mitsubishi Deck Crane - Inspection of Jib Gooseneck* and an *MSA Memorandum to the Shipping Agents And Stevedores in Tauranga*, dated 21 February 1994. This was to ascertain whether any inspections had been conducted on the Mitsubishi cranes recently by the ship's crew.
- 2.8 The MSI found that the above documentation had already been given to the Chief Officer by the ship's Supercargo, following the vessel's arrival at Tauranga. The Chief Officer told the MSI the ship's staff had recently carried out an inspection of the heel jib retaining bolts of each crane. In support of this, he showed him the ship's planned maintenance record of the Mitsubishi cranes. This indicated that an inspection of the jib gooseneck of each crane had been carried out satisfactorily on 26 July 2004.
- 2.9 The Port Of Tauranga's security camera system recorded the operations and collapse of the ship's No. 2 crane. The sequence downloaded from the security camera system showed that the logs were lifted from the wharf at 2254 hours 00 seconds and the crane started to slew, toward the ship's side, at 2254 hours 20 seconds. The sling of logs was seen slewing above the middle of the cargo hold and the boom started to collapse and fall at 2254 hours 42 seconds. The crane jib came to a rest at 2254 hours 45 seconds.



- 2.10 The logs were lifted from a log cradle placed on the wharf. The centre of this cradle was situated approximately 3.5 metres from the ship's side shell plating. The breadth of the ship was about 27 metres. On this basis, the logs would have been moved a horizontal distance of approximately 17 metres (m) (3.5m+27/2m), from the centre of the log cradle to the middle of the hatch square, over a period of about 22 seconds (2254 20 to 2254 42). The total weight of the logs and spreader/slings was approximately 24 040 kg (23 140 kg +900 kg). The maximum allowable radius of the crane was 22 m and the crane driver stated that he intended to place the logs in the starboard forward corner of the hatch square. On this basis, it is calculated that the horizontal distance (d), between the centre of the load and the heel pin retaining bolts would have been approximately 20m. The exact angular acceleration and the radius of the log sling to the centre of the jib heel pin, at the time of the crane failure, could not be determined.
- 2.11 After the failure of No. 2 deck crane, the retaining bolts on the remaining three Mitsubishi cranes were inspected. The MSI found the following during his inspection:
- No. 1 crane – one retaining bolt on the starboard/right heel pin was broken.
- No. 3 crane – one retaining bolt on the starboard/right (3s) heel pin was loose.
- No. 4 crane – one retaining bolt on the port/left (4p) heel pin was loose
- 2.12 The six broken bolts from No.2 crane, the broken bolt from No.1 crane and the two loose bolts from Nos. 3 and 4 cranes were sent to Societe Generale de Surveillance (SGS) New Zealand Ltd, for failure analysis. The results of the tests conducted by SGS were as follows:
- No. 1 crane – the broken bolt (*bolt 1*) was found to be fatigue cracked for two thirds of its diameter, before failure occurred.
- No. 2 crane (starboard) – the three broken bolts on the starboard/right heel jib pin (*bolts 2(s) - a, b and c*) were found to have been pre-fatigue cracked for half their diameter, before failure.
- No. 2 crane (port) – the retaining bolts on the port/left side heel jib pin (*bolts 2 (p) - a, b and c*), and two unmarked broken studs, indicated that one bolt (*bolt a*), was pre-fatigue cracked slightly and that the two other bolts (*bolts b and c*), had failed at the time of the accident. Bolts b and c appeared to have failed under tension.
- No. 3 crane (starboard) - one loose bolt from the starboard/right side jib heel pin (3s), showed no sign of any defect under visual inspection. However, a non-destructive crack test performed on this bolt, revealed that it was fatigue cracked
- No. 4 crane (port) – one loose bolt from the port/left side jib heel pin (4p), showed no sign of any defect under visual inspection. However, a non –destructive crack test performed on this bolt revealed that it was fatigue cracked
- 2.13 Inspection of the No. 2 crane jib revealed that the port/left jib arm was bent to an angle of 60 degrees at a distance of about 1.5 metres from the heel pin bearing. The starboard/right jib arm was bent to an angle of approximately 40 degrees at the enforcement of the bottom cross member, about one third of the length of the jib from the heel pin bearing.
- 2.14 A close examination of No. 2 crane's heel pin bearing covers, revealed that the old paint/coating put on the covers' joints and bolts had not been disturbed or broken for some time. This was contrary to the evidence of the Chief Engineer and the entry in the ship's planned maintenance schedule/report, which gave the last inspection of the jib end goose neck as occurring on 26 July 2004, about 3 weeks before the accident.
- 2.15 Two previous accidents, involving Mitsubishi cranes, occurred at Tauranga. One was in the mid 1980's and the other in 1992. Another accident, involving a Mitsubishi crane, occurred on a vessel that was loading logs at Port Chalmers, in 2003. After the second crane accident in 1992, a "Memo to Shipping Agents and Stevedores in Tauranga" (Memo), dated 20 July 1992,



was issued to advise ship owners and masters to follow the six monthly inspections of heel pin retaining bolts as recommended by the *MHI Technical Information* booklet. Another similar memo, dated February 1994, was re-issued after the local MSA Surveyor/MSI found several ships at Tauranga, where Mitsubishi crane heel bolts had not been inspected properly by the ships' crew. Broken bolts were also found in at least one crane on every ship subsequently inspected by the Surveyors/MSI's at Tauranga.

- 2.16** In the late 1990's, during the course of a PSC inspection on a vessel at Tauranga, the investigating MSI found that the heel pin retaining bolts on one of the Mitsubishi 25 tonnes cranes had not been inspected by the ship's crew before loading of logs commenced. Further, there was no inspection report/record on the vessel to show when the heel pin retaining bolts had last been inspected. The Chief Officer initially refused to remove the heel pin bearing cover for inspection of the retaining bolts by the MSI, because the ship's Classification Society Surveyor had carried out a survey/examination on the cranes in Japan, utilising an ultrasonic machine, less than one month before. When the Chief Officer agreed to remove one of the crane's heel pin covers for inspection by the MSI, a broken bolt was found in the first heel pin. About 6 months later, when the vessel returned to Tauranga with the same Chief Officer on board, the MSI was shown that the three 20 mm diameter retaining bolts, fitted on each side of the crane's heel jib pin, had been replaced with six larger size bolts after the ship returned to Japan from the previous voyage to New Zealand.
- 2.17** On 31 August 2004, the investigating MSI inspected a 1992 built vessel and found that the jib heel pin of one of the 30 tonnes SWL Mitsubishi cranes, was fitted with six 30mm (*MSA emphasis*) diameter retaining bolts on each side (as opposed to the three 20mm (*MSA emphasis*) diameter retaining bolts that was fitted on each side of the 25 tonnes SWL No.2 Crane on **S Venus** – see paragraph 2.4 above) inside a steel cover. Another vessel, built in 2004, was inspected on 14 September 2004. On this occasion, the MSI found that the six heel pin retaining bolts did not have a steel cover and were exposed to the elements. No broken bolts were found on either of these two ships.



Contributing Factors

N.B. These are not listed in order of importance.

- 3.1** Mitsubishi cranes are fitted with a powerful hydraulic motor that enables the jib of the crane to be accelerated/retarded rapidly during the slewing of cargo. Further, the jib of the crane has been used to pull cargo wires/slings clear of cargo that has been loaded, thereby imparting increased stress forces on the retaining bolts of the jib's heel pins. On the basis of the number of broken/fatigue cracked bolts that have been found on Mitsubishi 25 tonnes SWL cranes by the investigating MSI, there is evidence to show that insufficient analysis and testing has been conducted to accurately assess the cyclic stresses that the crane's heel jib pin retaining bolts can be subjected to, particularly when a full load of cargo, at the jib's maximum radius of 22 metres, is undertaken. It is the opinion of the investigating MSI, that the number of broken/fatigue cracked bolts that were found on the 25 tonnes SWL Mitsubishi cranes on board **S Venus** raise serious doubts that the safety factor/design stresses of the three 20mm diameter retaining bolts, fitted on each heel pin swivel/bearing, were adequate to meet operational cyclic loading requirements.
- 3.2** The ship's crew and the Class Surveyor (KRS) either failed to inspect, as claimed, or failed to understand how to inspect correctly the heel pin retaining bolts as required/recommended by the *MHI Technical Information of Mitsubishi Deck Crane Inspection of Jib Gooseneck*, issued in March 1987 and updated on 30 September 1992. The ship's *Planned Maintenance Schedule & Machinery History Card*, documented that the cranes' jib end goose necks had been inspected on 26 July 2004. Further, the ship's Cargo Gear Register showed that all lifting appliances were thoroughly examined on 23 June 2004 by a KRS surveyor in Korea. Examination, however, of the condition of the paint coating on the jib heel pin bearing covers, that was conducted on 18 August 2004, revealed that the heel pin bearing covers had not been removed for inspection for some time, and possibly for over 6 months.



Cause

Human Factor

<input type="checkbox"/> Failure to comply with regulations	<input type="checkbox"/> Drugs & Alcohol	<input type="checkbox"/> Overloading
<input type="checkbox"/> Failure to obtain ships position or course	<input type="checkbox"/> Fatigue	<input type="checkbox"/> Physiological
<input type="checkbox"/> Improper watchkeeping or lookout	<input type="checkbox"/> Lack of knowledge	<input type="checkbox"/> Ship Handling
<input type="checkbox"/> Misconduct/Negligence	<input type="checkbox"/> Error of judgement	<input type="checkbox"/> Other . . .

Environmental Factor

<input type="checkbox"/> Adverse weather	<input type="checkbox"/> Debris	<input type="checkbox"/> Ice	<input type="checkbox"/> Navigation hazard
<input type="checkbox"/> Adverse current	<input type="checkbox"/> Submerged object	<input type="checkbox"/> Lightning	<input type="checkbox"/> Other . . .

Technical Factor

<input checked="" type="checkbox"/> Structural failure	<input type="checkbox"/> Wear & tear	<input type="checkbox"/> Steering failure
<input type="checkbox"/> Mechanical failure	<input type="checkbox"/> Improper welding	<input type="checkbox"/> Inadequate firefighting/lifesaving
<input type="checkbox"/> Electrical failure	<input checked="" type="checkbox"/> Inadequate maintenance	<input type="checkbox"/> Insufficient fuel
<input type="checkbox"/> Corrosion	<input type="checkbox"/> Inadequate stability	<input type="checkbox"/> Other . . .

- 4.1 It would appear that when No.2 crane stopped, the retarding force required to bring the slewing log cargo and crane jib to a stop, exceeded the residual strength of the starboard/right heel jib retaining bolts, which were already fatigue cracked. The remaining retaining bolt or bolts sheared and the starboard/right heel jib bearing detached from the pin/shaft. The momentum of the jib caused it to swing further to starboard until the port/left side of the jib bent and the port/left heel pin retaining bolts were broken under excessive tension. The boom then fell and landed on No. 2 after hatch cover and the starboard bulwark rail.



Opinions & Recommendations

- 5.1 Following the issue of the second MSA *Memo (Memo)* and the *MHI Technical Information (Information)* to shipping agents and stevedores in Tauranga, this documentation was disseminated to ships' masters by local MSI's, during their PSC inspections. Notwithstanding this action, they still found that many of the vessels, fitted with Mitsubishi cranes, were arriving at Tauranga with a number of broken heel bolts that had clearly not been inspected by the ships' crew.

Frequently, after a change of ownership or crew, the *Information/Memo* was not passed onto the new owners/crew. In many instances, the MSI's had to draw the attention of the ships' crew to the presence of a broken heel pin bolt before the crew were convinced that there was a problem with the 25 tonnes SWL Mitsubishi cranes.

MSI's also found ship's crew who mistakenly had inspected the jib heel gooseneck bearing cover bolts instead of the heel pin retaining bolts. On **S Venus**, the Chief Officer had been given the *Memo* and *Information* by the ship's Supercargo, and been advised by the local MSI of previous crane accidents in Tauranga and the problems with heel pin bolts. Nevertheless, this accident still occurred. The measure taken by MHI, to increase the size and numbers of bolts fitted in the jib heel pin on their 30 tonnes SWL cranes, may be the answer to the problem on the 25 tonnes SWL cranes.

In commenting on the draft report the Manager, Power Systems Business Group, Machinery Business Department, MHI, informed MSA "*We have applied improvement on the retaining bolts of the Jib's heel pins of our 25 t SWL cranes delivered since 1993 as well as the improvement of that was done on 30 t SWL cranes after the incidents in Tauranga in 1992*".

The attached drawing No.DSB110481 clearly shows that the new model 25 tonnes cranes which were delivered from 1993, are fitted with six 30 mm diameter retaining bolts instead of three 20 mm diameter bolts found in the older model).

- 5.2 It is recommended that Mitsubishi Heavy Industries (MHI), promulgates advice to the owners/operators of all ship's currently installed with 25 tonnes SWL cranes, delivered before 1993, and still fitted with three 20 mm diameter retaining bolts, of the need to implement, as soon as practicable, the appropriate steps required to modify and up-grade the heel pin retaining bolts to meet the revised/new specifications as shown in drawing No. DSB110481 25t Hydraulic Deck Crane Assembly of Gooseneck For Jib.
- 5.3 The *MHI Technical Information Of Mitsubishi Deck Crane Inspection* recommended that the end plate fitting/retaining bolts for the jib heel pin bearings should be inspected once every six months or that a more frequent inspection than every 6 months should be made, taking into consideration the maintenance of cranes manufactured before 1988. The *Planned Maintenance Schedule* on board **S Venus**, merely stipulated an inspection interval of one year for these items. This was in breach of the requirements of the *International Safety Management (ISM) Code, i.e. ISM Code (10) Maintenance Of The Ship And Equipment*.

It is therefore recommended that a copy of this report be sent to the management of **S Venus**, drawing their attention to following matters:

- The Company to establish documented procedures to ensure that the ship's cranes are maintained in full conformity with manufacturer's instructions and any additional requirements that may be imposed by the manufacturer as a result of stress analysis tests conducted by them.
- The Company to establish documented procedures in its Safety Management System (SMS) to ensure that the inspection or maintenance of ship's equipment be carried out properly before it is documented as a completed item in the maintenance log/record.



5.4 A Thorough Examination of Lifting Appliances in the ship's Cargo Gear Register, was endorsed by the KRS surveyor in Korea on 23 June 2004. However, there was evidence to indicate that the steel covers on the jib heel pin bearing had not been removed for inspection for some time, and possibly much longer than the period of two months that elapsed between the date of the Thorough Examination and the date of this accident. It would appear that Class/KRS surveyors were not aware of the existence of the *MHI Technical Information* and the apparent design problems of MHI 25 tonnes SWL hydraulic cranes' heel pin retaining bolts.

It is recommended therefore that a copy of this report be sent to The International Association of Classification Societies (IACS) for their Member Societies' general information, to include the following matters:

- IACS to draw the attention of their Member Societies' Surveyors to the *MHI Technical Information* before conducting any inspection/examination of MHI 25 tonnes SWL hydraulic cranes that were delivered before 1993.
- IACS Member Societies should encourage their clients, whose ships are installed with MHI 25 tonnes SWL hydraulic cranes, delivered before 1993 and still fitted with three 20 mm diameter retaining bolts to arrange to have their cranes' jib heel pin retaining bolts modified and up-graded to meet revised requirements/specifications as shown in drawing No. DSB110481, 25t Hydraulic Deck Crane Assemble Of Gooseneck For Jib, as soon as practicable.

5.5 It is recommended that the Maritime Operations Division of the Maritime Safety Authority (MSA) forward a copy of this report to the MSA district offices in New Zealand, so that when MSI's are carrying out PSC inspections, they will be reminded of the need to ascertain that the required inspections of Mitsubishi cranes, as specified in the *MHI Technical Information*, are being carried out and recorded in a format similar to that shown in the *Technical Information's "Check List Of Thrust Stopper-Bolts."* The investigating MSI in this accident, has noticed that when heel pin inspections are recorded in a format, similar to that specified in the *MHI Technical Information's "Check List Of Thrust Stopper-Bolts"*, it is more likely that ship's crew have carried out the inspections properly. If, however, the inspections have only been entered into the deck log book or other maintenance record, he has considered it prudent to check carefully that the jib heel pin covers have in fact been removed for inspection recently and in the event of any doubt to carry out another inspection himself.

5.6 It is recommended that a copy of this report be sent to all the stevedoring companies in New Zealand ports with a recommendation that before working cargo they obtain verification from the vessel that the jib heel pin retaining bolts on any Mitsubishi cranes have been inspected by the ship's crew, as specified in the *MHI Technical Information*.

