Accident Report

Perla Tank Failure

Port Taranaki on 2 March 2004

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Maritime Safety

MARITIME SAFETY AUTHORITY OF NEW ZEALAND

Kia Maanu Kia Ora

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REPORT NO. 04 3523

VESSEL NAME: PERLA

CASUALTY DETAILS:

Date of Casualty:	2 March 2004
Time of Casualty:	0845 hours New Zealand Daylight Time
Casualty Type:	Tank Failure
Casualty Location:	Port Taranaki, New Plymouth
Weather Forecast Area:	Raglan
Date MSA Notified:	2 March 2004
Date Investigation Started:	2 March 2004
Date Investigation Completed:	21 July 2004
Investigator:	David Coker

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REPORT NO. 04 3523

VESSEL NAME: PERLA

VESSEL DETAILS:

Ship Name:	**Perla**
Date of Build:	1994
Ship Category:	Oil/Molasses/Chemical Tanker
Certified Operating Limit:	International
Overall Length (m):	125
Maximum Breadth (m):	18.8
Gross Tonnage:	5 965
Net Tonnage (t):	3 254
Flag:	Singapore
Registered Owner:	Shenlong Maritime Pte Ltd
Ship Charterer:	Stolt-Nielsen Transportation Group Pty Ltd
Management Company:	Maruta Industries Co Ltd
Classification Society:	Nippon Kaiji Kyokai (NKK)

1. KEY EVENTS

1.1 At 1448 hours New Zealand Standard Time (NZST) on the 23 of February 2004, the chemical tanker ***Perla*** arrived at Port Taranki and berthed at the Newton King Tanker.

1.2 The vessel had arrived from Bluff in ballast and was to load a full cargo of chemical grade methanol for Chiba, Japan.

1.3 Between 1515 and 1615 hours, cargo surveyors from SGS (Societe Generale de Surveillance), performed wall wash tests on all the vessel's cargo tanks prior to loading.

1.4 At 1945 hours, the results from the wall wash tests were received by the vessel. Cargo tanks No. 4 port and No. 5 centre had failed the tests.

1.5 Between 2000 and 2100 hours, No. 4 port and No. 5 centre cargo tanks underwent further cleaning by the ship's crew.

1.6 Between 2100 and 0030 hours on 24 February, No. 4 port and No. 5 centre tanks were gas freed. The cargo tanks were then re-tested by SGS cargo surveyors.

1.7 At 0035 hours, No. 4 port cargo tank was passed.

1.8 At 0145 hours, No. 5 centre cargo tank was passed.

1.9 At 0225 hours, the methanol loading arm was connected to the No. 6 centre cargo tank manifold on the vessel. The No. 6 centre cargo tank manifold was cross-connected to all the vessel's cargo tank drop lines.

1.10 Between 0235 and 0550 hours, first foots (305mm dip) of methanol were loaded in all cargo tanks and methanol samples were taken for testing by SGS Cargo Surveyors.

1.11 At 0800 hours, the test results from the samples showed that methanol in ten of the cargo tanks had failed. The failed cargo tanks were Nos. 3 port, 4 starboard, 5 port, 5 centre, 6 port and starboard wings, 7 port and starboard wings and 8 port and starboard wings.

1.12 Between 0800 and 0815 hours, the failed tanks were re-sampled by SGS cargo surveyors. The methanol in No. 5 centre cargo tank was found to be within the required specifications. The other tanks returned failed results.

1.13 At 1300 hours, SGS cargo surveyors took a sample from the vessel's cargo line for testing.

1.14 At 1620 hours, the methanol loading arm was disconnected from the vessel.

1.15 Between 1640 and 1810 hours, the methanol in the cargo tanks that was not up to specification was transferred to No. 8 port cargo tank.

1.16 Between 1810 and 2005 hours, the vessel's cargo line was blown through.

1.17 Between 2130 and 2150 hours, a sample was taken by SGS cargo surveyors from the vessel's cargo line for testing.

1.18 At approximately 2300 hours, the vessel was made ready for sea.

1.19 At 2330 hours, the Pilot boarded and the vessel departed for the anchorage.

1.20 At 0036 hours on 25 February, the vessel anchored off New Plymouth. The vessel's crew then undertook cleaning of the contaminated cargo tanks and gas freeing.

1.21 At 0718 hours, tank cleaning had been completed. The anchor was weighed and the vessel proceeded back to the port.

1.22 At 0730 hours, the Pilot boarded for berthing the vessel.

1.23 Between 0806 and 0830 hours, the vessel was berthed at the Newton King Tanker Terminal.

1.24 Between 0845 and 0910 hours, SGS cargo surveyors sampled the tanks that had previously been passed.

1.25 At 0915 hours, the methanol loading arm was re-connected to the No. 6 centre tank manifold.

1.26 At 0940 hours, the vessel's cargo lines were filled and SGS cargo surveyors sampled No. 8 starboard and No.6 centre cargo tanks.

1.27 At 1100 hours, the No. 8 starboard cargo line sample was failed.

1.28 At 1130 hours, the No. 6 port cargo line was passed.

1.29 At 1200 hours, SGS cargo surveyors re-sampled the tanks that had previously been passed.

1.30 At 1340 hours, the results of the samples showed that all cargo tanks with first foots of methanol had failed.

1.31 At 1515 hours, the methanol loading arm was disconnected from the vessel.

1.32 Between 1600 and 1700 hours, the methanol from cargo tanks Nos. 1 port, 1 starboard, 2 port and 5 starboard was transferred to Nos. 6 starboard, 7 port, 7 starboard and 8 starboard tanks.

1.33 Between 1710 and 1720 hours, SGS cargo surveyors took samples from cargo tanks Nos. 6 starboard, 7 port and starboard wings and 8 starboard.

1.34 Between 1730 and 1945 hours, contaminated methanol from cargo tanks Nos. 2 centre, 2 starboard, 3 centre, 3 starboard, 4 port, 5 centre 6 centre 6 starboard 7 port was transferred to Nos. 8 port and 8 starboard.

1.35 Between 0001 and 1800 hours on the 26 February, the vessel waited for the arrival of tank cleaning chemicals and further instructions.

1.36 At 1800 hours, the vessel was made ready for sea and the Pilot boarded for departure.

1.37 At 1815 hours, the vessel left for the anchorage.

1.38 On the 27, 28 and 29 February, the vessel remained at the anchorage, conducting further tank cleaning of the cargo tanks.

1.39 At 0536 hours on the 1 March, tank cleaning was completed. The anchor was weighed and the vessel returned to the port.

1.40 At 0554 hours, the Pilot boarded the vessel for berthing.

1.41 Between 0630 and 0700 hours, the vessel berthed at the Newton King Tanker Terminal.

1.42 At 0715 hours, the Third Officer completed the vessel's deck checklist #1. This was signed off by the Master.

1.43 Between 1400 and 1405 hours, SGS cargo surveyors performed wall wash tests on cargo tanks Nos. 5 starboard and 7 port.

1.44 At 1600 hours, the test result showed cargo tanks Nos. 5 starboard and 7 port had passed.

1.45 Between 1610 and 1815 hours, the atmosphere was checked in the remaining cargo tanks to be loaded.

1.46 Between 1820 and 1915 hours, SGS cargo surveyors performed wall wash tests on all the remaining cargo tanks to be loaded.

1.47 At 2000 hours, the vessel's deck checklist #2, for the cargo operations plan, was completed and signed off by the Master and all deck officers.

1.48 Between 2110 and 2125 hours, the ship/shore safety checklist and loading plan was completed and agreed by the Chief Officer, the Terminal Representative and the Cargo Representative.

1.49 At 2050 hours, the results from the wall wash tests showed that all cargo tanks to be loaded had passed.

1.50 At 2150 hours, the methanol loading arm was connected to the No.6 centre tank manifold.

1.51 Between 2205 and 0135 hours of 2 March, the vessel loaded first foots of methanol into the cargo tanks.

1.52 At 0300 hours, SGS cargo surveyors tested the first foots of methanol from the cargo tanks, with the result that all cargo tanks had passed.

1.53 At 0305 hours, the vessel commenced bulk loading in cargo tanks Nos. 2 centre, 3 centre, 5 centre and 6 centre. The cargo was loaded through a single loading arm to the vessel's manifold at a pressure of approximately 2.5 bar.

1.54 Between 0600 and 0700 hours, the centre cargo tanks were shut off when they reached approximately 40% of the tanks capacity. Loading of Nos. 2 port, 2 starboard, 7 port and 7 starboard commenced.

1.55 At approximately 0800 hours, the Third Officer checked that the P/V (pressure/vacuum) valves were working properly and the pressure in the loading tanks were normal. This was reported to the Chief Officer.

1.56 At 0810 hours, Sealab Operators set up equipment on the wharf to bunker ***Perla***.

1.57 At 0843 hours, Sealab Operators started the bunker transfer.

1.58 At 0845 hours, a strong blast was heard and a strong vibration was felt throughout the vessel when the main deck ruptured, in way of No. 2 port cargo tank. An area of the deck plating, measuring 800mm by 500 mm, was pulled into the tank. A release of vapour was seen coming from the vicinity of the tank by the ship's staff on deck and the shore personnel on the wharf. The release of vapour lasted for approximately 30 seconds. Particles of paint and rust from the ruptured tank came down onto the ship and wharf. Cargo loading was stopped by the emergency shut down, operated by the shore loading operator from his control position. Sealab Operators stopped the bunker transfer

1.59 At 0845 hours, the Newton King Tanker Terminal Manager was designated as the Person in Charge of the accident.

1.60 Non-essential personnel were taken off the terminal and ship. The Fire Service was informed and asked to stand by. The Maritime Safety Authority (MSA) and the vessel's class society, Nippon Kaiji Koykai (NKK), were informed of the situation. The area around the ruptured deck was cordoned off and access was restricted. The Newton King Tanker Terminal was closed to all other shipping and activities.

1.61 At 0945 hours, the methanol loading arm was disconnected.

1.62 During the morning and afternoon, the various parties with interest in the vessel assessed the situation and a meeting was scheduled for 1700 hours.

1.63 At 1700 hours, a meeting was held in the Westgate boardroom. Representatives from the following organisations attended:

- Class Society Surveyor - Nippon Kaiji Koykai (NKK)
- Maritime Safety Inspector - Maritime Safety Authority (MSA)
- Master - ***Perla***
- Cargo Surveyor SGS - Methanex
- P&I Club for Owners - Japan Mutual P&I Association
- Phoenix Shipping Agents - Charterers Agent
- P&I Club - Charterers
- Marine Services Manager - Westgate, Port Taranaki
- Chief Fire Officer - New Plymouth
- NKTT Manager - Westgate, Port Taranaki
- Operations Manager - Westgate, Port Taranaki
- Operations Manager - Methanex, NZ

1.64 The Westgate Operations Manager opened the meeting. Introductions were made by each of the attendees. The MSA confirmed that preliminary investigations into the incident had begun. The NKK class society surveyor stated his brief was to get the ship operating again in a safe condition. He recommended that the cargo from Nos. 2 port 2 centre and 2 starboard cargo tanks be transferred to other tanks. The contents of No. 2 port double bottom tank could be discharged to sea once the vessel left port. The next step was to effect a temporary repair to the deck by constructing a cement box. The Master and the NKK class society surveyor had been in touch with the ship's owners, who suggested the vessel could discharge the cargo at a suitable port in the South Island of New Zealand, if that option was available. The Operations Manager of Methanex commented that a discharge of all the cargo on board (approximately 3 000 tonnes, including off- specification cargo in Nos. 8 port and starboard tanks) would take at least two weeks, if carried out by road tanker at New Plymouth. Methanex was willing to assist by supplying reception facility for the off- specification cargo, if requested by the owners. The NKK class society surveyor mentioned that the vessel's next docking was due on 22/6/04. The vessel would need to be completely gas free for permanent repairs to be effected in a New Zealand port.

1.65 The Westgate Operations Manager announced that the Newton King Tanker terminal was closed for all other shipping until further notice. All stand-by arrangements, such as marine services, fire services, tanker terminal staff, etc., were to stay in place until temporary repairs were completed. SGS was to check the quality of the methanol in Nos. 2 port, 2 centre, 2 starboard, 8 port and 8 starboard cargo tanks, to help decide cargo transfer procedure. The use of the fresh water line along the wharf was to be perused for the methanol transfer, subject to a hydro test on the line. This would avoid trucks having to go onto the wharf. A safety zone, outside the Newton King Tanker Terminal, was put in place for truck transfer operations. Phoenix Shipping Agents indicated that the ship's Owners would need to appoint owners agents, as there would be a conflict of interest.

1.66 At 0830 hours on 3 March, it was decided to transfer the methanol from No. 2 port to No. 6 port cargo tanks, so temporary repairs to the deck could be undertaken.

1.67 At 1000 hours, the transfer started. During the transfer, the methanol in the adjacent No. 2 centre cargo tank was found to be going down

1.68 At 1400 hours, the transfer of methanol from Nos. 2 port and 2 centre cargo tanks was completed.

1.69 At 1400 hours, the work started on temporary repairs to the ruptured plating on the main deck.

1.70 At 1430 hours, a meeting was held in the Westgate boardroom. Changes to personnel attending from the previous meeting were Cape Shipping Agents, representing the Owner and the Logistics Supervisor for Methanex NZ. Apologies were received from SGS and from the NKK class society surveyor. The Westgate Operations Manager opened the meeting. The NKTT Manager gave an update on the situation. 'At 0830 hours this morning, it was decided to commence transfer of cargo from No. 2 port, so as to facilitate temporary deck repairs. During the cargo transfer from No. 2 port to No. 6 port, the vessel's crew noticed the cargo level dropping in the No. 2 centre cargo tank. Both these tanks were expected to be almost empty by about 1500 hours. Repairs were postponed last night due to a lack of resources, insufficient light and adverse weather conditions. Temporary repairs to the deck, by constructing a cement box, are in progress and expected to be completed late tonight'. The Westgate Operations Manager advised that the Newton King Tanker Terminal was likely to be open again for shipping at about 0800 hours the next day, subject to inspection of the repairs by MSA. The Maritime Safety Inspector said that the possibility of overflowing the methanol from No. 2 port double bottom tank onto the main deck was ruled out. This action would cause the cargo tanks Nos.2 port and 2 centre to fill up first. The Methanex Operations Manager commented that Methanex could assist by receiving contaminated product. He stated that 'there could be issues with compatibility of fittings at the receiving tank end' and stressed that this should be sorted out beforehand. 'The suitability of a pipeline to transfer the product was also to be confirmed'. Pheoenix Shipping, the Charterers Agents, asked if the possibility of a discharge in the South Island still existed. The Methanex Operation Manager advised that there was a facility to receive up to 2 000 tonnes only. SGS was re-checking the quality of the cargo in Nos. 6 port and 4 starboard (transferred from Nos. 2 port and 2 centre cargo tanks). The Master said that he had not received any instructions in regard to the discharge of any cargo.

1.71 At 0100 hours on 4 March, temporary repairs, comprising a cement box, were completed to the ruptured plating on the main deck.

1.72 At 0700 hours, the MSA Maritime Safety Inspector inspected the temporary repair to the deck, which was found to be satisfactory.

1.73 At 0800 hours, logistical planning of the discharge operation of the contaminated methanol to Methanex shore facility commenced.

1.74 At 1545 hours, the planning was completed. A temporary pipeline was to be constructed. It would run from the vessel along the wharf to a point outside the tanker terminal, where road tankers would load and transport the contaminated methanol to the reception facility at the Methanex site.

1.75 At 1545 hours, work started on a temporary pipeline to run from the vessel to an area outside the Newton King Tanker Terminal.

1.76 At 1915 hours, the temporary pipeline was installed.

1.77 At 0315 hours on 5 March, preparation and pressure testing of the temporary pipeline commenced.

1.78 At 0450 hours, pressure testing of the pipeline was completed.

1.79 Between 1330 and 1400 hours, a discharge hose was connected from the vessel to the temporary pipeline.

1.80 Between 1500 and 1520 hours, a tanker loading hose was connected to the outlet end of the temporary pipeline.

1.81 At 1540 hours, the first discharge into a road tanker commenced.

1.82 Between 1540 hours on 5 March, and 1110 hours on 9 March, road tankers continued to load the contaminated methanol and discharge it to the reception facility at the Methanex site. A total of 51 discharges to road tankers from the vessel occurred during this time, operating 24 hours a day.

1.83 Daily meetings to update the situation to the interested parties continued. During these meetings, the condition of the damaged tanks and the atmosphere within them was evaluated. It was decided that Nos. 2 port and 2 centre cargo tanks would be purged with nitrogen to reduce the oxygen content of the tanks to below the explosive limit; it was suspected that Nos. 2 port and centre cargo tanks were common. This would also provide an inert blanket to the methanol in No. 2 double bottom tank. On 6 March, Nelson was fixed as the discharge port for the remaining cargo of methanol. The MSA issued a Notice of Conditions for the voyage to Nelson.

1.84 At 1250 hours on 9 March, BOC Ltd set up a nitrogen system for purging the vessel's tanks. The temporary discharge pipeline was to be used to deliver the nitrogen to the vessel. The check valve in the line was removed. A cryopurge (vaporiser) was sited outside the Newton King Tanker Terminal and connected to the pipeline. The liquid nitrogen was supplied by road tanker, which was connected to the vaporiser.

1.85 At 1530 hours, the road tanker started pumping the liquid nitrogen through the vaporiser, up the wharf, to the lines on the vessel connected to Nos. 2 port and 2 centre cargo tanks. The nitrogen was pumped at a temperature of 1 degree or above freezing point. The vapour lines from Nos. 2 port and 2 centre cargo lines were opened at the P/V valve platform and connected to the No. 4 starboard manifold and opened to Nos. 4 starboard, 8 starboard, 8 port and 6 port drop lines, to collect the vapour which vented in the normal way through the P/V valve system. The pressure was checked

continually at the P/V valve line together with the oxygen content. Pressure was kept at 0.05 bar. At 2035 hours, approximately 3 to 5 volume changes had been achieved with a final result of an oxygen reading of under 3% in the damaged tanks.

1.86 Between 2030 and 2315 hours, the vessel made preparations for sailing.

1.87 Between 2315 and 2330 hours, ***Perla*** departed Port Taranaki.

1.88 During the voyage to Nelson, the vessel tank cleaned Nos.2 port, 2 centre and 2 double bottom tanks. The tank washings were discharged in accordance with **Maritime Rules Part 140.8**, for a Category D product.

1.89 At 1605 hours on 10 March, ***Perla*** arrived at Port of Nelson to discharge the remaining cargo of approximately 2000 tonnes of methanol. The MSA Maritime Safety Inspector at Nelson and the NKK class society surveyor boarded the vessel and an inspection of the damaged cargo tanks was carried out. The longitudinal corrugated bulkhead, between Nos. 2 port and 2 centre cargo tanks, was found to be fractured at the lower and upper filleted welds, at a point located approximately between frames 126.5 and 133.5. The bulkhead was displaced and distorted to starboard by approximately 1500mm from its centre line and set-over to a maximum of approximately 2500mm at mid point. A section of the No. 2 port cargo tank main deck plating, located approximately between frames 129 and 131, was seen to be ruptured, but still partly attached to the displaced bulkhead. The longitudinal corrugated bulkhead located at the tank bottom, had torn holes on the tank top between frames 127 to 128 and 133 to 134, where the bulkhead had been displaced into No. 2 centre tank and the weld to the tank top had not failed. These openings measured approximately 300mm by 100mm and 100mm by 100mm, respectively. The tank bottom plating was found to be distorted in way of the bulkhead fracture, located approximately between frames 126 to 134. The affected area measured approximately 4000mm by 2000mm and was either set up, or down, by approximately 20mm. The No. 2 port heating coil pipes, attached to the longitudinal bulkhead, was set over and distorted as per the bulkhead. The No. 2 port double bottom tank could not be entered due to pockets of gas remaining in the tank. Due to the extent of the damage to the vessel, the repair facilities in Nelson were unable to carry out permanent repairs. The vessel was permitted a further single voyage in ballast to Auckland by the NKK class society, where temporary repairs were proposed. The MSA reissued conditions for the voyage to Auckland.

1.90 At 0720 hours on 11 March, ***Perla*** left Port Nelson for Auckland.

1.91 At 1040 hours on 13 March, ***Perla*** arrived at Auckland and berthed at Queens Wharf. The Owners instructions were that temporary repairs would be carried out in Auckland, with permanent repairs carried out in Australia.

1.92 On 14 March, MSA Inspectors inspected the damage to the vessel. SGS New Zealand Ltd, NDT and Material Testing were commissioned to conduct detailed examination of the welds and material in the damaged area.

1.93 On 15 March, the MSA issued a Notice of Conditions for the voyage to Brisbane, Australia.

1.94 At 1635 hours on 16 March, temporary repairs had been carried out to the satisfaction of the NKK class society surveyor. The MSA issued a Notice of Withdrawal of Condition. ***Perla*** departed Auckland for Australia. During the voyage to Australia, the Auckland Company of Aimecs tendered its quote and secured the contract for the permanent repair work to the vessel. The vessel returned to Auckland.

1.95 At 0715 hours on 21 March, ***Perla*** berthed at Queens Wharf to carry out permanent repairs.

1.96 On 10 April, permanent repairs were completed.

1.97 At 1200 hours on 11 April, a series of hydro tests were carried out on the cargo tanks. This was completed satisfactorily and a final inspection by the NKK class society surveyor was carried out.

1.98 At 0040 hours on 15 April, ***Perla*** sailed from Auckland for overseas.

2. KEY CONDITIONS

2.1 Details of the vessel, Ownership and Classification

2.1.1 ***Perla*** was launched on April 25 1994, by Asakawa Zosen K.K. at Imabari, Japan as ***Panan Perla.*** She was registered under the Bahamian flag, through the nominal ownership of Geisel Compania Martima S.A. In 1997, the vessel's registry was transferred to the Singaporean flag, under the nominal ownership of Hailong Maritime Pte. Ltd. In 1998, the vessel was transferred to the nominal ownership of Shenlong Maritime Pte. Ltd. ***Perla*** was built as an oil/molasses/chemical tanker with 20 stainless steel (316L) cargo tanks situated forward of the after accommodation block and engine room. Each tank had its own loading drop line and in-tank pumping system for discharging. The vessel at the time of this accident was time chartered by Stolt-Nielson Transportation Group Pty Ltd, and managed by Maruta Industries, Japan. She is classed with NKK, and has a gross tonnage of 5 965 and a deadweight capacity of 10 331 tonnes. Propulsion is by a 6 cylinder 4387 kW Hitachi built Man-B&W engine.

2.1.2 The material used in the fabrication of the failed cargo tank bulkhead was stainless steel 316L. This is a low carbon austenitic chromium-nickel-molybdenum stainless steel with general corrosion resistance, but which has superior resistance to inter-granular corrosion following welding or stress relieving. It is used in corrosive environments for components that are fabricated by welding and cannot be subsequently annealed.

2.1.3 All SOLAS certificates, exemptions and other relevant International Certificates were found to be valid; this included an International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk. There were no restrictions on the carriage of chemical cargos with high specific densities. The Certificate was issued on 11 July 2002 with an expiry date on 22 June 2004. The last endorsement on the Certificate by an NKK surveyor, was at Brisbane on 28 June 2003.

2.1.4 The Port State Control Asia-Pacific Computerized Information System (APCIS), gave ***Perla*** a high risk factor of 43, due to the number of deficiencies and detentions in the last 4 initial inspections. Port State Control inspections of the vessel were carried out every 3 months.

2.2 Crew Details

2.2.1 The crew complement of ***Perla*** was 20, consisting of Master, Chief Officer, Second Officer, Third Officer, Chief Engineer, First Engineer, Second Engineer, Third Engineer, Pumpman, 2 AB's, 2 Ordinary Seaman, 2 Fitters, 2 Motorman, Wiper, Chief Cook and Mess boy. The nationality of the crew was 12 Croatian and 8 from Myanmar.

2.2.2 All Officers and crew held appropriate national Certificates of Competency for their rank, and Singaporean Certificates in accordance with STCW 95 Regulation 1/10.

2.2.3 The record of the hours of rest for the Deck Officers, during February 2004, showed an average of 10 to 14 hours work per day. The Master, Chief Officer and Second Officer joined the vessel in Singapore on the 2 November 2003. The Third Officer joined the vessel on the 22 January 2004, at Pohang.

2.3 Cargo Loading and Tank P/V Valves

2.3.1 At 0300 hours on 2 March, all tanks passed the SGS pre-loading inspection. Bulk loading of the cargo commenced at 0305 hours. Cargo tanks Nos. 2 centre, 3 centre, 5 centre and 6 centre were opened for cargo. The loading rate was approximately 350 tonnes per hour, with a pressure at the vessel's manifold of 2.5 kg/cm2. The loading arm was connected to the manifold of No.6 centre cargo tank and distributed through the manifold connections to the various drop lines of each cargo tank. Drop lines in the wing tanks measured 100mm in diameter and 150mm in the centre tanks. Between 0600 and 0700 hours, the centre tanks were part filled to approximately 40% capacity and shut off. Cargo tanks Nos. 2 port, 2 starboard, 7 port and 7 starboard were opened for cargo. As the cargo in Nos.2 port and starboard tanks was approaching 80% of the tanks' capacity, the Chief Officer calculated ullages for a ship stop in these tanks. He told the Third Officer that Nos.1 port and starboard cargo tanks were the next tanks to be loaded. It was at this point that the divisional bulkhead, located between Nos. 2 port and 2 centre cargo tanks, failed.

2.3.2 Ullages of the cargo tanks were being taken every hour. At approximately 0630 hours, loading of the wing tanks was commenced. Nos. 2 port and starboard and No. 7 port tank were loading at the same rate. No. 7 starboard was loading at a reduced rate. From the start of bulk loading cargo until the time of the accident the loading rate was averaging 365 tonnes per hour.

2.3.3 The Third Officer was using a portable pressure gauge to check the tank pressures at regular intervals, the last check was at 0800 hours and he informed the Chief Officer that the pressures were normal and that the P/V valves were operating normally.

2.3.4 Shear force and bending moments were within the limits for the vessel at the time of the accident. The other operation being conducted at the time of the accident, was the discharge of ballast water from the double bottom tanks; No.2 port double bottom ballast tank had just been emptied. Fuel oil bunkers from ashore had also just started to be transferred to the vessel.

2.3.5 The vessel was to load 8 930.7 tonnes *(ship figures)* of chemical grade methanol in the ship's twenty cargo tanks, for discharge at Chiba, Japan.

2.3.6 The Newton King Tanker Terminal has a closed cargo tank loading policy for tankers loading at the terminal.

2.3.7 The cargo tanks were vented through 80mm Niikura Hi-Vent, high velocity venting valve (pressure valve), made by Niikura Kogyo Co. Ltd, Japan. The valves were last tested by Gestnave Servicos Industriais on 17 November 2001, and lifted within the range of 192 to 182 kg/cm2. The valves were visually inspected and manually operated by the Chief Officer between 6 and 11 February 2004. Maruta Industries Co. Ltd had a planned maintenance schedule for the P/V valves that required a visual inspection to be carried out every 3 months, to check for the presence of rust, dirt and any other impurity that could possibly affect the correct functioning of the valve. An on site functional test was also conducted, using the proper lever. Verification was carried out every six months to ensure that the flame screens were in good condition. After this accident, the P/V valve on No.2 port cargo tank was inspected by the ship's staff, the NKK class society surveyor and MSA representatives, and found to be operating normally. The vent line was opened up and found to be clean, with no evidence of any viscous substance derived from cargo vapours.

2.3.8 The requirement of Chapter 8 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code), states that a high velocity venting valve vertical efflux velocity at the outlet, should be at least 20 m/s when protected by a suitable device to prevent the passage of flame. This required that a pressure built up in the tank before the valve operated.

2.3.9 The IBC Code required that in those chemical tankers constructed before 1 July 2002, a controlled tank venting system should be fitted, consisting of a primary and secondary means of allowing full flow relief of vapour to prevent over-pressure or under-pressure in the event of failure of one means. Alternatively, pressure sensors were to be fitted in each tank with an alarm facility. A monitoring system in the ship's cargo control room could be fitted, instead of a secondary pressure venting system. This was to be completed by the first scheduled dry docking after 1 July 2002 but no later than 1 July 2005. ***Perla*** was due for schedule dry docking in June 2004, at which time pressure sensors were to be fitted.

2.4 Cargo and Weather Details

2.4.1 The terminal operational agreement for loading the vessel was agreed within the following criteria:

- Product Methanol

- Quantity 8 430 tonnes
- Temperature - 18.1 degrees Centigrade
- Density 0.7918
- Actual Operating Pressure 2 – 3 bar
- Maximum Operating Pressure Shore 7 bar
- Maximum Operating Pressure Ship 6 bar
- Target Transfer Rate 400 tonnes
- Tanks to be loaded - all tanks *(28 tanks),* except 2 slop tanks.
- Venting System High Velocity Vents
- Closing rate of ships valves - 10 seconds
- Closing rate of shore valves - 15 seconds
- Responsibility for stopping - Ship
- Sailing draft - 7.7 metres, even keel

2.4.2 The weather conditions at Port Taranaki at the time of the accident consisted of an atmospheric pressure of 1007Kpa, a wind direction of 355 degrees (T) and a wind speed of 16 knots. High water was at 0740 hours.

2.4.3 Methanol is a colourless, polar, volatile, flammable liquid with a mild alcoholic odour when pure. It decomposes on heating, producing carbon monoxide and formaldehyde. Methanol reacts violently with oxidizing materials such as perchlorates, chromium trioxide, bromine, sodium hypochlorite, chlorine and hydrogen peroxide, resulting in fire and explosive mixtures.

2.4.4 Methanol mixes well with air, easily forming explosive mixtures. It is miscible with water, alcohols, esters, ketones and most organic solvents and forms many azeotropic mixtures.

- Boiling point - 65C
- PH - 7.2
- Solubility - 100%

- Specific gravity - 0.792 @ 20 degrees Centigrade
- Vapour density - 1.11 @ 15.6 degrees Centigrade
- Vapour pressure - 0.131 kg/cm2
- Critical temperature - 240.3 degrees Centigrade
- Critical pressure - 7.87kg/cm2
- Flash point – 12 degrees Centigrade
- Explosive limit – Volume % in air: 6 - 36%

2.4.5 Methanol is identified as a category D product an is subject to certain operational requirements of Annex II of Marpol 73/78.Methanol Un Number 1230.

2.5 Previous Repairs

2.5.1 On 12 November 1998, ***Perla***, then trading as ***Panam Perla***, was taking a cargo of sulphuric acid to Wilmington, USA. When the vessel arrived, sulphuric acid was found to be leaking from No.5 cargo tank into No.5 ballast double tank. This had caused welds to fracture in the No.5 cargo tank, in way of the side bulkheads and cargo tank bottom plate, in the following locations:

- Frame 89 – on both the port and starboard side of tank
- Frame 86 - port
- Frame 76 - starboard
- Frame 74 - port

A fracture was also found at frame 89 starboard, where the corrugated bulkhead extended through the stainless steel/carbon steel laminated plate into No. 5 starboard ballast double bottom tank. At the request of the owners, an Occasional Survey was carried out by the classification society NKK. Preparation and re-welding the areas of cracking repaired the vessel's cargo tank. Additional stiffeners were fitted in No. 5 starboard double bottom ballast tank

2.6 Previous Cargo

2.6.1 Prior to the arrival of ***Perla*** in Bluff, New Zealand, the vessel had loaded a cargo of sulphuric acid (98.5%) from the Pasminco Hobart Smelter, Hobart, Tasmania. The cargo was loaded in six tanks namely, Nos. 2 centre at 88.0% of capacity, 3 centre at 86.4% of capacity, 4 port at 81.0% of capacity, 5 centre at 85.9% of capacity, 6 centre at 86.3% of capacity and 7 starboard at 87.6% of capacity. All other cargo tanks were empty.

2.6.2 During the four day voyage, the sea and weather conditions were from the southwest, initially at force 5 rising but rising to gale force 8. The weather was coming from a direction on the aft starboard quarter, causing the vessel to corkscrew and pitch heavily. The vessel made an average speed of 13.58 knots for the.

2.6.3 Sulphuric acid is a colourless viscous corrosive oily liquid. It is a powerful protonating agent. It is a moderately strong oxidizing agent. Sulphuric acid is also a powerful dehydrating agent and is used to remove a molecule of water from many organic compounds:

- Boiling point – 338 degrees Centigrade
- PH - 0.98
- Solubility – miscible
- Specific gravity - 1.94 @ 20 degrees Centigrade
- Flash point – None

2.7 The Tank Failure, Repairs, Inspection and Testing

2.7.1 As a result of the tank failure at New Plymouth, the deck ruptured inwards at a point on the main deck, in line with the longitudinal bulkhead between cargo tanks Nos. 2 port and 2 centre. This rupture produced a release of vapour from the tank, which rose into the air. From the area of the rupture, flakes of paint and rust rained down on the ship and wharf. There was no evidence of an explosion or fire. The closed loading and the effect of the high velocity vent valve would give a positive pressure in No. 2 port cargo tank which resulted in the vapour releasing from the rupture.

2.7.2 When the vessel reached Nelson, the methanol residue in tanks Nos. 2 port and 2 centre had been cleaned and gas freed so that an inspection of the failed bulkhead could be undertaken. It was found that the weld attachments at the deckhead and tanktop had given way, in way of the distorted bulkhead, but not for the full length of the tank.

2.7.3 The vessel then proceeded to Auckland to conduct temporary repairs, which were later changed to permanent repairs. At the request of MSA, the welds were examined by SGS New Zealand Ltd, NDT & Materials Testing. The conclusion of the report was that this section of welding did not comply with class requirements or with the shipyard standards, because the fillet welds were found to be too small and unapproved filling, between the bulkhead and the tank, had been practiced. There was some evidence that fatigue cracking had occurred in these sub-size and unsuitable welds. Such cracks, on reaching a critical size, will propagate rapidly and catastrophically, which was the end result in this case. The failed bulkhead material was tested and found to be within specification for 316L stainless steel.

2.7.4 The MSA's Naval Architect conducted calculations into the loading of the failed bulkhead and the conclusion of his report was that the weight of the methanol in No.2 cargo tank should not have caused the longitudinal bulkhead to fail, providing the weld attachments were sound. Poor welding at the tank-top would have caused large bending stresses at the deckhead, but these would not have caused bulkhead failure.

2.7.5 Further analysis showed that a pressure of over 0.082 kg/cm2 in No.2 port cargo tank would be required to cause the bulkhead to yield, provided the bottom welds were not intact or bearing any load i.e.the bulkhead was supported at one end only and acting as a cantilever beam. The average pressure of 0.186 kg/cm2, required to lift the high velocity venting valve, was sufficient to cause large bending stresses that exceeded the yield stress. However, this would only occur if the welds at the tank-top were not bearing load. The calculations suggested that the weld at the tank-top failed first, which caused large bending stresses at the deck-head. The weld attachments at the deck-head then failed as the bulkhead was being distorted into cargo tank No.2 centre, under the combined effect of the differential pressure head and cargo vapour. This conclusion is supported by the report of the two separate sounds occurring at the time of the accident.

2.7.6 Class NKK attended the vessel for Occasional Surveys on the following occasions:

- New Plymouth – 2 March to 3 March 2004
- Nelson – 10 March 2004
- Auckland – 16 March 2004
- Auckland - 23 March to 11 April 2004

2.7.7 Based on the observed gap between the longitudinal bulkhead and the tank-top/deck-head plating, in the area of the failed welds, the MSA was concerned that there might be other areas in the construction of the vessel, that were not to class or shipyard specification. This latent defect could result in other failures occurring during loading in other ports. MSA therefore requested the vessel's Manager to have an ultrasonic NDT examination conducted of the fillet attachment between the longitudinal and transverse bulkheads, where they joined the tank-top/deck-head. The ship's Manager, however, refused to have these tests conducted as it was his opinion, and that of his company, Maruta Industries, that such examination was not possible; this was despite the NDT operator offering to conduct random examinations, with verification checks of his recorded readings, by gouging out the weld and physical measurement. The owner was prepared to conduct gouging and physical measurement of the set up gap of the welds under class supervision. MSA accepted this proposal and Class prepared an examination programme where welds would be gouged, if the filet leg length exceeded 15mm. Class undertook the further examination and produced an inspection report. The conclusion of the report into the close up examination, was that a total of three pinholes and one undercut were found in fillet welds of the inner bottom of all cargo tanks. This did not include Nos. 2 port and centre cargo tanks, as these were under repair. A total of eight cracks at corner welds of faceplates was found at the lower ends of vertical web frames in several cargo tanks. These cracks were examined by a dye penetration check, gauged and repaired satisfactorily. In total, 28 fillet welds were gouged. The maximum gap found measured 3mm in diameter. The welds were selected as follows: three with a leg length of more than 15mm, nineteen randomly selected at the inner bottom welds and six randomly selected at the upper welds. The gouged welds were re-welded to class satisfaction. A total of 20 examinations with a dye penetration check of overhead fillet welds at the upper deck and bulkhead were found to be in order, at the conclusion of all weld inspections. A total of seven hydrostatic tests were conducted in accordance with instructions from Asakawa Shipbuilding Co. Ltd, as a final verification check, and found to be satisfactory.

2.7.8 Repair work was carried out by Aimecs Ltd to the Nos. 2 port and centre cargo tanks, approximately between frames 126 to 134. A new section of longitudinal bulkhead was fitted between Nos. 2 port and centre cargo tanks. An area, covering approximately 4000mm by 2500mm of tank top plate was cropped in way of the damaged bulkhead and replaced. Damaged sections of the transverse and longitudinals in No. 2 double bottom tank was cropped and renewed as required. A section of tank upper and deck plate was cropped and renewed as required. Pressure/vacuum valves were tested and found to be satisfactory. Deck longitudinal and transverse frames in way of the affected deck plate were reinstated on completion. Material specification, welding consumables, welding procedures, welder qualification tests and finished NDT tests were carried out to the NKK Surveyors satisfaction. Nos. 2 port and centre cargo tanks and No.2 port

ballast double bottom tank were hydrostatically tested on completion of repairs and found to be satisfactory.

3. CONTRIBUTING FACTORS

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

3.1 The setting up of the failed bulkhead during construction did not meet the requirements of good ship building practice and class requirements. The resultant construction was the root of low cyclic fatigue cracking that slowly propagated.

3.2 During the 10 year life of the vessel the loading on the failed bulkhead was constantly changing with cargoes of different specific gravity or when adjacent tanks were empty.

3.3 It is the opinion of the MSA Investigator that during the voyage from Hobart to Bluff, cracks in the attachment welds of the bulkhead between Nos. 2 centre and port cargo tanks, propagated rapidly due to a combination of the sea and weather conditions and the No. 2 centre cargo tank being loaded with a heavy cargo of sulphuric acid and the adjacent tank being empty. It is possible that the fillet weld in the centre tank may well have failed during this passage, as it was under tension.

3.4 When the vessel arrived at Port Taranaki, the attachment welds of the bulkhead between Nos. 2 centre and port cargo tanks, were in such a condition that they failed due to the differential head of methanol between the cargo tanks and the vapour pressure within the No. 2 port cargo tank. It is possible that the weld on the No. 2 port side of the longitudinal bulkhead failed at this time, as it was under tension because the bulkhead was unevenly loaded.

3.5 The cyclic operation of the high velocity vent valve during loading could have caused pressure surges within the tank. The accident appeared to have occurred when the pressure was at a peak in No. 2 port cargo tank.

4. CAUSE

Human Factor

❑ Failure to comply with regulations	❑ Drugs & Alcohol	❑ Overloading
❑ Failure to obtain ships position or course	❑ Fatigue	❑ Physiological
❑ Improper watchkeeping or lookout	❑ Lack of knowledge	❑ Ship Handling
❑ Misconduct/Negligence	❑ Error of judgement	❑ Other . . .

Environmental Factor

✗ Adverse weather	❑ Debris	❑ Ice	❑ Navigation hazard
❑ Adverse current	❑ Submerged object	❑ Lightning	❑ Other . . .

Technical Factor

✗ Structural failure	❑ Wear & tear	❑ Steering failure
❑ Mechanical failure	✗ Improper welding	❑ Inadequate firefighting/lifesaving
❑ Electrical failure	❑ Inadequate maintenance	❑ Insufficient fuel
❑ Corrosion	❑ Inadequate stability	❑ Other . . .

4.1 The failure of the sub-standard welding attachment to the bulkhead, both at the tank top and deckhead, between Nos. 2 port and centre cargo tank.

5. OPINIONS & RECOMMENDATIONS

5.1 Chemical tanker ship construction has to be of the highest possible standard because traditional stiffening inside the tanks has been minimized, so that tank cleaning can be undertaken more easily and safely. The tanks have to be designed and constructed in such a way that stresses are avoided as far as possible, since these can lead to fatigue cracks. During vessel construction, welding and other constructional features must be of the highest possible quality. This was clearly not the case in the area of failure on this vessel.

5.2 It recommended that the ship builder, Asakawa Zosen K.K. of Japan, consider this report in that other vessels' constructed at their shipyard may also have latent defects that may result in similar failures in other vessels of this type, and that the small area of substandard workmanship and lack of quality control in this case, could have led to a major disaster at a nationally strategic port in New Zealand.

5.3 That Asakawa Zosen K.K. review their quality control procedures, to ensure correct fit up is achieved for all construction welds.

5.4 That Asakawa Zosen K.K. conduct urgent inspections on other vessels built of this vessel type, for signs of similar failures

5.5 That class NKK review their procedures for inspection and approval of construction welds in vessels that are constructed to their class rules.

5.6 That Class NKK review seriously their procedures for inspection of ship structures after failures of this type to require detailed inspection, inclusive of NDT examination and visual inspection of other welds in other areas of the subject vessel and vessels of the same class. NKK is also encouraged to require owners to arrange such examinations as well as hydrostatic testing on completion, rather than undergo hydraulic testing only.

5.7 That a copy of this report be forwarded to IACS for the general information of all affiliated class societies to their organisation and that members review their inspection and approval procedures for vessels built under their class rules.

5.8 That this report be forwarded to IMO for inclusion in their accident database.

Opinions & Recommendations - Nippon Kaiiji Kyokai

Nippon Kaiji Kyokai had experienced similar damage on other chemical tankers caused by the malfunctioning of the high velocity venting valves. It is their opinion that this was the cause of the bulkhead failure in this vessel. The high velocity venting valves were manufactuired by Niikura Kogyo Co.Ltd. It is thought that the difficulty of inspecting and maintaining the valve seat contributed to the adhesion of a viscous substance and resulted in an over pressure condition exceeding the allowable structural strength of the cargo tank.

Nippon Kaiji Kyokai have requested that the following steps be taken when examining the high velocity venting valves valve seats (type: NHV-SCS) as shown in Fig 4 of drawing No. NHV-SCS-65-125

1. the hood is to be taken off,
2. the valve cover is to be lifted up, and
3. the valve cover is to be kept lifted during inspection and maintenance.

Nippon Kaiji Kyokai and Niikura Kogyo have discussed and worked to improve the design of the high velocity venting valve in order to make the inspection and maintenance of the valve seat easier (Fig.2 and Fig.3 of drawing No. NHV-LI-SUS-SDT-A01), which were subsequently type approved by class on the 9th August 2004. The manufacture of the high velocity venting valve type NHV-SCS has been discontinued.

Nippon Kaiji Kyokai have issued a Technical Information, TEC –0590 dated July 2004, to all parties concerned advising them to pay special attention to the inspection and maintenance of the high velocity venting valve manufactured by Niikura Kogyo Co. Ltd.

Nippon Kaiji Kyokai and Asakawa Shipbuilding have reviewed and revised the design of the fillet welds to full penetration with smooth grinding of the weld surfaces so as to reduce any stress concentrations.

This improvement has already been applied to new ships that were delivered on or after December 1999.

During a pre-loading survey on 6 March 2005 at Port Taranaki on the chemical tanker ***Southern Royal***, a cargo surveyor noticed a 100mm crack in the longitudinal bulkhead of No. 6 starboard cargo tank. Further inspection of the cargo tanks was carried out and a total of 10 cracks were found at the corners of the corrugated bulkheads were they joined the tank tops. This vessel had been carrying sulphuric acid cargoes regularly in cargo tanks Nos. 1 P&S, 3 P&S, 6 P&S, 9 P&S, and 11 P&S. The cracks were found in cargo tanks 3 P&S, 6 P&S, 9 P&S, 11 S, and 12 P. The vessel was built at Asakawa Shipbuilding in 1999, Yard Number 415.

Nippon Kaiji Kyokai carried out inspections and measurements of the gap between the corrugated bulkheads (longitudinal and transverse) and the tank top during patrol surveys.

Nippon Kaiji Kyokai will request that surveyors in charge of Asakawa shipbuilding carry out witness inspections of the gaps prior to the execution of the fillet welding with full penetration, in order to maintain the highest level of quality during construction.

Nippon Kaiji Kyokai has circulated the damage report on the vessel and other ships with over pressure damage to ensure that field surveyors are fully aware of such potential problems during their surveys. Nippon Kaiji Kyokai will also issue instructions requesting all field surveyors to carry out through examination of the fillet welds between the corrugated bulkhead and the tank top during internal inspections of the cargo tanks.