Report 98-208

Ro-Ro cargo vessel *Union Rotoma*

shift and loss of cargo

off the south-western coast of South Australia, in the Great Australian Bight

29 July 1998

Abstract

At 1249 on Wednesday 29 July 1998, the Ro-Ro cargo vessel *Union Rotoma* had encountered heavy weather in the Great Australian Bight while on passage from Sydney to Adelaide. Four containers stacked two-high on the weather deck toppled, and while this event was being investigated, three larger waves caused the ship to roll heavily, resulting in a more substantial shift of cargo above and below deck. Three containers were lost overboard in the shift.

The Commission investigated the accident because the potential existed for the seaworthiness of the vessel and the safety of its crew to be compromised. Additionally, cargo lost overboard can pose a significant hazard to navigation.

Safety issues identified included poor:

- securing of cargo to cargo bases
- packaging of Ro-Ro cargo
- securing of cargo within containers
- condition of lashing equipment
- lashing procedures.

A number of safety actions were proposed by the operator and the charterer, and two further safety recommendations were made to address most of the safety issues. The Maritime Safety Authority will soon circulate draft maritime rules for the Carriage of Cargo - Stowage and Securing which, once adopted, and if complied with, should address those safety issues remaining.

The foredeck of *Union Rotoma,* on arrival at Adelaide

Transport Accident Investigation Commission

Marine Accident Report 98-208

Vessel particulars:

Type:	Ro-Ro (roll-on roll-off) cargo vessel
Class:	VII: Foreign-going cargo vessel (SOLAS)
Classification:	Bureau Veritas
Length (overall):	207.38 m
Breadth (extreme):	29.57 m
Draught (summer):	9.586 m
Tonnage (gross):	29 040 t
Tonnage (dead-weight):	21 653 t
Construction:	Steel
Built:	Chantiers de France, Dunkerque in 1976
Propulsion plant:	Two, 13 428 kW, S.E.M.T. Pielstick, 16PC3V-480 type diesel engines, connected via a reduction gearbox to a single shaft and controllable-pitch propeller
Service speed:	19 knots
Owner/operator:	Union Shipping New Zealand Limited
Port of registry:	Auckland, New Zealand
Persons on board:	Crew: 19
Injuries:	Nil
Nature of damage:	Substantial loss of cargo; moderate damage to ventilator trunks, fire main and hand railings

Location:	Off the south-western coast of South Australia, in position 37° 18' S 139° 21.2' E
Date and time:	Wednesday 29 July 1998, at 1249[1]
Investigator-in-Charge:	Captain Tim Burfoot

[1] All times in this report refer to ship's local time and are expressed in the 24 hour mode

1. Factual Information

1.1 History of the voyage

1.1.1 *Union Rotoma* was on voyage number 638 of a liner trade between New Zealand and Australia having exchanged cargo at the New Zealand ports of Auckland, Tauranga, Wellington and Nelson; the Australian ports of Brisbane and Sydney, and was en route from Sydney to Adelaide when the accident occurred.

1.1.2 As with most ports on the trade route, cargo operations at Sydney had consisted of discharge, and back-load for New Zealand ports. Two gangs of wharf labour were employed to work simultaneously on different cargo decks. The exchange of containers on deck 5 (the weather deck) was effected using a shore container crane, while the cargo exchange on the lower decks was made by roll-on roll-off (Ro-Ro) over the stern ramp.

1.1.3 Cargo operations on deck 5 were completed at 1600 on Sunday, 26 July 1998. Cargo loading in the lower decks continued until 1930 that evening. *Union Rotoma* sailed from Sydney at about 2300 that evening for Adelaide with a departure draft of 7.8 m forward and 8.35 m aft, and a fluid GM[2] of 0.981 m.

1.1.4 The trip down the east coast of New South Wales and into Bass Strait was uneventful. The master obtained at least two weather facsimiles each day in addition to the automatic reception of frequent sea and weather situations and forecasts through the Inmarsat Safety NET-C Enhanced Group Calling (ECG) Area system.

1.1.5 As *Union Rotoma* entered Bass Strait, a deep low pressure system centred in the Great Australian Bight was moving south-east and as the vessel proceeded through the Strait the centre of this low passed to the south of the vessel.

1.1.6 *Union Rotoma* rounded Cape Otway in Bass Strait at about 1300 on 28 July and turned broadly west. The master chose to take what was referred to as the "lobster route" which took the vessel further south than usual, outside the 100 fathom line. This route was taken during the lobster fishing season to avoid the high concentrations of fishing vessels close to the coast. The master occasionally opted for the lobster route in inclement weather, as the wave pattern in the deeper water was less severe on the vessel.

1.1.7 The sea and swell became progressively worse that night. At midnight the weather was recorded in the bridge log book as being west-by-south wind at 45 to 50 knots; very high sea and short heavy swell; vessel shipping moderate, occasionally heavy, water forward.

1.1.8 From midnight to 0800 on 29 July, *Union Rotoma* made a succession of course alterations as it made its way around the coast toward Backstairs Passage. By 0800 the course of the vessel was broadly north-west. Meanwhile the wind and sea had backed to the south-west and abated; the direction of the swell also changed to broadly south-west, but it remained heavy.

1.1.9 At 0800 the weather as recorded in the bridge log book was: south-west wind at 25 knots; a rough sea, and heavy swell from south-west-by-west; vessel rolling and pitching heavily at times.

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[2] Metacentric height, which is a measure of static stability for the vessel, allowing for the free surface effect of all liquids on board.

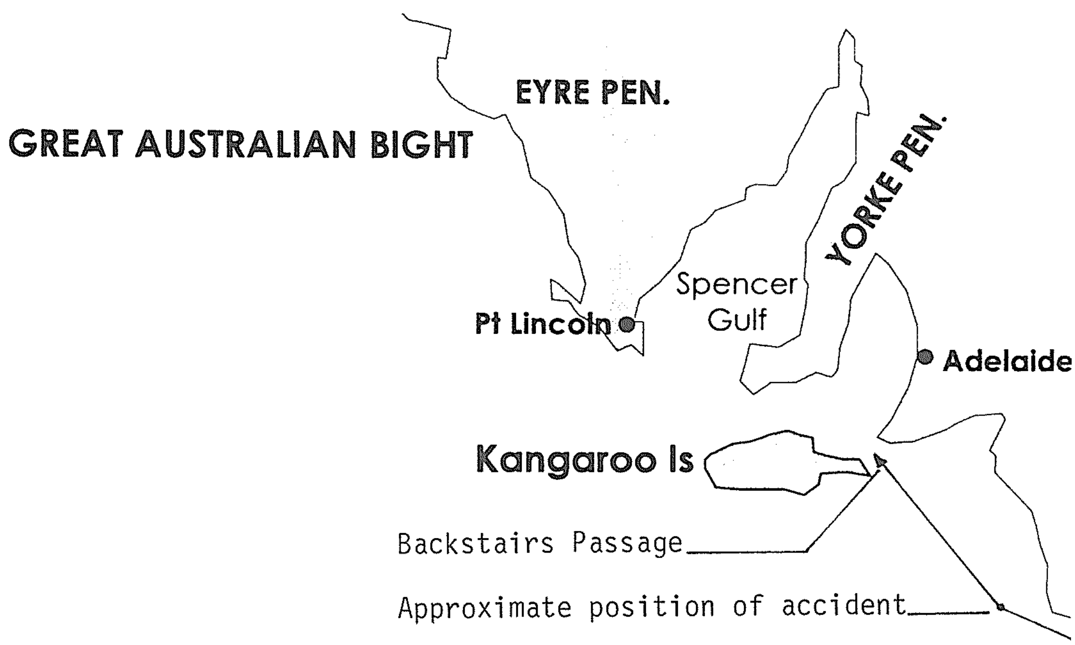
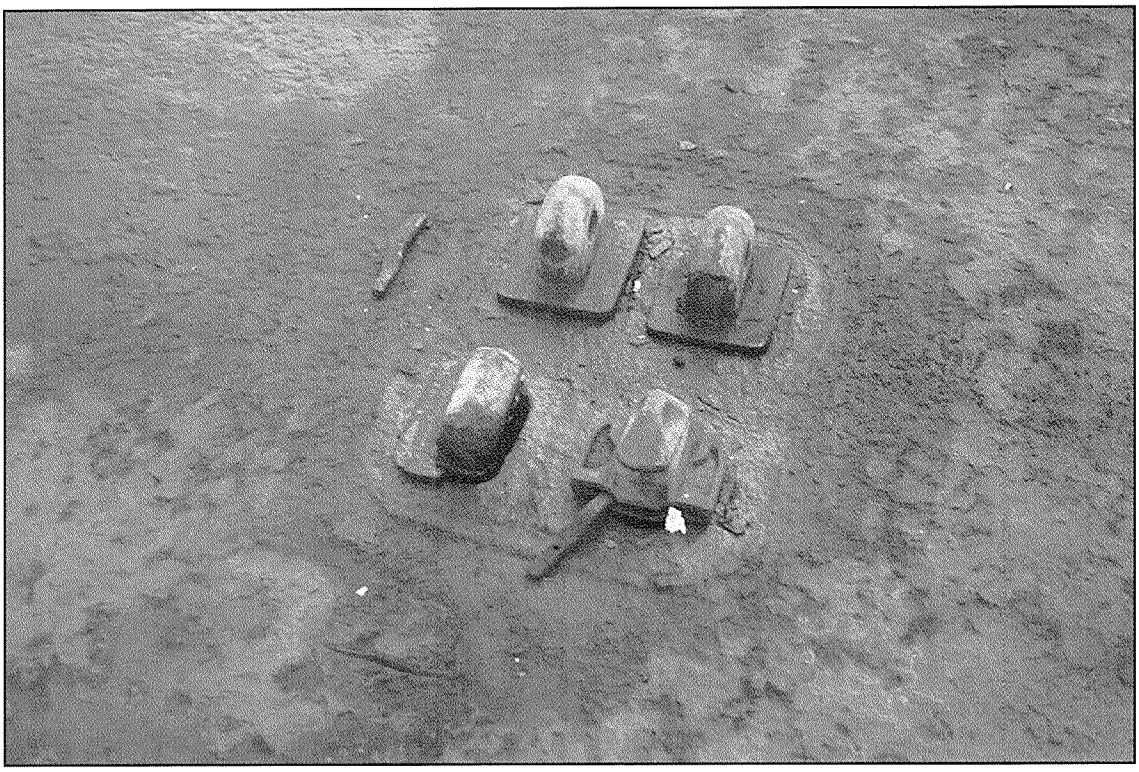


Figure 1
Location chartlet

1.1.10 Throughout the rest of the morning the wind again increased to 45-50 knots, still from the south-west. At 0935 the course was adjusted to 328 degrees true to make for Backstairs Passage (see Figure 1), which put the swell on the port quarter of the vessel and caused the rolling to increase, typically 20 to 25 degrees either side of a constant 5 degree starboard wind heel angle.

1.1.11 At 1030 the master ordered one of the engines be stopped to decrease the speed of the vessel from about 14.5 to 8 knots, which altered the apparent wave period to the vessel and reduced the rolling to about 15 to 20 degrees.

1.1.12 The 328 degree track toward Backstairs Passage took *Union Rotoma* into progressively shallower water, which had the effect of building and steepening the swell profile. *Union Rotoma* was still rolling moderately, over to 20 degrees at times (25 degrees to starboard due to the wind heel angle).



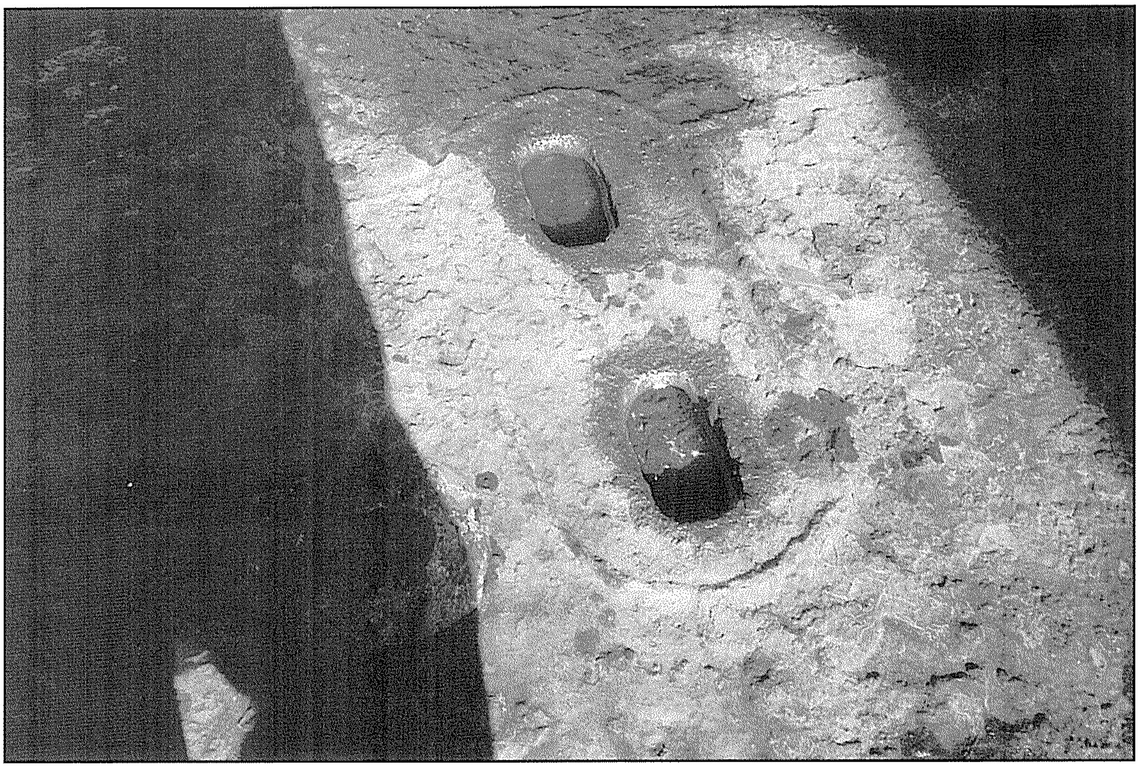


Figure 2
Photographs showing enlarged openings in the deck sockets caused by a combination of corrosion and stacking cones being pulled out under load (bottom photograph), and incorrect use of twistlock (top photograph {note half the load bearing plate missing from the bottom left stacking cone causing it to sit on an angle})

1.1.13 At midday the weather recorded in the bridge log book was: south-west wind at 45-50 knots; very rough sea; heavy south-west-by-west swell; vessel pitching moderately, rolling heavily, very heavily at times; shipping moderate water. The second mate estimated the typical height of the combined swell and wind waves was about 6 m.

1.1.14 At about 1240 the officer-of-the-watch noticed that two free-standing stacks comprising four TEU[3] containers on the port side of the vessel at Bays 15 and 17 had toppled over and had slid across to the starboard side of the vessel. He informed the master, who proceeded down onto the deck to assess the situation.

1.1.15 While the master was on deck, *Union Rotoma* encountered three larger waves and "rolled violently to starboard". Five additional TEU and three FEU[4] containers stowed in Bays 21, 23, 27 and 35 toppled in the roll. Of the toppled units, two TEU and one FEU were lost overboard.

1.1.16 The second mate had seen the series of waves approaching but did not have time to take evasive action before they reached *Union Rotoma*. He estimated that the waves were 12 to 15 m in height and that *Union Rotoma* had rolled in excess of 30 degrees to starboard. He observed the starboard deck edge was almost in the water at the extremity of the roll to starboard. On seeing the loss of containers overboard, the second mate pushed the man overboard button on the GPS navigation receiver, and turned *Union Rotoma* head to wind and sea.

1.1.17 For the ensuing four hours *Union Rotoma* was kept head to wind and sea while the crew re-secured the containers where they lay on deck, and similarly, the Ro-Ro cargo on decks 1, 3 and 4 that had suffered a substantial shift also.

1.1.18 At 1730 on 29 July, *Union Rotoma* resumed passage to Adelaide. The weather abated through the night and good progress was made, with the vessel berthing at Adelaide at 0915 the following morning.

1.2 Cargo and vessel damage

1.2.1 In addition to the loss overboard of two TEU and one FEU containers, all eight containers on deck 5 that toppled were extensively damaged. Damage to their contents ranged from minor to substantial. Additionally, three other containers appeared to have toppled part way over, coming to rest against other toppled containers and then returned to the upright again with some resultant damage, mainly caused by their contents shifting within.

1.2.2 Most of the damage to cargo on below-decks 1, 3 and 4 was caused by either the failure of the cargo packaging, or the failure of the material securing it to the flat racks or bases. Little of the damage was due to movement of the bases in stow.

1.2.3 Damage to the vessel was limited to deck 5 and included:

- substantial damage to seven cargo-hold ventilator cowls and trunkings
- a section of the deck fire main was sheared, including two valves
- a fire hose box was sheared
- a section of the hand rail was sheared.

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[3] Twenty foot equivalent unit.
[4] Forty foot equivalent unit.

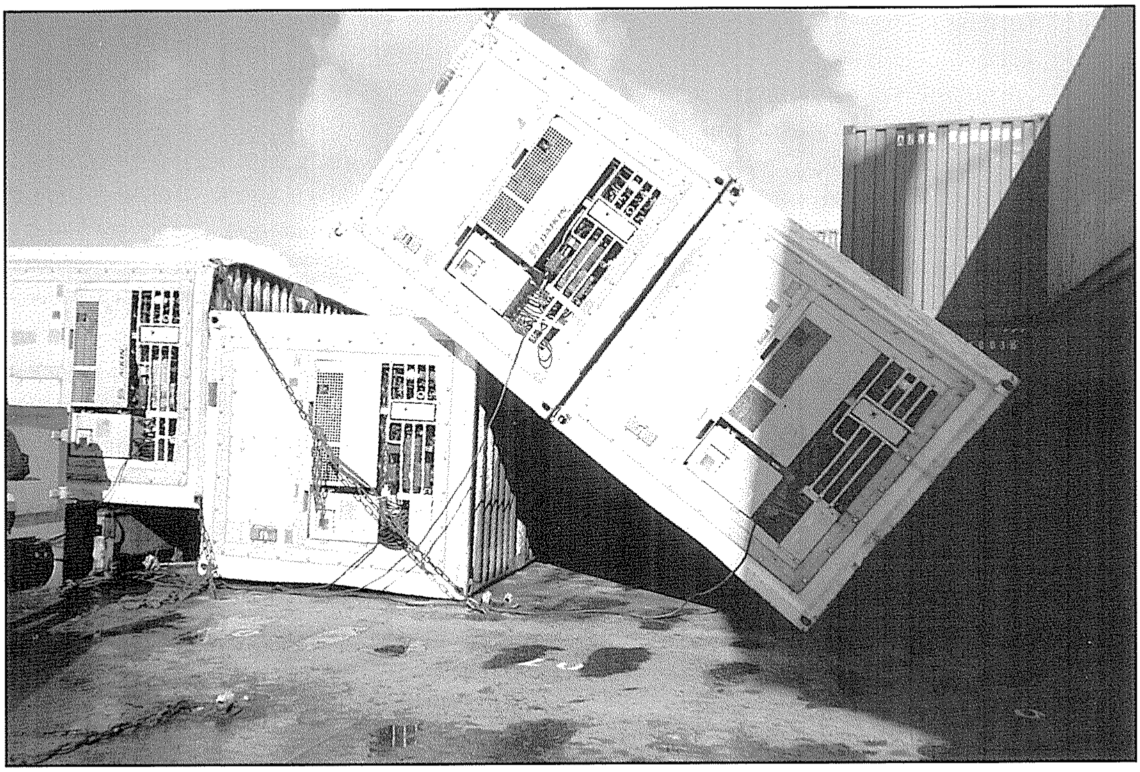

Figure 3

Photographs showing toppled reefer containers in Bay 21; note the stacking cone still pinned to the bottom corner casting in the top photograph; the cone was torn from the deck socket. The two bottom containers weighed about 17.5 t each; the one far left (top stow) weighed about 21.5 t. Two containers, one TEU and one FEU, stowed outboard of the containers shown were lost overboard

1.2.4 After the accident the crew found a number of broken container lashing devices lying on deck in the vicinity of the shifted containers. At the request of the Commission, the broken fittings were collected and retained for inspection.

1.2.5 Due to the need for the crew to re-secure the containers with haste and in a hostile environment, and due to the time elapsed before *Union Rotoma* returned to New Zealand, it was not possible to determine which fittings had secured which containers, with the exception of some base cones that had either been torn from the deck and remained attached to a container base, or had sheared, leaving their bottom section fitted into a container socket recessed in the deck.

1.2.6 The following are some examples of damage noted (see section 1.4, container lashing arrangement, for details of types of devices):

- some stacking cones had sheared in overload
- some stacking cones had sheared as a result of what appeared to be pre-existing cracks in their casting
- some stacking cones had damaged downward load bearing plates (some showed pre-existing damage)
- some container sockets recessed into the deck had been deformed by a base stacking cone pulling out under load (some of these deformities appeared to be recent, others appeared to have been existing before the accident; see Figure 2)
- some twistlocks had failed in overload, with their top locking pin bent over and separated from the main casting
- some chains had parted in overload
- some cast hooks on the chain tensioners had failed in overload
- some small hooks on the end of the "twitch bar" securing chain were missing.

1.2.7 On devanning some containers it was apparent that the contents had not been adequately stowed and there was evidence that cargo had shifted within the containers, possibly before they had toppled.

1.3 Vessel information

1.3.1 *Union Rotoma* was originally built for French owners, after which it underwent a succession of name changes - *Rostand, CGM Rostand, PAD Australia, Kagoro and Rost*, before it was acquired by its present owners, Union Shipping New Zealand Limited, in January 1991 and named *Union Rotoma* under the New Zealand flag.

1.3.2 Cargo was carried on four internal decks and one weather deck, numbered 1 - 5 from the lowest deck up. Cargo could be loaded either over the stern ramp as Ro-Ro cargo, or directly onto deck five using a single 36 tonne safe-working-load crane, or by shore crane. All five decks were interconnected by a series of ramps, in much the same way as a car park building. (See Figure 4.)

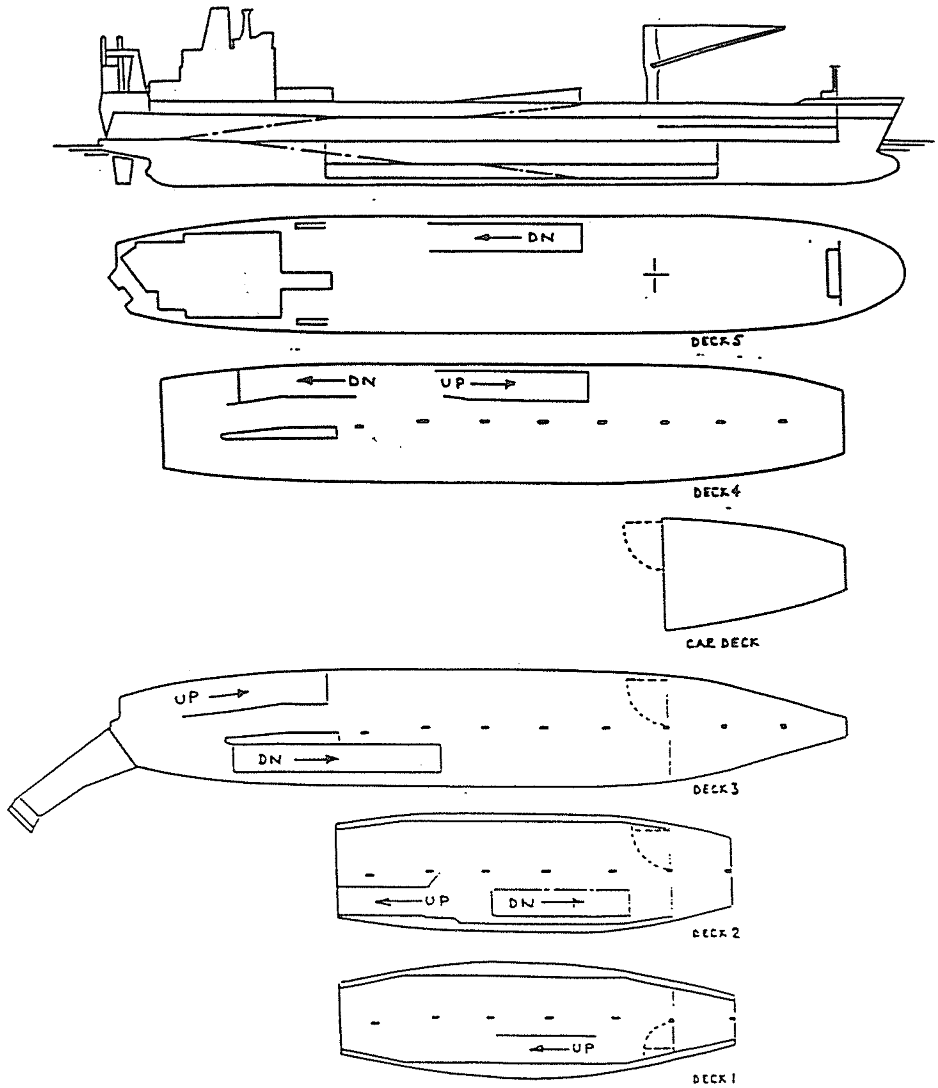

Figure 4
***Union Rotoma* cargo deck arrangement**

1.3.3 *Union Rotoma* was powered by two S.E.M.T. Pielstick type 16PC3V- 480, non-reversing diesel engines connected, via a reduction gearbox, to a single shaft and controllable-pitch propeller.

1.3.4 The ship operated a regular service between New Zealand and Australian ports at a service speed of up to 19 knots. The complement of the ship comprised the master, three mates, four engineers and 11 integrated ratings (IRs), a total of 19.

1.3.5 *Union Rotoma* was on a time charter to Australia New Zealand Direct Line (ANZDL), who were responsible for accepting cargo for shipment and pre-planning the cargo stowage.

1.4 Container securing arrangement on deck 5

1.4.1 The majority of containers on deck 5 were stowed fore and aft, with the exception of 26 slots where they could be stowed athwartships. *Union Rotoma* could carry up to 10 containers across its breadth, which were divided into two blocks by a space along the centreline of the vessel. Each block was normally lashed as a separate unit in accordance with the Bureau Veritas approved cargo securing manual.

1.4.2 Recessed sockets were arranged in the deck in which stacking cones were placed, four for each container slot. The sockets were arranged in such a way that denied access between two consecutive TEU container bays in the same block. This design peculiarity was to allow FEU containers to be intermingled with TEU containers within the same block without having to have additional sockets in the deck (see Figure 5).

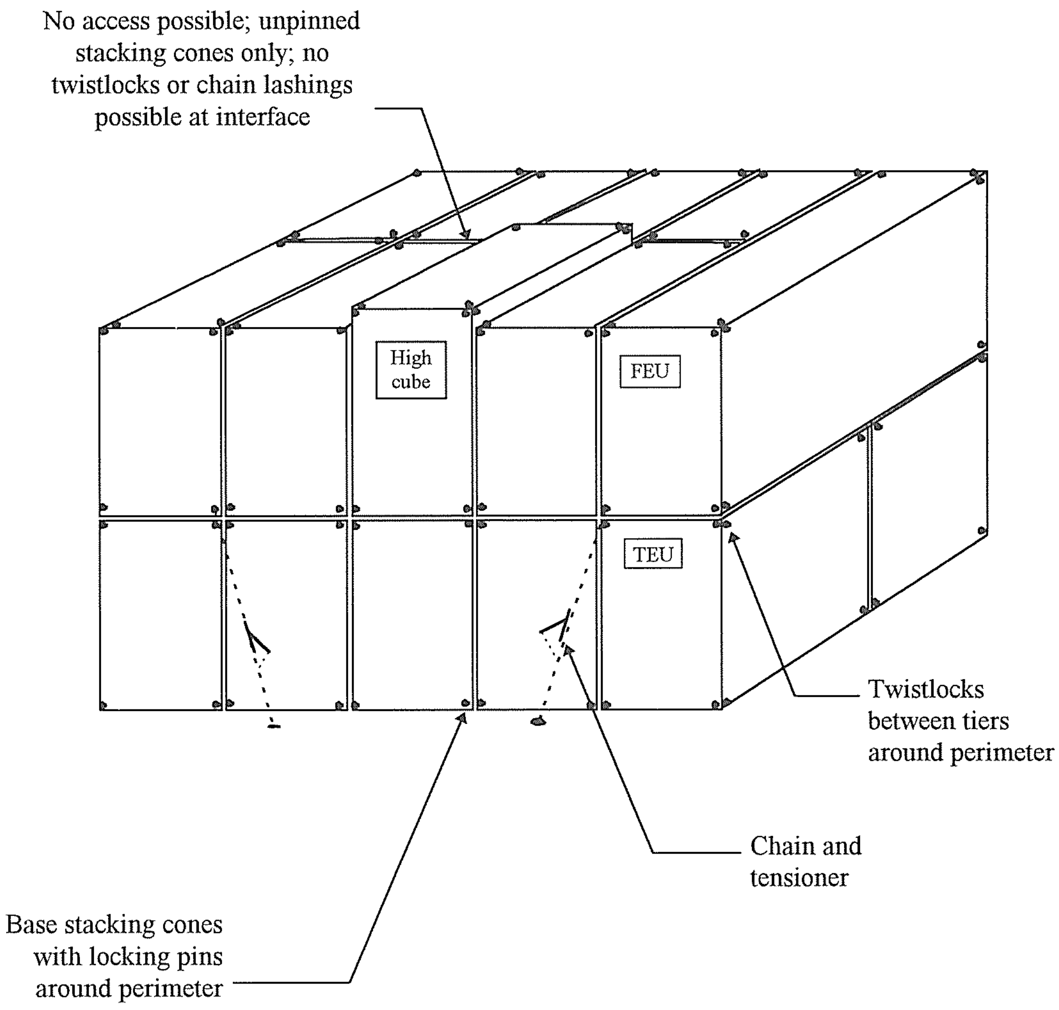

Figure 5
Diagram showing a typical block stow of containers on *Union Rotoma*, lashed as per the cargo securing manual

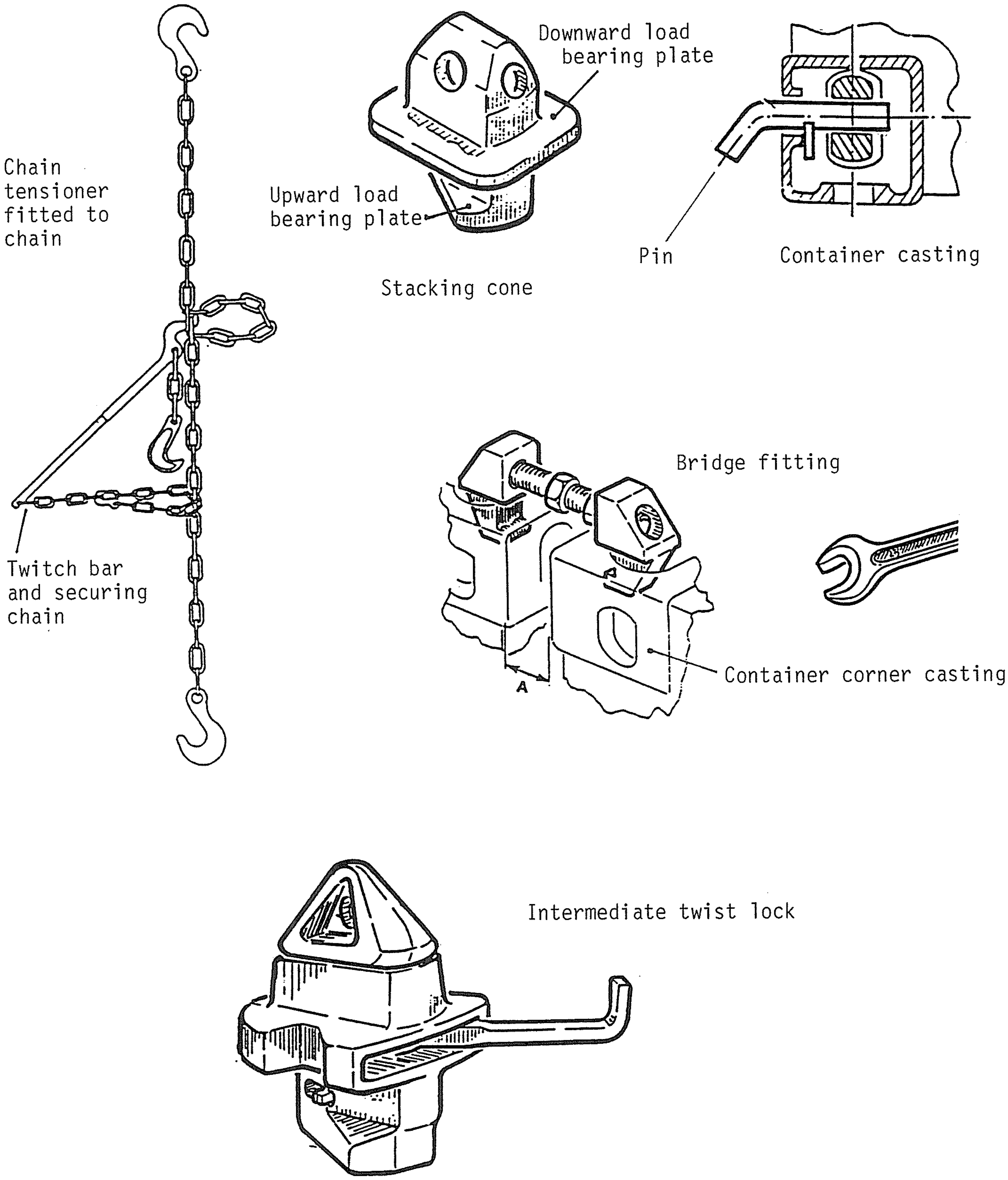

Figure 6
Diagrams showing the relevant lashing devices, copied from the cargo securing manual

1.4.3 Where a container was to be loaded into a slot, stacking cones were inserted into each of the four deck sockets and locked into the socket by turning the cone through 30 degrees. Once the container was placed onto the four cones, pins were inserted through holes in the corner casting of the container and the cone, locking the container to the cone.

1.4.4 Pins could not be fitted to cones located between consecutive bays of TEU containers, as shown in Figure 5. Note in Figure 6 below that the stacking cones had holes for receiving the pins in longitudinal or athwartship directions. The instructions in the cargo securing manual stated that the pins "should preferably be inserted through the side of the cone/corner casting. If the pin is inserted through the end hole, it will not reach through the cone and consequently only offer one locking surface to the upper container". Only the stacking cones along the sides of a block stow could be pinned from the side. The ones along the forward and aft faces of the block stow could only be pinned from the end.

1.4.5 A number of the stacking cones on board *Union Rotoma* did not have side holes, and a bar had been welded across one of the end holes which prevented the insertion of a pin. This feature was not shown in the cargo securing manual. The crew were of the opinion that this type were supposed to be used exclusively below decks, where pins were rarely used.

1.4.6 When containers were carried two-high, twistlocks were to be fitted between the first and second tier. The twistlock system on board was right-hand-locking. Where twistlocks could not be fitted at the interface between two bays of TEUs, unpinned stacking cones were used instead.

1.4.7 Bridge fittings formed part of the lashing equipment inventory on *Union Rotoma*. They were designed to resist lateral or longitudinal movement at the top of container stacks, depending on which direction they were fitted. The cargo securing manual listed bridge fittings as equipment "used principally on deck 5 to connect exposed face of top tier containers in either longitudinal or athwartship direction", yet the "stowage and securing principal" section of the manual made no mention of using bridge fittings on the top tier. The crew could not recall bridge fittings ever being used for securing containers on deck 5.

1.4.8 It is not possible to bridge-fit all top-tier containers when high cube (overheight) containers are included in a stow, as shown in Figure 5 above. Additionally, if bridge fittings were to be used, it would require personnel to be lifted onto the containers in a personnel cage in order to carry out the task safely.

1.4.9 Finally, if containers were carried two or three high then the top outboard containers of each block stow were required to be lashed using chains. The cargo securing manual stated that "chain lashings are to be placed vertically from the inboard bottom corner casting of the second or third tier container to the appropriate deck lashing point". The associated diagram, however, depicted the chains leading in toward the centre of the block stow, as shown in Figure 5. As with the twistlocks and pinned stacking cones, chains could not be fitted at the interface between consecutive bays of TEU containers.

1.4.10 A lashing plan was displayed on the bulkhead in the deck cargo office, to which some crew referred when seeking advice on how containers were to be lashed. The plan showed a different method again to those indicated in the cargo securing manual. The plan stipulated that the top outside containers in each block stow were to be lashed **vertically** down from both bottom corner castings. This was the method adopted by most of the crew. Nobody could recall precisely from where the lashing plan originated, but it was thought to have formed part of a lashing plan adopted by one of the former owners of the ship.

1.5 Cargo operations, policy and procedures

1.5.1 A standing order was issued under the heading "marine operations - instructions and guidelines" under the "scope of the duty deck officers". The standing order formed part of the international safe ship management (ISM) system for *Union Rotoma*. The order covered the various responsibilities of the duty deck officer in port and included the following instruction:

> TEU/FEU: All containers sit on cones on all decks. Four cones to each unit on deck 5. . . Arrows have been painted on deck 5 to indicate only where cone pins to be inserted and twistlocks locked.

1.5.2 The instructions often referred to the gearmen being trained to carry out certain tasks, but always referred the final responsibility for checking to the duty deck officer.

1.5.3 The deck officers maintained the traditional three watch system in port and at sea. It was the normal practice on *Union Rotoma* when working more than one deck in port for the duty deck officer to supervise the Ro-Ro cargo operations on the lower decks, while an IR (gearman) supervised cargo operations on deck 5.

1.5.4 The shore labour was responsible for placing and securing cones and twistlocks, while the duty deck officer and gearman were responsible for chain lashings. Dedicated lashing gangs were not employed by the charterer. If the task of monitoring cargo operations and applying lashing chains became too great, the gearman or the duty deck officer could call on the day working IRs to assist. This would more often occur nearing the completion of cargo operations for the port, when lashing activity was at its highest, and other preparations for readying the vessel for sea had to be considered.

1.5.5 The gearman on deck 5 did not routinely check that the shore labour had applied the cones and twistlocks correctly. He was usually fully occupied with recording container figures, plugging in reefer containers and applying chain lashings.

1.5.6 The duty deck officers were aware that they were supposed to check the lashings on deck 5, but they were not always able to, usually due to time constraints.

1.5.7 The chief IR and the forward mooring gang usually made a final check of the chain lashings when they had been stood down after departure from the port. The chief IR would also make daily checks of the lashings while at sea, although both those checks were made of the chain lashings only. The stacking cone pins and twistlocks were not checked. The chief IR usually only reported to the chief officer if he had noticed any problems with the cargo.

1.5.8 On the accident voyage, deck 5 loading was completed at 1600, and all cargo operations completed by 1930. The deck officer on duty between 1600 and 2000 did not specifically check the lashings on deck 5. He had been occupied on the lower decks until 1930 and thereafter with readying the vessel for sea.

1.5.9 The chief IR checked the chain lashings before departure, and again each day at sea on 27 and 28 July. Other than having to re-tighten some chain lashings, no problems were encountered. It was not unusual to find a chain tensioner that had disengaged, particularly when the vessel was rolling. This occurred when the container stow racked, allowing the chain lashings to flex. Occasionally the flexing of the chain would cause a twitch bar securing chain to disengage, allowing the main lashing chain to fall slack.

1.5.10 The crew were not able to check the deck lashings on the morning of 29 July, the day of the accident, as the seas invading the deck and the heavy rolling of the vessel made it unsafe to do so. The crew checked the cargo below decks and found that several packs of timber had begun to shift, their securing bands having broken. Most of the morning was spent applying extra lashings to that cargo. Having completed that task, the crew were having their meal break when the main shift and loss of cargo occurred.

1.6 Subsequent observation of lashing equipment

1.6.1 About two weeks after the accident, the investigator-in-charge attended the *Union Rotoma* during its call into the Port of Wellington to make a further inspection of the container lashing equipment and how it had been used to lash a sample two block stows of containers spanning two bays, stacked three high. The following observations were made:

- of 60 intermediate twistlocks between tiers, 13 were not able to be locked because either the locking bar was missing or the twistlock had been inserted backwards; a further 15 which were able to be locked, had not been
- of 48 stacking cones around the base perimeters, nine pins were missing; some had been omitted, others could not be inserted because either the wrong type of stacking cone had been used, or the stacking cone was damaged preventing the insertion of a pin
- no bridge fitting devices had been used
- chains were used to lash vertically down from the base of both the second and third tier outboard containers; only two of the chains from the third tier containers were crossed, leading inboard as per the cargo lashing manual.

1.6.2 It was not possible to inspect the status of the stacking cones between bays as there was no gap at the interface.

1.6.3 A general inspection of the container lashing equipment in the bins on deck 5 revealed a number of cracked stacking cones, damaged twistlocks and chain tensioners with their twitch bar securing chain hooks missing.

1.6.4 Some weeks later the ship owner's representative made a similar inspection of a block stow of cargo on deck 5. The results of his inspection showed a marked improvement in the way the lashing equipment was utilised.

1.7 Personnel information

1.7.1 The master of *Union Rotoma* had 42 years sea-going experience, the last 28 of which were in command. At the time of the accident, he had been sailing as master on the *Union Rotoma* for six years.

1.7.2 The first and second mates were also experienced officers who were familiar with *Union Rotoma*. The third mate was a reliever, who was on his second voyage on the vessel.

1.7.3 The chief IR had 34 years sea-going experience, the last seven of which was served on the *Union Rotoma*. He and one other IR were the only ratings with significant experience on the vessel. The rest had varying degrees of experience at sea, but were on their first voyage on board *Union Rotoma*.

2. Analysis

2.1 Weather

2.1.1 The master of *Union Rotoma* had been receiving regular weather updates during the voyage from Sydney to Adelaide and was well aware of the low pressure weather system in the Great Australian Bight. The passage of deep low pressure systems from the Great Australian Bight, south-eastwards across Tasmania and into the Tasman Sea is not an unusual phenomenon during the southern hemisphere winter.

2.1.2 The weather forecasts were from all accounts reasonably accurate for the area through which *Union Rotoma* was steaming at the time of the accident. The master was familiar with the weather pattern, and the sea conditions likely to be expected for the passage through Bass Strait and around the South Australian coast, as evidenced by his choosing to keep south in deeper water for as long as possible.

2.1.3 The stretch of coastline leading up to Backstairs Passage was known to those on board to usually be the worst part of the trip for rolling during south-west gales. Even in calm weather, large swells generated further south often caused the vessel to roll uncomfortably, especially as the vessel entered shallower water as it converged with the coastline.

2.1.4 Waves and swells are generated by the wind. The Beaufort wind scale shows that winds of 45 to 50 knots, as recorded in the bridge log book at midday, can be expected to generate waves with a mean height of 8 m, with a probable maximum height of 10 m, given sufficient fetch. Combine this with the recorded 7 m south-west-by-west swell and a mariner could expect the waves and swells to combine periodically to form a peak-to-trough height of 12 to 15 m. The wave that caused the *Union Rotoma* to roll violently to starboard could not, therefore, be regarded as a "rogue" wave.

2.1.5 There may have perhaps been an element of synchronous rolling[5], which would account for the larger and more violent roll to starboard on the second of the three reported larger waves; however, the fact that the vessel had begun to experience problems with shifting cargo below decks earlier that morning, and that the four containers stowed in Bays 15 and 17 toppled before *Union Rotoma* encountered the three larger waves, suggests that other factors had contributed to the final shift and loss of cargo. The accident, therefore, cannot be attributed wholly to the elements of the weather, only that such elements were the final contributing factor following a series of failed defences within the cargo planning, loading and securing system for *Union Rotoma*.

2.2 Shippers and cargo lashing

2.2.1 The responsibility for proper stowage and securing of cargo lies firstly with the shipper, secondly with the carrier (who may be the charterer rather than the ship owner), and finally with the master, who has the right to reject any cargo he believes is not fit for carriage on the vessel.

2.2.2 Most of the cargo shift below decks was a result of poor lashing of cargo to bases, or insufficient strapping to contain the cargo as integral units when they were subjected to what were foreseeable dynamic forces of carriage at sea. Some shippers of cargo, the carrier and the master had not, therefore, met their responsibility for proper cargo stowage and securing[6].

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[5] When the roll period of the ship equals the apparent wave period, each roll is boosted by the waves causing progressively larger angles of roll.

[6] Shipper, carrier and master are general terms and include the authorised servants of each.

2.2.3 In the case of cargo accepted for carriage by sea in containers, masters are disadvantaged in that they have no practicable way of knowing how well cargo is secured within the container. There is evidence that cargo inside some of the containers that toppled on *Union Rotoma*, and those adjacent to the toppled containers was not adequately secured within.

2.2.4 Cargo that is free to move within a container can:

- sustain damage
- cause damage to the container
- add to the dynamic forces at work on a block stow of containers
- put additional strain on container lashing systems
- in some cases, pose a hazard to the ship and its crew.

2.2.5 It was not possible to establish to what degree cargo shifting within the containers on deck 5 contributed to the accident, but it is considered to have been a contributing factor.

2.2.6 The International Maritime Organisation (IMO) and the Nautical Institute have prepared numerous publications and documents to assist shippers in preparing cargo for carriage by sea. In New Zealand, the Maritime Safety Authority will shortly circulate to the transport industry, for discussion, draft rules for the Carriage of Cargoes - Stowage and Securing, which if adopted will make compliance with the IMO documents on cargo securing mandatory for shippers, ship owners and ship masters. If complied with, these rules will have the potential to significantly improve safety at sea by reducing the number of accidents such as this.

2.3 Planning and loading of containers

2.3.1 A prudent mariner, where practicable, will load deck containers with “heavies” on the bottom and progressively lighter ones on top. It is usually planned as such, not only to improve the stability of the ship, but also to lower the centre of gravity of each container stack, thereby significantly reducing the dynamic loads on the lashing equipment.

2.3.2 If the stability of the ship is not critical, the second advantage is often overlooked and containers destined for the same port of discharge are planned or loaded having little regard for the stability of each individual stack. Such loadings are often thought of as “easy loadings” by the planner and by the stevedoring services ashore.

2.3.3 The loading disposition for *Union Rotoma* on its voyage from Sydney to Adelaide bore some resemblance to such a loading. The stability of the vessel at 0.91 m GM was not critical. There were examples throughout the load on deck 5 of heavy containers loaded on top of light ones, heavy containers loaded on other heavy ones adjacent to light containers loaded on other light ones.

2.3.4 After discharge in Sydney, two free-standing stacks of two-high containers remained in Bays 15 and 17. These were the first containers to topple, before Union Rotoma encountered the larger waves that caused the main shift of cargo. A prudent measure would have been to re-stow the second tier containers down beside the first tier for safer stowage and easier lashing. Had this been done, it is unlikely that they would have sustained damage.

2.3.5 Since the advent of high cube containers, ships that utilise bridge fittings as part of their lashing system have had to arrange the disposition of high cube containers in the stow to facilitate the fitting of bridge pieces. If bridge fittings are to be utilised on *Union Rotoma*, the disposition of high cube containers will have to be considered by the cargo planners.

2.3.6 To follow all of the practices mentioned above will take additional time and careful planning, both ashore and on the ship. It will not always be practicable to achieve the perfect stow, but it should certainly be possible to achieve a better stow than that on deck 5 of *Union Rotoma* when bound for Adelaide.

2.4 Lashing system and procedures

2.4.1 The system the crew were using to lash containers on deck 5 of *Union Rotoma* was not consistent with the cargo securing manual. The diagram posted on the bulkhead in the cargo deck office showed that chains should be applied vertically. The diagram in the cargo securing manual showed chains angled towards the centre of each block stow; however, this diagram was not supported by the text, which referred to chains being "vertical".

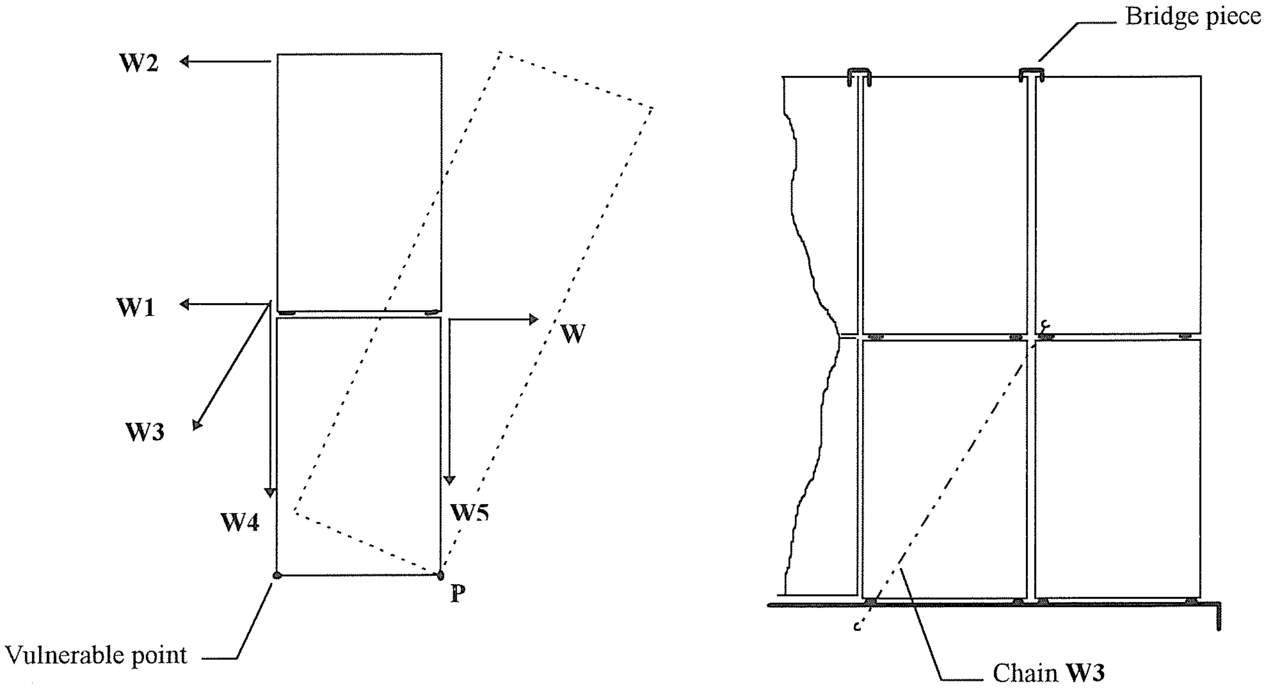

Figure 7
Preferred lashing system

2.4.2 If stacking cones and twistlocks are serviceable and fitted correctly, the whole stack becomes integral with the deck. When the vessel rolls there will be a tendency for the outside stack in a block stow to topple about its pivot point P in Figure 7 above. Chains should be fitted to alleviate the tension at the most vulnerable points, the deck fittings on the inboard side. The most efficient lashing to counter the toppling force W would be a chain in direction W1 or a bridge piece at W2. As W1 would not be practicable, the next best option would be a chain in direction W3, as shown in the cargo securing manual. A less effective direction is W4, the method used on *Union Rotoma*. A chain in position and direction W5, also used on *Union Rotoma*, serves little purpose unless the stack is free-standing.

2.4.3 If the chain at W3 is of sufficient strength, then the bridge piece may not be required; however, where chains could not be fitted at the opposite end of the container, then it would have been prudent to fit a bridge piece.

2.4.4 The instruction in the cargo securing manual with regard to the use of bridge fittings was somewhat vague. From reading the manual, it was not possible to establish conclusively whether bridge pieces were supposed to form part of the standard lashing equipment on deck 5.

2.4.5 The calculations made with respect to the cargo securing manual were based on the lashing equipment being in serviceable condition, and fitted correctly. From inspection of the failed container lashing equipment, and observations made after the accident, it appears that the portable lashing equipment on board *Union Rotoma* was in need of some sorting, repair and replacement.

2.4.6 Container fittings are only as good as the permanent fixture to which they are attached. Some of the recessed sockets in deck 5 of *Union Rotoma* had become enlarged through corrosion which resulted in a reduced holding potential. There was evidence that some sockets had been damaged prior to the accident, probably by containers being lifted with a pin still inserted through a stacking cone.

2.4.7 Container fittings require frequent on-going maintenance. The incidence of damage due to rough handling can be high. When different fittings are used on different decks, frequent sorting is required to eliminate the possibility of the wrong type of fitting being used for a task. The progression of fittings between decks is a natural process, as is the infiltration on board of rogue fittings from other ships. The indications were that the procedure for sorting, repairing and replacement of container lashing equipment on board *Union Rotoma* was not carried out frequently enough.

2.4.8 Although the shore labour were responsible for placing and locking the stacking cones and twistlocks on deck 5, the ultimate responsibility lay with the crew for checking that the task was carried out using the correct fittings and in accordance with the cargo securing manual.

2.4.9 It was apparent from the statements of the crew that the gearmen did not routinely check the work of the shore labour, nor did the duty deck officer. Both were usually occupied with other tasks. Even the checks carried out by the chief IR did not encompass the stacking cones and twistlocks. Evidence of this was seen during the visit on board in Wellington subsequent to the accident.

2.4.10 Judging by the pattern of cargo shift and loss overboard, it appears that not all twistlocks and stacking cones that were able to be locked, had been.

2.4.11 With the cargo operation procedures as they stood on board *Union Rotoma*, it was not possible for the master to know conclusively if the cargo had been stowed and secured as per the cargo securing manual, or stowed in accordance with prudent seamanship.

2.5 Summary

2.5.1 A number of factors have been discussed which are considered to have contributed to the loss of and damage to cargo on board *Union Rotoma*. None of the factors on their own would have caused the accident. Most were latent failures in the system for planning, stowing, securing and checking cargo on board the vessel; failures in defences designed to safeguard the cargo, the vessel and its crew.

2.5.2 The adverse weather encountered on the day of the accident was foreseeable, and not unusual for the area. It was merely the final factor needed to push the weakened system beyond its tolerable limits.

3. Findings

Findings and safety recommendations are listed in order of development and not in order of priority.

3.1 The *Union Rotoma* was crewed as required by its safe manning certificate, and its statutory and trading certificates were current.

3.2 The weather and sea conditions encountered by *Union Rotoma* were adverse, but not beyond those which the vessel and its cargo could reasonably be expected to endure.

3.3 The following are some of the factors contributing to the loss of and damage to cargo on *Union Rotoma*:

- some cargo had not been adequately secured to cargo bases, or adequately secured within containers by its shippers
- the cargo carrier had failed to recognise that some cargo was not adequately prepared for carriage by sea
- the master had failed to recognise that some cargo was not adequately prepared for carriage by sea
- prudent seamanship had not been applied to the planning and stowage of some containers on deck 5
- the cargo securing manual on board *Union Rotoma* was not clear on how cargo on deck 5 should be lashed
- the cargo lashing chains were not put to optimum use
- some unserviceable container fittings, and some of the wrong type for the stow, were made available to and were used by the shore labour
- the effectiveness of some fixed container lashing points on deck 5 was reduced by corrosion and/or existing damage
- the on-board system for checking the lashings on containers did not ensure that stacking cones and twistlocks were in the correct location and locked.

3.4 The system on board *Union Rotoma* for sorting and maintaining the lashing equipment, and for ensuring its proper use, appeared to have suffered from a lack of resources.

4. Safety Actions

4.1 Union Shipping undertook to:

- conduct shipboard inspection of cargo securing devices and remove any defective items from use
- continue to replace defective equipment with equipment of suitable quality
- fully implement a maintenance plan based on the requirements of section 2 of the cargo securing manual, and more closely monitor maintenance and record keeping
- discuss cargo securing, and this accident in particular, with the charterer of the ship
- conduct a review of instructions relating to cargo care and cargo securing and review the cargo securing manual

- review instructions/guidance on the management of ships in heavy weather
- fully discuss the accident with the master and satisfy themselves that he is clear on his authority.

4.2 Australia New Zealand Direct Line advised the following:

- preferred securing methods for a wide range of goods carried on platforms, flat-racks and as break bulk consolidations are held on file. Since the incident, the preferred method for timber master pack consolidation and securing has been circulated to timber exporters
- material has been gathered for circulation to exporters, giving preferred methods to achieve a correct and immovable stow of goods within containers
- in accordance with long-standing procedure and practice, representations were made to the exporter of goods that were identified as having shifted within containers
- a meeting was held with the ship managers to review the standard of cargo presentation, the planning of stowage and stevedoring practices
- it is intended to address all stevedores of the need to ensure container interlocking devices are placed in accordance with the approved lashing plan and locked correctly.

5. Safety Recommendations

5.1 On 1 December 1998 it was recommended to the Managing Director of Union Shipping New Zealand Limited that he:

5.1.1 liaises with the Bureau Veritas Classification Society to re-assess the requirements for lashing containers on deck 5, (112/98); and

5.1.2 surveys the fixed container lashing points and makes repairs as necessary. (113/98)

5.2 On 21 December 1998 the Chief Executive of Union Shipping New Zealand Limited responded as follows:

5.2.1 We will liaise with Bureau Veritas Classification Society in respect of the requirements for lashing containers on Deck 5.

5.2.2 We shall be repairing container lashing points as necessary whilst the ship is in service and expect to carry out a detailed survey/repair at the next scheduled docking (January 2000).

Approved for publication 3 February 1999

Hon. W P Jeffries
Chief Commissioner

Glossary of marine abbreviations and terms

aft	rear of the vessel
beam	width of a vessel
bilge	space for the collection of surplus liquid
bridge	structure from where a vessel is navigated and directed
bulkhead	nautical term for wall
cable	0.1 of a nautical mile
chart datum	zero height referred to on a marine chart
command	take over-all responsibility for the vessel
conduct	in control of the vessel
conning	another term for "has conduct" or "in control"
deckhead	nautical term for ceiling
dog	cleat or device for securing water-tight openings
draught	depth of the vessel in the water
EPIRB	emergency position indicating radio beacon
even keel	draught forward equals the draught aft
freeboard	distance from the waterline to the deck edge
free surface	effect where liquids are free to flow within its compartment
focsle	forecastle (raised structure on the bow of a vessel)
GM	metacentric height (measure of a vessel's statical stability)
GoM	fluid metacentric height (taking account the effect of free surface)
GPS	global positioning system
heel	angle of tilt caused by external forces
hove-to	when a vessel is slowed or stopped and lying at an angle to the sea which affords the safest and most comfortable ride
Hz	hertz (cycles)
IMO	International Maritime Organisation
ISO	International Standards Organisation
kW	kilowatt
list	angle of tilt caused by internal distribution of weights
m	metres
MSA	Maritime Safety Authority
NRCC	National Rescue Co-ordination Centre
point	measure of direction (one point = 11¼ degrees of arc)
press	force a tank to overflow by using a pump

SAR	Search and rescue
SOLAS	Safety Of Life At Sea convention
sounding	measure of the depth of a liquid
SSB	single-side-band radio
statical stability	measure of a vessel's stability in still water
supernumerary	non-fare-paying passenger
telegraph	device used to relay engine commands from bridge to engine room
ullage	distance from the top of a tank to the surface of the liquid in the tank
VHF	very high frequency
windlass	winch used to raise a vessels anchor