Headquarters
New Zealand Defence Force
Defence House
Private Bag 39997
Wellington Mail Centre
Lower Hutt 5045
New Zealand

OIA-2024-5001

6 September 2024

[redacted]@rnz.co.nz

Dear [redacted]

I refer to your email of 16 April 2024, and subsequent refinement of 16 June 2024, seeking under the Official Information Act 1982 (OIA), any reports held by the New Zealand Defence Force (NZDF) about why one or both of the two Royal New Zealand Navy (RNZN) frigates have been *out of action* over the past 18 months. I apologise for the significant delay in providing this response.

For the past three years, HMNZS Te Kaha has been in deep maintenance to address repairs to the hull, auxiliary support machinery and to replace the propulsion diesel engines. Once this work was completed in April 2024, HMNZS Te Kaha returned to sea on 13 May 2024. It was unavailable for tasking for 15 days following a collision with the wharf at Kauri Point. A copy of the incident report is enclosed. The rank and name of a member of the Royal New Zealand Navy is withheld to maintain the effective conduct of public affairs in accordance with section 9(2)(g)(i) of the OIA. Signatures and contact details are withheld in accordance with section 9(2)(k) of the OIA to avoid the malicious or inappropriate use of staff information, such as phishing, scams or unsolicited advertising.

Outside of maintenance availability periods, HMNZS Te Mana has not been unavailable for tasking during the period of your request.

Capability and Readiness Reports provided to the Minister of Defence, which include information about the frigates' status, are publicly available on the NZDF website[1].

You have the right, under section 28(3) of the OIA, to ask an Ombudsman to review this response to your request. Information about how to make a complaint is available at www.ombudsman.parliament.nz or freephone 0800 802 602.

Please note that responses to official information requests are proactively released where possible. This response to your request will be published shortly on the NZDF website, with your personal information removed.

Yours sincerely

AJ WOODS
Air Commodore
Chief of Staff HQNZDF

Enclosure:
1 Incident Report

[1] https://www.nzdf.mil.nz/assets/Uploads/DocumentLibrary/OIA-2023-4872_Capability-and-Readiness.pdf

CLASSIFICATION: RESTRICTED

TITLE OF DOCUMENT: FNO'S INITIAL INCIDENT REPORT FOR ALLISION AT DEFENCE ARMAMENT DEPOT – KAURI POINT INVOLVING HMNZS TE KAHA – 16 MAY 24

Author: s. 9(2)(g)(i) [redacted]

Staff Officer	Signature	Date	Comments
MCC	s. 9(2)(k) [redacted]	14/6/24	Noted and directed. I do note that TEK put a bit of weight into the comms issues which did not feature within. I am keen therefore that TEK's trial or new comms has some structure behind it and linked to Cap Br. CFOR to action.
XO MCC	s. 9(2)(k) [redacted]	23 MAY 24	Sir, This is FNO's report on TEK's berthing incident @ Kauri Pt on 16 MAY 24. You are requested to note & direct at para 48. Separately, I will follow up direct with TEK that the points at para 4 are addressed.
Assistant to XO MCC	s. 9(2)(k) [redacted]	22/5/24	

Royal New Zealand Navy

RNZN MTG MINUTE 33/2024

21 May 24 PHL 3095-0013

See distribution

FLEET NAVIGATING OFFICER'S INITIAL INCIDENT REPORT FOR ALLISION AT DEFENCE ARMAMENT DEPOT – KAURI POINT INVOLVING HMNZS TE KAHA – 16 MAY 24

References

A. RNZN 232: HMNZS TE KAHA dated 16 May 24
B. HMNZS TE KAHA Minute 76/2024
C. NFGO, Part 3, Chap 6
D. MM 33.45, Chap 2, Para 2.02
E. BR45(6)

Aim and Purpose

1. This minute formalises the findings of the Fleet Navigating Officer's (FNO) investigation into an allision involving HMNZS TE KAHA (TEK) at Defence Armament Deport Kauri Point (DADKP) on 16 May 24. The incident resulted in damage to the Ship's starboard bow, as outlined in refs A and B.

2. In accordance with refs C and D, FNO is authorised to investigate collisions, near misses, and maritime incidents involving HMNZ Ships for MCC JFNZ. This report will only identify and describe the causal factors that led to the incident occurring.

Limitations of Report

3. As this report only covers the initial investigation, only the readily accessible evidence has been used. The primary source used has been the ECPINS voyage data recordings to recreate the Ship's historical track and environmental condition. For this initial report, in order to maintain objectivity and accuracy without bias, no one was interviewed by FNO.

4. The following limitations prevented a full construction of bridge events:

   a. TEK was unable to extract bridge voice recordings from the Ship's Voice Data Recorder (VDR)[1] system, meaning no recreation of bridge conversations was possible[2].

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[1] The Voice Data Recorder is not to be mistaken with the synonymous acronym for ECPINS' Voyage Data Recorder. The Voice Data Recorder systems allows playback of bridge conversations, including transmissions on internal and external circuits. The ECPINS Voyage Data Record (similar to an aircraft's black box) provides a replay and interrogation function of all data processed in WECDIS. This is useful for reconstructing a vessels movements and environment conditions.

[2] TEK's NO reported to FNO on 20 May 24, that the Ship's WE department identified an issue with the Ship's VDR, whereby the system was only storing the last 15 mins of recorded only. The system is designed to store up to 7 days' worth of information.

b. TEK's Ship's Log and Navigation Record Book are both scant of details. Additions by the OOW are insufficient to create any narrative or understand the sequencing of events[3].

5. When available, IPMS data can be manually overlayed to the ECPINS records, to understand helm and engine orders passed throughout the evolution. At the time of writing, this was not available.

Equipment Defects and Limitations

6. The ECPINS voyage data recorder does not record AIS contact information to a sufficient standard to reconstruct movements/actions based on orders passed by TEK. While position, COG and SOG[4] are recorded these do not provide enough information for understanding working loads and what effect the tugs had during the incident.

Since the allision, TEK has reported that the ICOM VHF radios used for tug control are defective/ineffective.

Reconstructed Summary of Events

7. TEK was scheduled to berth at DADKP for ammunitioning at 0800, 16 May 24. The berthing was discussed by the CO and NO the day prior and it was later briefed again during the entering harbour brief the morning of the incident. The Ship was fully closed-up at Special Sea Dutymen, in DE mode, bridge control, with the gas turbine at 5 mins notice.

8. During the pilotage it was noted that the weather had deteriorated from the briefed weather, as squalls and increased winds were passing. The CO and NO discussed the weather condition and decided to proceed with the evolution as briefed. The wind sat at 25kns from the NW gusting 30kn during the approaches.

9. Two Ports of Auckland Limited tugs were in attendance to support the manoeuvre; Waipapa (ASD, 50T bollard pull) positioned forward, and Hauraki (ASD, 70T bollard pull) positioned aft.

10. As TEK rounded Kendall Bay, the ship maintained a consistent 70yds displacement from the wharf, continuing NW. The Ship was carrying 4kn of speed and overshot the berth by approximately 115yds. Wind at this time was 290° at 25kn, gusting 28kn.

11. The Ship came to a stop in the water in this position before commencing a stern board SE to recover the intended position abeam the wharf, and still maintaining the 70yds later displacement. The CO reported that it was hard to find a suitable lever setting – this is likely due to the collective impacts of shallow water effects and virtual mass. Wind at this time was 290° at 24kn, gusting 26kn.

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[3] This is in contravention to guidance provided in **MM33.45, Chap 5, Para 5.03**, which states, in part: Contrary to BRd 45 Vol 1 and 4, the Navigation Record Book will remain in service in the RNZN.

It is expected that RNZN BWKs record all pertinent information, that is not otherwise included in the ECPINS voyage data recorder.

[4] Course over-ground and Speed over-ground.

12. When TEK was approximately 60yds from the intended abeam position the Ship generated slow headway, and lateral closure towards the wharfing structure of DADKP. Tugs were used to aid the lateral closure. This lateral movement was slowly checked, with the Ship now 35yds displaced and approximately 80yds ahead of the intended final position. Wind at this time was consistent at 290° at 25kn.

13. A slow stern board commenced, which would increase up to 1.2kn. The Ship now closed the wharf on a G135 vector, and the bow started slowly sheering to stbd towards the wharfing structures. The power applied astern, would have moved the pivot point aft and centre of windage to a point of rotation aft. Wind at this time was at 300° at 23kn.

14. Tugs were ordered to reposition and manoeuvre for a pull to control the Ship's movements. Allegedly the forward tug did not execute the directed order. A second order was passed for the forward tug to increase weight, which was noted to be slow in response by bridge staff. The slow response is likely attributable to the collective impacts of shallow water effects and virtual mass.

15. The combination of wind conditions on the port bow and sufficient sternway both created a turning effect where the bow would sheer towards the wharf. With the Ship's sternway of 1.2kn , and the Ship's bow contacted the first NW dolphin from main jetty structure. Wind at this time was 302° at 24kn. The time of allision was 0832.

The forward tug then commenced lifting off as the Ship applied more stern power get away from the wharf. The tug's power was not sufficient and the starboard shoulder scrapped the crane situated on the wharf. Both tugs were then stopped and re-ordered to pull the ship off the wharf; this was successfully executed and the Ship's bow came around to the line of the wharf. From this point tugs and lines were used to steady the ship to the wharf with no further reported incidents.

Contributing Factors

Berthing Conditions

16. Annex A includes a breakdown of berthing conditions including tidal calculations and environmental conditions.

Relevant Shiphandling Principles

17. Annex B includes a breakdown and technical descriptions of relevant shiphandling principles which apply to this incident.

Identified Factors

18. It is assessed that the cause of the allision is the compounded effects of the following two factors:

a. Effect of Virtual Mass on Acceleration and Deceleration in Shallow Water

b. Movement of the Pivot Point – Effect on Centre of Windage (Wind Sheer)

Effect of Virtual Mass on Acceleration and Deceleration in Shallow Water

19. As explained in Annex B, virtual mass can be described as inertia added to a system because a solid immersed in a fluid must move a certain volume of the surrounding fluid as it moves through it. For a ship to generate headway, it must overcome the forces of water interacting against its hull form – most commonly by the application of power by main engines.

20. In deep water, virtual mass (M1) is about 105% to 110% of mass for most warships (M). However in shallow water, because of the changes in flow pattern around the hull this increases to about 140%. In consequence, a given propulsion force produces smaller acceleration and deceleration in shallow water than in deep water. By applying Bernoulli's Principle to these percentages (ie 105% and 140%) it can be seen that in shallow water the effect of virtual mass can make about a 30% difference to the effect of the propulsion force.

21. This means that a ship in shallow water will take longer, in both time and distance, to accelerate to the required speed and to stop; even if astern power is applied. Ref E highlights that this effect has caused a number of berthing incidents and should always be borne in mind when assessing safe speed.

22. **Effect of Shallow Water on Physical Efficiency of Propellers.** In addition to the effect of virtual mass in shallow water on the stopping/acceleration power of a ship, propellers operating close to the sea bottom also encounter greater turbulence as a result of the constriction in water flow, particularly when being used to take the way off a moving ship, and thus the physical efficiency of the propellers is reduced. This compounds the reduction in stopping/acceleration power caused by virtual mass.

23. **Effect on Sideways Manoeuvring and Use of Tugs.** The difference between M and M1 is known as the 'Added Mass'. Added Mass is much greater for sideways movement (e.g. when the ship is being moved bodily sideways with little or no headway/sternway) than for ahead movement, because the water flow pattern is entirely different.

24. When berthing alongside, sideways motion may increase the virtual mass of a ship by several hundred percent rather than by just a few tens of percent. This increase in virtual mass has to be allowed for when considering the use and required power of the tugs for manoeuvring the ship sideways, particularly when lowering a ship down onto a jetty with an onshore wind.

Movement of the Pivot Point - Effect on Centre of Windage (Wind Sheer)

25. As explained in Annex B, the pivot point does not remain stationary but rather it will change as factors such as ship's speed change; these dynamic effects are particularly important when the interaction with the wind is considered.

26. When berthing or in other confined-water situations, the effect of the wind in relation to the movement of the pivot point (known as wind sheer) is critical. Wind sheer effect is exacerbated on Anzac Class frigates by the fact that CPPs[5] delivers astern power much more sharply than FPP[6], and so the pivot point movement is consequently also more rapid. The reduced athwartships turning forces in CPP fitted ships have made the effects of wind sheer harder to counter, especially when it is unexpected and thus unanticipated, and happens very quickly.

27. **Centre of Windage.** Anzac frigates have evenly distributed superstructures, and when stopped in the water with no power applied by the propellers have their centre of windage near the mid-point of the ship; close to the equivalent pivot point when stopped. As a result, they lie roughly beam to the wind (i.e. with wind at Red/Green 90°).

28. **Movement of the Pivot Point and Wind Sheer.** When astern power is applied to a ship with headway, the pivot point moves smartly aft to a position roughly at the mid-point of the ship (close to the 'stopped in the water' pivot point position), even though some headway remains.

29. This dramatically changes the tendency of the bows to seek the wind. It was the failure to appreciate this change, almost immediately after the application of astern power, which is often incorrectly interpreted as an 'unpredictable' sheer in many CPP fitted ships. Figure 2 shows the wind sheer turning effect on approaching a berth for various wind directions on a typical frigate/destroyer with headway immediately after it applies astern power.

a. **Wind Sheer - Moment of Inception.** Inspection of Figure 2 shows that as soon as astern power is applied to a ship making headway, the pivot point moves aft to the mid-point of the ship. When this occurs, instead of the bows seeking the wind, in ships with a balanced superstructure the wind sheer contributes to turning the ship beam-on to the wind.

b. **Wind Sheer - Most Dangerous Quadrants.** Further inspection of Figure 2 also shows that, in common with the empirical experience of many shiphandlers, a wind on the inboard quarter or on the outboard bow are by far the most dangerous as they institute a wind sheer turning effect towards the jetty. In these circumstances, the best action is to apply outboard helm and start a gentle swing away from the jetty, before applying astern power.

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[5] Controllable pitched propellers.

[6] Fixed pitched propellers.

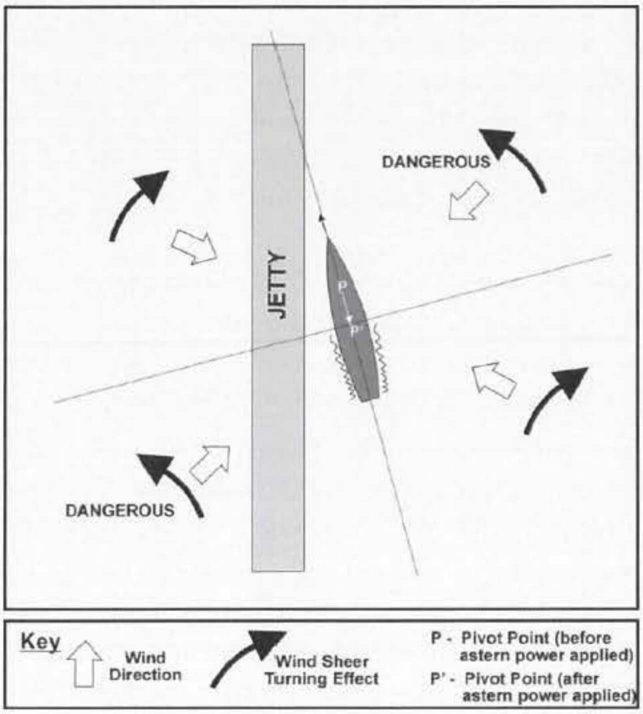


Figure 2: Wind Sheer Turning Effect, when Astern Power Applied to a Ship with Headway

Summarised Events Relevant to the Contributing Factors

30. Conditions for the pilotage and berthing presented at the higher end of the safe operating envelope. This had actively been discussed by Command prior to transiting under the Harbour Bridge.

31. As TEK made their final turn around Kendal Bay towards DADKP, the Ship was making 4kn SOG. When the speed reduction was made, the Ship had already past DADKP. The Ship came to a momentary stop 115yds further NW than the initially planned positioned. This was a departure from the briefed plan – the CO rightly made a conscious decision not to pull-up short, though it was intended to be so far ahead..

32. The departure from the briefed plan, and forward positioning of TEK, required the ship to generate sternway to return to the SE, to then be safely laterally walked to starboard.

33. As astern power was applied and the ship generated slow sternway and the pivot point would have shifted aft, thus moving the Ship's centre of leverage for forces, especially the wind. The CO reported that it was hard to find a suitable lever setting at this time. This is likely due to the collective impacts of shallow water effects and virtual mass.

34. TEK was able to appropriately balance forces with the tugs and stern power alone. A decision was made to reposition the tugs for a push-on to achieve the desired lateral close towards DADKP. Lateral closure commenced before the Ship was adjacent to the final berth position.

35. As TEK closed the wharf sternway was slowly generated again, but this time without the control of the tugs that had previously been pulling off iaw berthing guidance in ref E.

36. As TEK continued astern the bow was not under positive control and the pivot point was now firmly aft with the wind in the dangerous sector – the conditions had been laid for wind sheer to take effect.

37. As seen in Figures 3 through 6, the bow and stern vectors dramatically increased in speed (represented by growing length) as sternway increased. Though the initial movement of the bow to starboard is almost certainly because of wind sheer, part of this bow movement was possibly exasperated by the tugs; reportedly only the after tug was acting.

38. Sluggishness of both TEK and the tugs to respond to engine and helm orders is attributable to the shallow water effect on virtual mass, and decreased efficiency in the shoaling water close to DADKP.

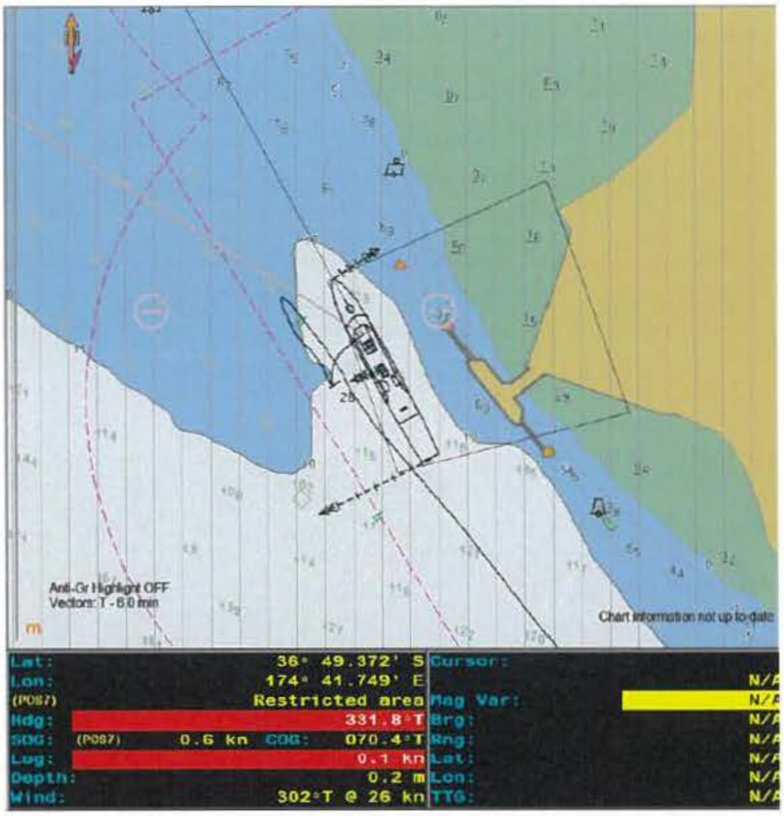


Figure 3: Screen Capture 0829:24, 16 May 24.

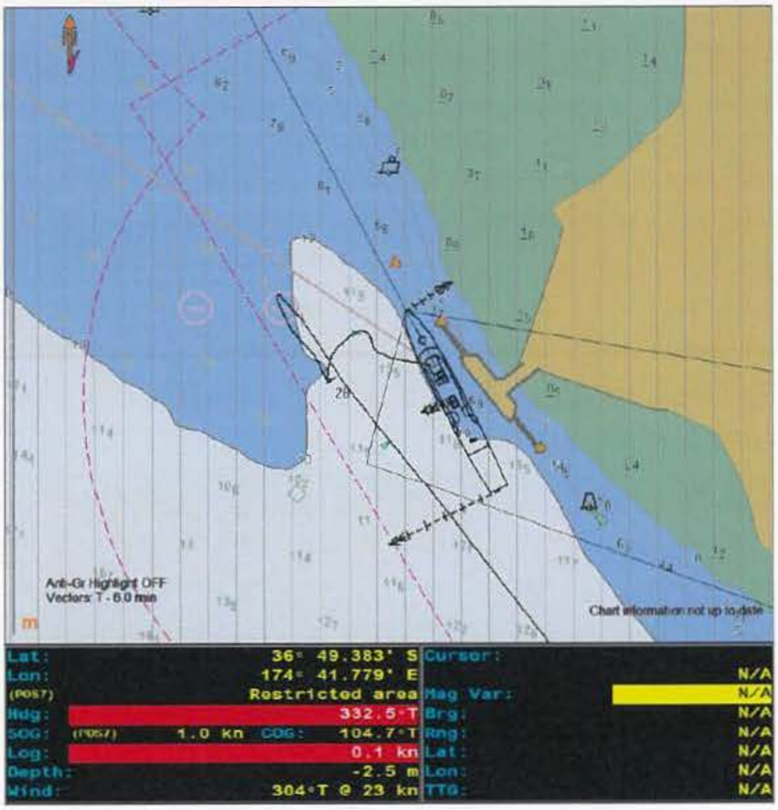


Figure 4: Screen Capture 0831:57, 16 May 24.

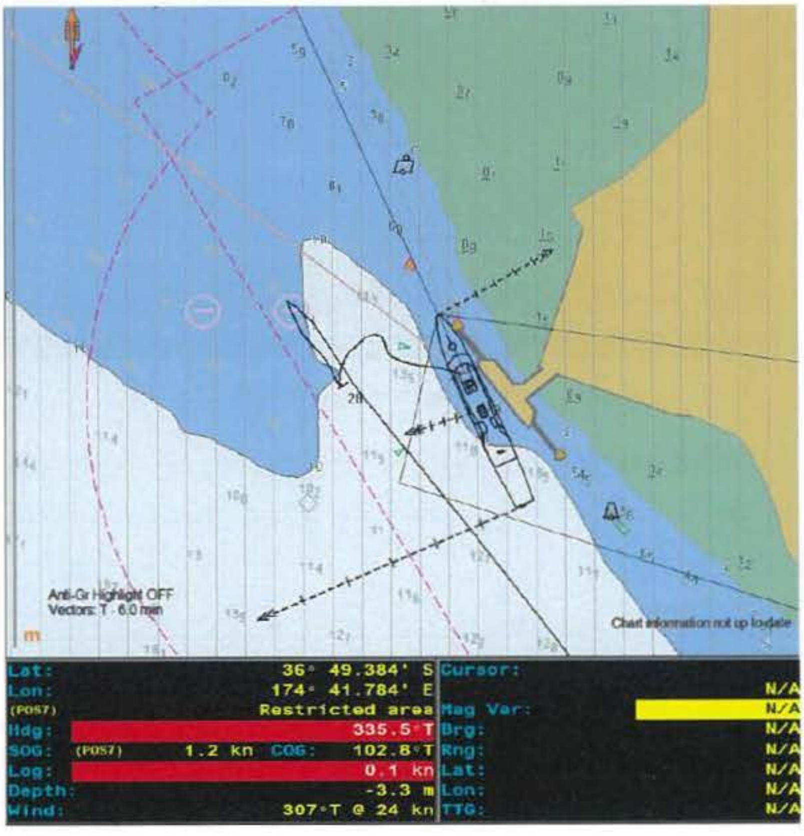


Figure 5: Screen Capture 0832:12, 16 May 24.

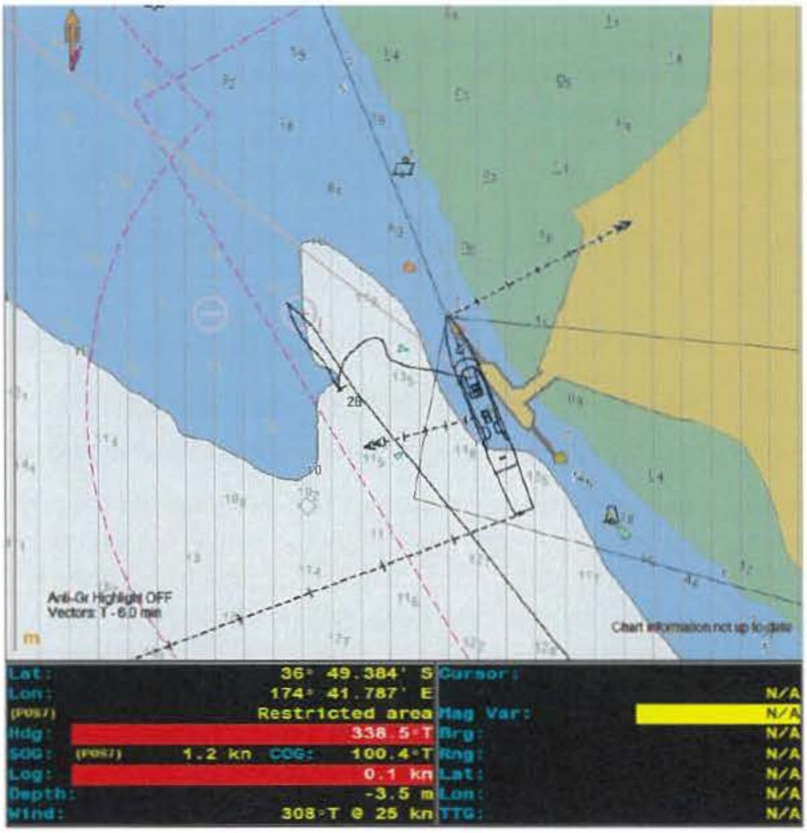


Figure 6: Screen Capture 0832:18, 16 May 24.

Ports of Auckland Tugs

39. Allegedly the forward tug did not execute a couple of directed orders. A potential reason for the slow response can be attributed to the collective impacts of shallow water effects and virtual mass.

40. The tugs were also requested to quickly reposition from a push-on to achieve a pull-off. While this can be done quickly, it does not necessarily happen at the pace the shiphandler may desire when in the throes of shiphandling.

41. Since the incident, TEK has reported that they do not have full confidence in their ICOM VHF radios for communicating with the tugs. This is a potential point of failure and potentially contributing reason for the slow forward tug responses, however it was commented that the after tug had executed orders as directed over the same VHF comms.

42. The conduct of POAL tugs throughout the berthing evolutions does not change the identified causal factors identified.

43. It is recommended that POAL is contacted and notified of the incident, and requested to support any future investigation, including sharing of VHF and VDR recordings.

Findings

44. There is no evidence of negligence. Berthing conditions were tricky and presented at the higher end of the safe operating envelope – though conditions were considered and assessed throughout the evolution.

45. POAL tugs in attendance are a potential contributors to the allision, but based on information available to reconstruct events, their movements and actions cannot be corroborated.

46. It is assessed that the cause of the allision is the compounded effects of the following two factors:

a. Effect of Virtual Mass on Acceleration and Deceleration in Shallow Water, including:

(1) the effect of shallow water on physical efficiency of propellers, and

(2) the effect on sideways manoeuvring and use of tugs.

b. Movement of the Pivot Point – Effect on Centre of Windage (Wind Sheer).

47. Departures from the briefed plan meant that TEK was required to conduct a stern board with the dominant environmentals situated in the dangerous sector for berthing. This shifted the pivot point aft and meant the bow was susceptible to wind sheer, which is almost certainly what caused the bow to rapidly close the wharf structure.

Recommendations

48. It is requested that recommended that MCC JFNZ:

Noted a. **Note** the findings of this report.

Directed b. **Direct** SON and FNO to update MM33.45 and NZBR 46 to add commentary of wind conditions, especially from the west, and possibility of shallow water effects.

s. 9(2)(k)

s. 9(2)(g)(i)

FNO

DTelN s. 9(2)(k)

Annexes:

A. Berthing Conditions

B. Relevant Shiphandling Principles Related to the Incident

Distribution:

MCC (through: XO MCC)

For information

CN

CFOR

CO TEK

CFOR CoS

CO MTG

NTO

Annex A to
PHL 3095-0013
Dated 21 May 24

BERTHING CONDITIONS

1. **Tides.**

Auckland Lat. 36° 51´S., Long. 174° 46´E. Times and Heights of High and Low Waters		
16 MAY 2024		
Tide State	**Time**	**Height**
HW	0127	3.0m
LW	0741	1.1m
HW	1353	2.8m
LW	1951	1.1m

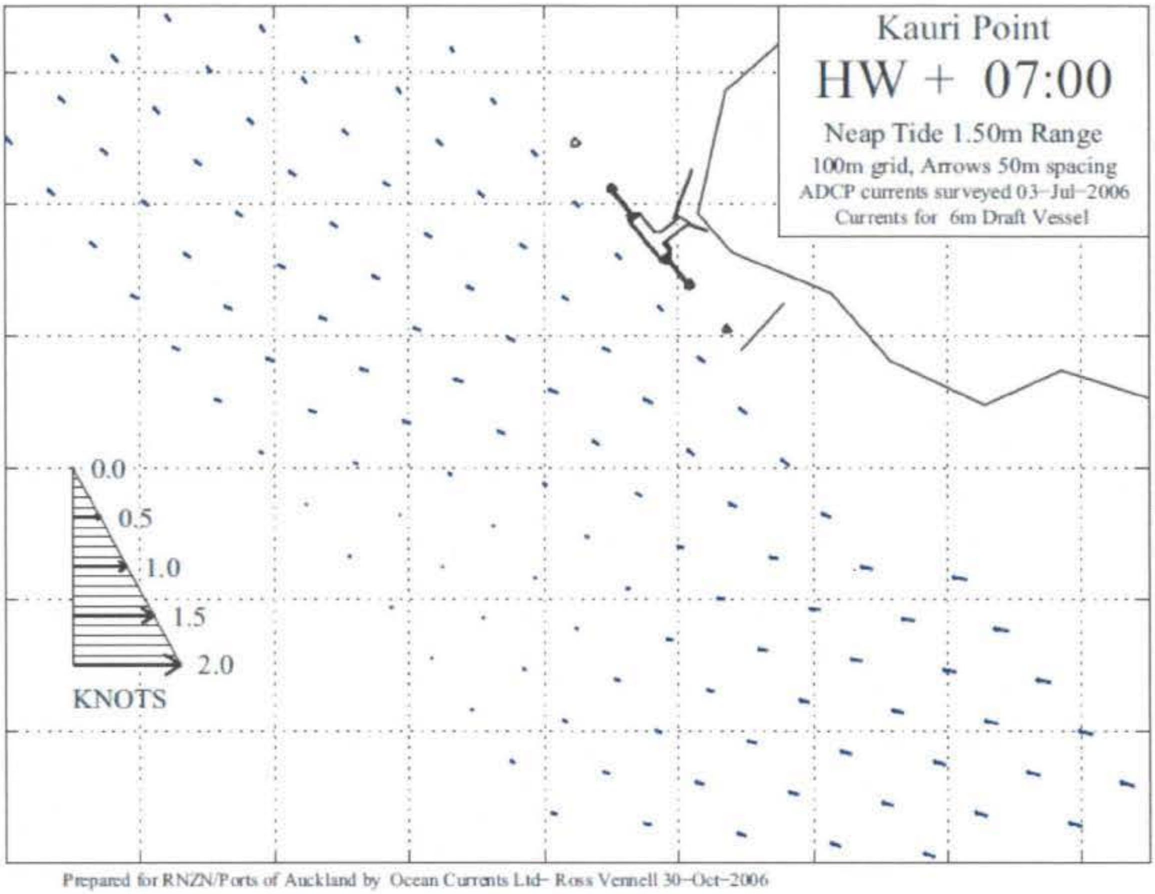
Tidal Levels

Standard Port	MHWS	MHWN	MLWN	MLWS	Spring Range	Neap Range	MSL	HAT	LAT
Auckland	3.34	2.79	1.06	0.51	2.83	1.73	1.92	3.72	0.08

2. **Tidal Calculations**

Tidal Calculations for 16 0832M May 24	
Height of Tide	1.2m
Limiting Danger Line	7.85m
State of Tide	Start of Flooding Tide
Percentage Springs	15.45%
Moon Phase	First Quarter - 15 2348 M May 24

3. **Tidal Stream**



4. **Wind Conditions:**

   a. **West transit past Kendal Bay:** 295° - 30kn (gusting 33kn)

   b. **Turn to STBD and northwest transit:** 290° - 25kn (gusting 28kn)

   c. **Adjacent to DADKP:** 290° - 25kn (gusting 29kn)

   d. **Commencement of sternboard (115yds ahead):** 290° - 24kn (gusting 26kn)

   e. **Time of allision:** 302° - 24kn

RELEVANT SHIPHANDLING PRINCIPLES RELATED TO THE INCIDENT

Bernoulli's Principle

1. Bernoulli's Principle describes how pressures within a flow stream change in proportion to the local velocity within the flow stream. Bernoulli found that when the velocity of a stream of moving fluid increases, the pressure decreases[7].

2. For ship handlers, Bernoulli's Principle is well documented, and, in addition to the lift and drag effects it causes on a hydrofoil, it has other more general effects such as squat or interaction between ships and seabed, especially in shoaling waters and during berthing evolutions.

   a. **Speed consideration:** It should be noted that, a decrease in pressure is proportional to the square of the ship's velocity. Thus, halving the ship's speed through the water will decrease the effects of interaction or squat by a factor of four, meaning that changing speed is a very effective way of mitigating any of the adverse effects of interaction/squat.

   b. **Wind consideration:** It is Bernoulli's Principle that means that a ship handler must pay close attention to the wind. Although air is much less dense than water, as the wind can blow at much higher velocities than water will ever flow, it can generate, by the operation of Bernoulli's equation, very significant effects on a ship.

Virtual Mass

3. Virtual mass is defined as the inertia added to a system because a solid immersed in a fluid most move some volume of the surrounding fluid as it moves through it. It arises out of the common sense observation that the ship and the water cannot coexist in the same place at once; therefore to accelerate a ship from rest the physical mass of the ship must be accelerated by the engines, but simultaneously an amount of water must also be moved aside.

4. For a ship of a given mass, M, the virtual mass that the engines must actually move to get the ship underway will be M1, such that M1 > M. In open ocean, M1 might only be in the order of 1.1xM, but in shallow water it will be much greater. This is due to the change in flow-pattern around the hull, and the fact that, to allow the ship to move, essentially the water must be moved further and faster due to the proximity of the bottom (due to Bernoulli's Principle).

   a. **Speed consideration:** The increased virtual mass explains why ships keep their way for longer in shallow water and will be slower to accelerate. Thus, they require greater power to effect speed change.

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[7] Mathematically, **Bernoulli's Principle** can be expressed as $\delta P \propto = V^2$, which shows that the change in pressure (δP) is proportional to the square of the velocity (V).

b. **Lateral movement consideration:** Self-evidently, the virtual mass of a ship moving sideways in the water will be many times larger than for that of a ship moving ahead, to the extent that it might amount to several times of the ship's displacement. Proportionally even greater power is needed to effect lateral movement change than for forward/aft speed change.

Berthing in Strong Onshore Winds (Using Tugs)

5. Guidance from ref E states that when berthing in strong onshore winds with tugs, the aim is to arrest the ship's forward movement parallel to the berth far enough off to give time for the tugs to take position to windward and manoeuvre to let the ship gently down on to the berth (see Figure 1).

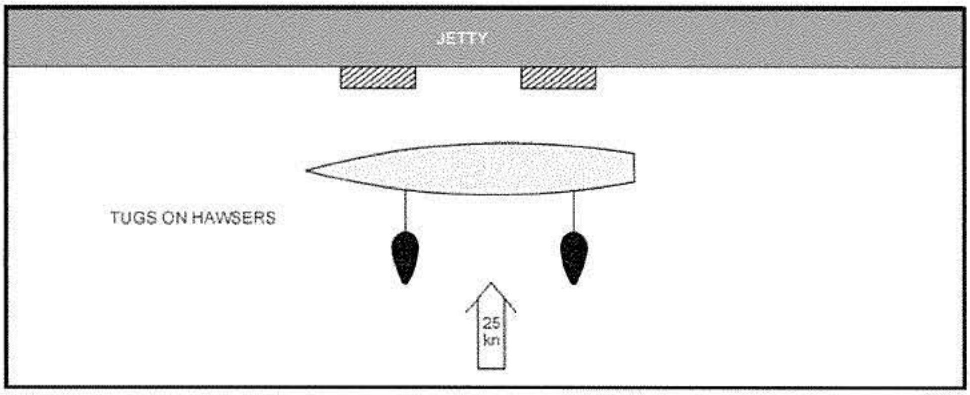

Figure 1: Berthing in Strong Onshore Wind – Tug Controlled Approach

6. For Anzac frigates, berthing alongside without tugs is not prudent in onshore winds above 15-18 knots, unless an anchor is used to hold the bow. Anzacs will only execute movements within Ports of Auckland limits using a minimum of two capable ASD tugs. Based on the environmental conditions, both tugs in attendance were capable of the power required and able to execute the work requested of them.

a. **Tug consideration:** Once the ship starts to move sideways the (greater) virtual mass of the ship and water system will require significantly more tug power to arrest any leeway generated than might be imagined. Therefore it is important to have tugs that are sufficiently powerful to check the ship's virtual mass when making leeway in these conditions.

Pivot Point

7. The pivot point is a hydrodynamic parameter considered to be the centre of leverage for forces acting on the ship. Effectively it is point of rotation of a vessel. The position of the pivot point is not fixed and varies with hull shape, rudder angle and speed.

8. The pivot point position will shift based on a ship's motion through the water changes, including when changes in power and direction is applied.

a. **Astern power with headway consideration:** Applying astern power when a ship has headway, will produce a sudden increase of pressure immediately forward of the propellers. This counteracts the bow pressure wave and causes the pivot point to move aft very rapidly to a roughly midships position.

b. **Wind consideration:** The rapid aft movement of the pivot point while the ship still has headway, as a result of applying astern power (e.g. in the final stages of a berthing manoeuvre), can have a significant effect that suddenly alters how the wind affects the ship. This phenomenon gives rise to the term 'wind sheer'.