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OIA-2016-2556

25 October 2016

Peter Griffiths
Director
New Zealand Diving and Salvage Ltd.
fyi-request-4665-813680e2@requests.fyi.org.nz

Dear Mr Griffiths

I refer to your email of 26 September 2016 to the Ministry of Defence requesting, under the Official Information Act 1982 (OIA):

…a copy of any incident reports and the subsequent safety investigation reports of all diving accidents that occurred on board HMNZS Manawanui ,during diving operations, Raglan, April 2013.

Your request was transferred to the New Zealand Defence Force (NZDF) for response, as the information you have requested is more closely connected with the functions of the NZDF.

Please find enclosed copies of the accident report, and the duty holder investigation report which the Royal New Zealand Navy provided to Worksafe New Zealand to inform their investigation. Please note that where indicated personally identifying information has been removed pursuant to section 9(2)(a) of the OIA.

I trust this satisfies your request for information. You retain the right, however, under section 28(3) of the OIA, to ask an Ombudsman to review my response to your request.

Yours sincerely

G.R. SMITH
Commodore, RNZN
Chief of Staff HQNZDF

ROYAL NEW ZEALAND NAVY
PHILOMEL
MINUTE

PHL 1006-0001
NAVOSH 352-1

9 July 13

CO PHL (Through: CSC)

ACCIDENT REPORT (OP POSEIDON - 06 APR 13)

References:
A. NZBR 23 4402 Responsibilities, Para 6c
B. Email MBIE - Dive Accident Report, Kawhia dated 24 June 13
C. Email DD(PL) DLS - Dive Accident Report dated 26 June 13

1. REF A requires an accident investigation and Annex A contains this report.

2. The accident involved a serious harm injury and was notified to the Ministry of Business Innovation and Employment, MBIE.

3. The MBIE Inspector, [redacted] refer REF B, requested a copy of the Navy accident report and that this now be forwarded to [redacted]

4. REF C considered this request and directs that Annex A be made first available to MCC and DRA through the command chain.

[redacted]
MNS

Annex:
A. Accident Investigation Report

ANNEX A TO
ACCIDENT REPORT (OP POSEIDON - 06 APR 13)
DATED 9 JULY 2013

ACCIDENT INVESTIGATION REPORT

Introduction

1. An Able Diver ADR was diving on the 6 April 2013, off Raglan and in support for Operation Poseidon when sea water entered the Dive helmet, and most probably water aspiration and removal of the helmet leading to an interruption in breathing air.

2. A subsequent difficulty in obtaining breathing air at a wet bell located 10-15m away then contributed to a state of unconsciousness. A serious harm injury.

Scope

3. The injured diver's helmet, neck dam, maintenance, surface supplied breathing air (SSBA)[1], a dive bell, regulatory and human factor and training aspects.

Aim

4. Take all practicable steps to identify whether this accident occurred as a result of a significant hazard and identify recommendations to prevent a recurrence.

Background

5. Op Poseidon 04/13 was the NZDF contribution in support of the NZ Police to recover a light aircraft, the Pilot and one passenger from the seabed off the Kawhia Coast, 1NM off Gannet Rock utilising the dive platform HMNZS Manawanui (MAN).

6. The diving provisioned by the RNZN underwater engineering team[2] whose function includes search operations pertaining to recovery of objects from seabed.

7. On the day of the accident a Petty Officer Diver PODR and an Able Diver ADR were tasked with fitting a lifting strop around the port wing of the aircraft at a depth of 56 metres. The ADR wearing a wet suit and a Kirby Morgan KMB Superlite SL 27 helmet bent under the aircraft wing.

8. The ADR stood upright, found that water had entered the helmet and had reached the nose, tried unsuccessfully to flush using a steady flow valve.

9. The ADR immediately went back to the bell and arrived with helmet and neck dam removed. The ADR was then seen by the PODR trying to don an AGA mask.

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[1] Surface supplied breathing apparatus SSBA diving equipment that supplies breathing gas at the required pressure for the depth, through a divers hose to a diver from plant at the surface.
[2] ODT Standing Orders 0107 3 a (1)

10. The PODR informed the Surface team to raise the bell and sought to hold the AGA mask to the face of the ADR during the ascent. This was partially successful.

11. The Standby Diver despatched met the bell at 25 Metres and attempted to also place the spare regulator into the mouth of the ADR and maintain his airway.

12. The ascent by dive bell and omitting the normal decompression process.

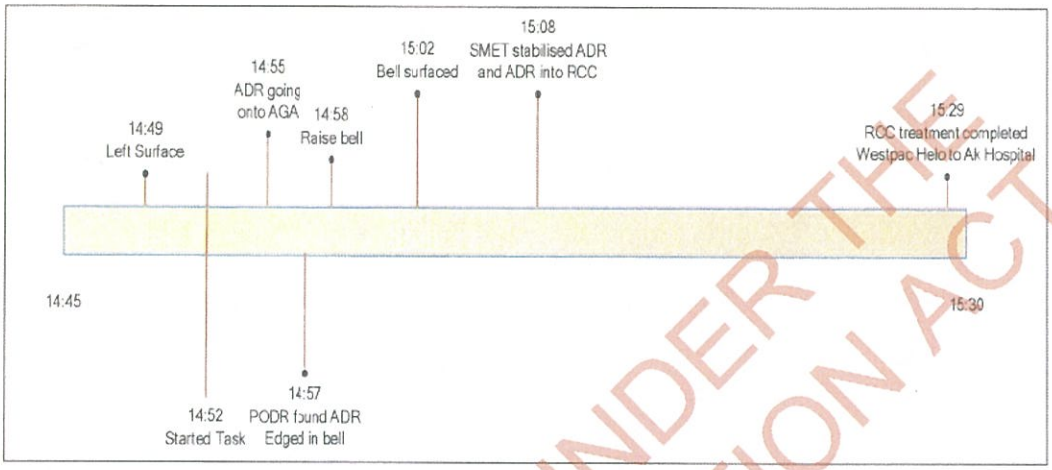

Figure 1: Accident Timeline

13. The accident timeline (Figure 1) shows that both divers arrived at the seabed safely at 1452 and that the accident occurred within the next three minutes.

Medical Treatment

14. At the surface the ADR was removed from the wet bell, placed onto a waiting stretcher and given 100% O2 via bag mask by the ships SMET team.

15. Once stable the ADR was moved to the Re-Compression Chamber (RCC) and treated for Omitted Decompression. This was a Therapeutic Flow Chart treatment.

16. On completion ADR was transferred by the Westpac Helo to Auckland Hospital.

17. The ADR was discharged, stood down from diving for a 4 week period and subsequently passed a full medical on 18 April 2013.

Reporting of Serious Harm

18. The Commanding Officer of the dive team, CO ODT, considered the definition of serious harm[3] and asked NAVOSH whether regulatory reporting was required.

19. NAVOSH, the Navy occupational safety and health unit, considered the Navy and NZDF policies and also the NZ regulatory diving guidelines[4].

[3] NZBR 23 Chapt 44, NZBR 45 chapter 0405
[4] Guidelines for Occupational Diving 2004. 1.14 Recording and notifying Accidents and Serious harm

20. A verbal notification made to MBIE on 7 April 13 and the accident report RNZN 001 received on the 8 April enabled a follow up in writing occurred on 15 April 13.

21. **Recommendation # 1** – Review RNZN and NZDF serious harm policies.

Environmental Conditions

22. Unusual diving incident or accidents are reported using a RNZN 1333 form and this report gave the environmental conditions. They appear unremarkable and could be described as good conditions for divers and for the dive platform, MAN.

Figure 2: HMNZS Manawanui

23. The environmental conditions were Sunny 1-1.5m swell, sea state 2; Tide LW 1334, Depth 55.4m; underwater visibility 3m, sandy bottom, hard and compact.

24. The water temperature reported as 9-10 C. The current as less than 0.5 kt[5].

25. MAN also reports being "well positioned with three anchors out and that there was very little movement (possibly up to 2m vertical movement due to swell) but with the depth of diving and the use of umbilical this unlikely to impact the ADR".

Further Tests and Considerations

26. A Literature Search identified a root cause model suitable for diving[6].

27. This model assumes a diving accident involves a head event and the contribution of four elements: plant, environment, the injured divers and dive teams performance. This model helped give a structure to this accident investigation.

Plant

28. The first focus was plant and especially the Divers helmet.

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[5] Current greater than 3 knots may allow water to enter exhaust valve causing regulator flooding
[6] Common factors in Diving fatalities Facility workshop Durham April 8-10 2010

29. The KMB 27 helmet[7] was formally introduced into service[8] in May 12 and in total 4 Helmets was purchased earlier and in Aug 11.

30. The reasons for purchasing included other Navies, increased diver safety and helmet protection from damage and overhead hazards eg crane operations.

Helmet Inspection Report

31. A helmet inspection[9] post accident had been completed.

32. This confirms correct maintenance and functionality of the helmet and that the neck seal was loose: it was a lot looser than the neck dams on other SL 27's.

33. A neck dam is donned prior to the head entering the helmet. The function is to provide a seal against water entry and is normally reported to have some leakage.

Neck dam variability

34. The neoprene neck dam for the SL 27 helmet has different sizes (small 11-13; med/standard 12-14; large 14-16 and X-Large 15-17 inches).

35. The injured ADR neck dam was untrimmed but trimming is permitted[10]. KMB reports this reduces length and provides a better individual comfort and fit.

36. The neck dam lacks a tracking number and the only label is an "M" ie Medium.

DTA testing

37. The assistance of the Defence technology Agency DTA[11] was obtained and who reported that only significant difference was the upper circumference.

a. "The used neck dam had a circumference that was 20 mm greater than the new neck dam. This may be due to stretching through use, but could also be the result of variability within manufacturing tolerances.

b. The circumference of the used neck dam should be compared to the neck circumference of the RNZN diver in question".

Supplier Input

38. The US based helmet manufacturer, KMB, provided further feedback[12].

[7] NSN 01-612-9799
[8] Introduction into Service – Kirby Morgan Superlite 27 (KMB 27). Naval Order 2012:07 31 May 2012.
[9] RNZN 1333B Kirby Morgan Superlite 27B Diving Helmet Inspection Report dated 16 Apr 13.
[10] BRM 3525 Superlite 27 helmet operations and maintenance manual 3.4.2 trimming the neck dam
[11] DTA technical memorandum C1278/1 Dated 20 May 13
[12] Email from [redacted] 17/4/13, Dive Lab for KMB

a. Size medium should work for necks from around 13 up to around 17 with trimming size large from 16 up to around 18.

Figure 3: KMB SL 27 Deck Dam and Helmet

b. If the neck dam is too loose gas will burp out the back of the neck whenever the diver looks down and may also leak water into the bottom of the helmet during inhalation.

39. In summary a photo of the ADR wearing a medium neck dam shows a good fit and the 20mm difference detected by DTA appears within stated KMB tolerances.

Product change

40. A comparison of the KMB operating and maintenance manual O&M and the Navy version as contained in BRM 3525 shows a difference. The BRM3525 and as updated in Jun 11 was not the current version.

41. The dive team had not been made aware of this information.

Head Cushion

42. The updated new product information[13] bulletin provides useful information.

a. Chin cushion. The chin cushion has been improved.

b. Head cushion. The fit of the head cushion is critical to both comfort and safety. The head cushion should be snug fitting and help hold the helmet to the head. The head cushion should also be adjusted so that is assists in the proper seal of the oral nasal mask to the face.

c. Head cushion foam spacer HCFS[14] for divers with smaller sized heads. The spacer helps properly position the top and back of the head in the

[13] KMB New/improved Product Bulletin #4 of 2012 13 Sept 12

helmet by using a larger foam piece in the low ever neck area which helps push the head forward and the nose and mouth into the oral nasal mask.

d. When all these products are used together they comprise a "system" that enables a customised and comfortable fit for all users.

43. **Recommendation # 2** – Fit SL 27 helmets individually

Helmet inversion

44. The SL 27 O&M manual was found to contain a warning against inversion of the helmet[15]. In fact all KMB helmet O&M and as viewed on the internet had this warning.

45. **Recommendation # 3** – Further consider the risk of helmet inversion.

Water Leakage

46. The O&M trouble shooting guide[16] identifies possible water leakage such as exhaust valve damaged or stuck open and were discounted.

47. Other causes such as Comms, neck dam torn or damaged, hair caught at the base of helmet, head cushion or chin strap caught under o-ring at neck dam and regulator assembled incorrectly were similarly discounted.

Bent Tube Assembly Damage

48. A witness mark on the bent tube assembly was found and suggests metallic contact although entanglement or rapid surfacing may have contributed. See Fig 4.

49. A further inspection was therefore completed and no defects were identified.

Helmet Specification

50. When the Superlite 27 commercial dive helmet and CE marked is used for air diving KMB stated that it may be used to a maximum depth of 50msw iaw EN 250[17].

51. This contrasts with other information eg the CE[18] marked equipment and as applicable in the EU was reviewed and the UK HSE report[19] claims performance of EN250 equipment greater than 50m cannot be guaranteed". Conversely KMB has tables[20] with regulator adjustments to 67m confirming helmet is safe to at least 67m.

52. **Recommendation # 4:** Clarify SL 27 performance beyond the 50m depth limit.

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[14] Updated KMB O&M manual page 31, see 3.4.2
[15] KMB 27 Manual. Page 12. Downloaded from http://kmdsi.com/products/helmets/superlite-27 .
[16] BRM 3525 Superlite 27 O&M Manual Troubleshooting Chapter 4 4.5
[17] Product datasheet KM SL 27 diving helmet
[18] CE (European conformity). Conforms to the provisions of safety, public health and consumer protection requirements imposed by European Directives. Information from www.ianz.govt.nz .
[19] Performance of diving equipment HSE 2006 Research report 424 page v
[20] BRM 3535 Superlite 27 helmet O& Manual Page 149

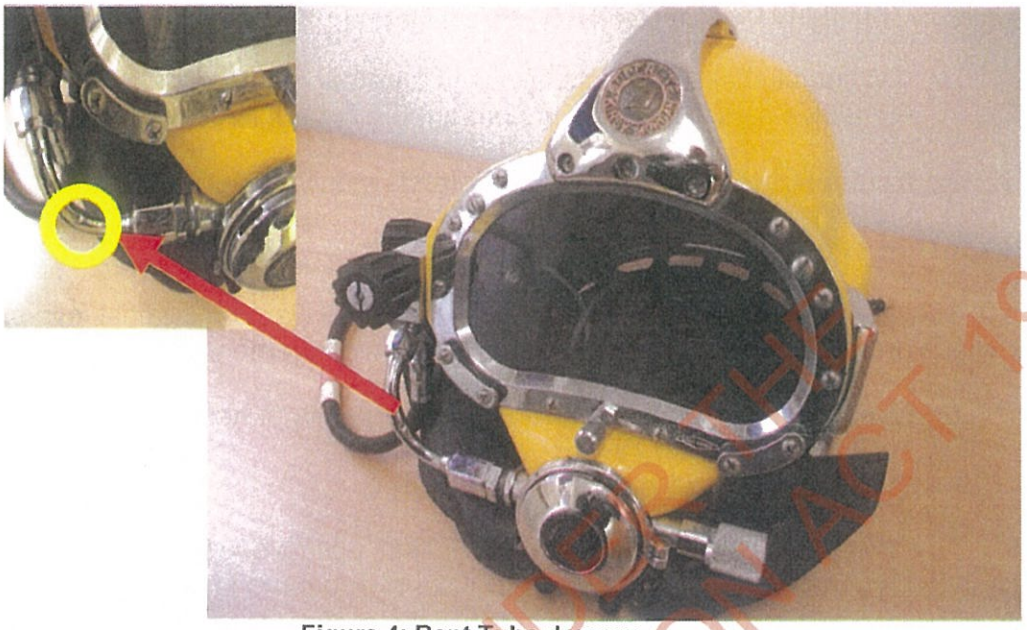

Figure 4: Bent Tube damage

Maintenance

53. The technical policy[21] details how RNZN dive equipment is maintained and maintenance was found to be correct. Some minor opportunities were identified:

a. Recording. Tracking "helmet no 1" rather than serial no eg 1B058-1B061.

b. Maintenance scheduling. KMB[22] state maintenance should vary with the actual use of the helmet but the electronic system specified monthly.

c. Tracking. The system does not track the state of the 2 spare helmets.

54. **Recommendation # 5:** Review maintenance requirements[23].

Breathing Air Quality

55. The divers breathing air is fed from MAN and MAN confirmed maintenance and air quality checks were up to date. Eg 12 Feb 13 breathing air within specification[24].

56. The ship also undertook a Drager test post accident to ensure air quality.

57. In summary all three supplies such as high and low pressure systems are also monitored and controlled from the Dive control station. No issues were apparent during any of the 12 Diving serials (24 Divers) that took place during Op Poseidon.

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[21] NZBR 7 030307 RNZN dive equipment. Maintain iaw guidance in OEM recommendations
[22] "Monthly" is the minimum recommended maintenance ... with continuous use, (> 20 diving days m).
[23] Guidelines to Occupational Diving 2004 4.6 page 23 Diving equipment
[24] BOC report references specification DEF STAN 68-284 Sect 2 table 1 Issue 3

Diving Communication

58. The divers tethered independently to MAN have independent systems, tied together at the surface and taped and available to the Diver Supervisor.

59. The digital recorder was not available so an analogue recorder[25] was used. The recording was requested but with no back up tape the content had been over written.

60. **Recommendation # 6** – Review diver audio recording systems.

Chain of custody

61. The ADR's helmet was secured post accident but a serial number not recorded.

62. **Recommendation # 7** – Review post accident securation policies.

Dive bell

63. MAN[26] and witness input was considered, eg the ADR lost consciousness when trying to establish an air source on AGA and bell a compounding factor – without the dome on the wet bell the risk of switching to the tertiary air supply is increased[27].

64. The perplex dome had been damaged during the passage to Raglan and the Perspex dome holed. See Fig 5. This was a concern as the dive umbilical could get snagged. The dome was therefore removed and prior to the ADR's accident.

65. Post accident it was found removing the dome led to the communication system becoming damaged and the dive bell gauges had became salt encrusted.

Figure 5: MAN Dive Bell damage

[25] Amron 100D (see NO50 – 2009)
[26] Command Inquiry Damage to Dive Bell 3 May 13
[27] Investigating officers report of diving accident 6 May 13

Dive bell functionality

66. The functionality of the dive bell was further investigated.

a. While a wet bell is not mandatory for SSBA, it contains an emergency Air Supply independent of the Ships supply and the Divers supply.

b. However the first option for divers should there be an interruption in the main air supply is to switch to the Divers emergency supply (Bailout).

c. The gas bubble in the dive bell dome is not monitored for oxygen content.

d. The Bell has two lights fitted, one provides light external for working and one internal to illuminate the gauges and valves and Divers would have encountered back scatter from particles in any of these dives.

e. The emergency Bell Comms is utilised by the Standby Diver when Diving SCUBA Twins and in the case of a Double Diver casualty incident.

Dive bell hazards

67. The Dive team reported they were responsible to ensure the dive bell was safe and that a risk assessment was conducted on the understanding that Helmet Diving precluded the removal of the helmet under any circumstances.

68. In summary while the bell dome is secondary to the flooded helmet the witness statements suggest that the ergonomics[28] of the control panel should be checked as this may have been a contributing factor in the ADR difficulties going onto AGA[29].

69. **Recommendation # 8** – Further review Dive bell hazards.

Injured Divers Performance

70. The ADR was reported to have deviated from standard procedures eg did not inform the diving Buddy, the PODR or the DS; not used the bailout supply; not used a head down position. This would increase gas flow 10 to 12 Bar and evacuated water.

71. There was also a report doubting whether water ingress was a flood eg ADR was able to communicate with the surface via Comms twice whilst at the bell.

Flooding Procedures

72. A review of the KMB flooding procedures[30] was undertaken and it was also noted that KMB[31] also warns about ditching the helmet underwater eg if the diver ditches the helmet underwater you will not be able to see.

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[28] The ability to fit, reach and see in reduced visibility or when no mask is worn.
[29] A breathing mask and require the operation of two valves in the dive bell to obtain breathing air.
[30] KMB 27 Operating and Maintenance Manual 3.10.1 Flooding
[31] BRM 3525 Superlite 27 helmet O&M manual 3.10 Emergency procedures page 42

73. A pinched umbilical and while not reported was considered eg KMB[32] report a pinched umbilical within 10-20 ft of the diver can result in involuntary inhalation drawing water into a helmet and lead to a flooded helmet and water aspiration.

74. **Recommendation # 9:** Review pinched umbilical risks.

Causes of Unconsciousness[33]

75. The possible causes of unconsciousness were considered.

Carbon Dioxide

76. The oral nasal mask separates the breathing gas flow from the larger gas space on the interior of the helmet and this in turn reduces carbon dioxide build-up[34].

a. Carbon dioxide is a by product of respiration and leakage in any reduced breathing air flow or a high and sustained work rate might impact[35].

b. KMB[36] states that as long as the mask fits properly and the regulator is adjusted properly carbon dioxide will stay lower than a free flow helmet.

c. It was also noted that the Australian Suppliers website shows two sizes of oral nasal mask while the Navy information shows only one size.

77. In summary there is no evidence increased carbon dioxide was an issue.

Laryngospasm

78. A doctor considered the witness statements and reported that the reason for unconsciousness can be most probably attributed to:

a. Hypoxia (asphyxiation) and due to interruption of the air supply and because of subsequent difficulties in re-establishing a secure air supply it is highly probable that the ADR inhaled some seawater.

b. The effect of this 'near drowning' was to induce laryngospasm (where the upper airway reflexly closes to prevent further inhalation of seawater).

c. On the surface the ADR's chest was seen to be rising and falling although he was still unconscious and not breathing.

d. This is caused by automatic spasmodic attempts to breathe when the diaphragm and chest wall muscles continue to try to move air into the lungs but are unable to because of the laryngospasm.

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[32] Surface supplied emergency breathing. DiveLab 2 May 2009. Page 4.
[33] http://best-diving.org/diving-accidents/249-causes-of-unconsciousness
[34] BRM 3525 Superlite 27 O&M Manual Oral nasal mask Page 19 2.8.7
[35] Dead space and inhaled carbon dioxide levels in respiratory equipment HSE RR27/1991 page 13.
[36] SSBA requirements and recommendations. August 22, 2008 Page 12 .

e. Eventually the laryngospasm eases and air (or oxygen) is able to enter the lungs and the diver may then vomit and cough up any inhaled seawater before regaining consciousness.

Nitrogen Narcosis

79. The likely impact of Nitrogen Narcosis[37] was considered.

a. The doctor claims wide individual susceptibility - "while some divers are hardly affected at 50m, others may be quite severely affected at 30m".

b. Another medical specialist also stated "simulated diving in a dry recompression chamber has not been shown to result in any discernible reduction in the risk of decompression illness or an increased tolerance".

Task Analysis

80. Task analysis was used and to identify any further significant hazards.

a. The injured diver was with a buddy. The buddy was placing a strop around the Starboard Wing, between the Aircraft body and the Engine.

b. The photo shows the area of the strop and the obstacles to getting a strop around the wing. The photo showing the strop placed during a further dive.

Figure 6: photo of recovered plane[38] debris

c. The Wing was hard up against the seabed hence the need to push the strop under with a boat hook.

d. The PODR was to push a boathook under the wing which was hard up against the seabed and the ADR task was to place the strop on the hook.

[37] If nitrogen is breathed under pressure, it induces narcosis similar to an anaesthetic agent. At depths 30-60 m effects are described as light headedness, euphoria and loss of fine discrimination.
[38] NZDF Official

e. Then the PODR would pull it back through.

f. Co-incidentally the PODR reported at no point did he invert the helmet, the body of the PODR positioned in the prone position to see under the wing.

g. The task analysis does suggest entanglement was a possibility but there is no feedback from either diver to support this possibility.

h. The ADR had dived on the first day with the damaged dive bell in place but the dome had been subsequently removed and prior to the accident.

Training

81. The Divers Branch training[39] is well developed and the injured ADR had successfully completed KMB, work ups and other prescribed training.

KMB training

82. The NZ service agent is Pacific Commercial Diving Supplies Sydney and this company had trained the ADR to undertake maintenance and to train others.

83. The KMB 17 and the KMB 27 helmets did have slightly different helmet flooding protocols[40] but in practice there seems no tangible difference.

84. **Recommendation # 10** – Consider a formal helmet conversion module.

Work Ups

85. The Divers use work ups[41] to optimise training and safety.

a. While the minimum of two procedural work ups per year each of 2 weeks duration had not been conducted the ADR was reported to have three years diving experience, and dived in excess of 50 m more than 40 times.

b. The ADR had completed a SSBA training period 3 weeks prior.

c. The SSBA dive would normally use MAN during the training course but the dive platform was not available.

d. There was one report[42] that indicated that the ability to train at 50m at SSBA had been reduced, particularly in the preceding 12 months.

86. In summary the ADR was found to have qualified in June 2010, had deep dive and SL 27 experience and last dived to 55m on 5 April 13.

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[39] NZBR37 Section 8
[40] Doc #EP-011509 Basic Emergency procedures for KMB helmets, DiveLab website
[41] NZBR 45 0313 deep air diving work ups
[42] Investigating Officers report of diving accident that occurred during Op Poseidon 06 Apr 13, p3

Emergency Simulation

87. The findings from a literature search was considered as Blumenberg suggests diver panic needs to be considered in recreational Diver training:

a. The principle cause of diver injury or death is panic or a loss of control[43].

b. Training can improve coping skills by developing response rules or templates to given stress situations and initial training for all divers should also include formal classroom discussion of Human Factors.

88. In summary new behavioural methods may be required for helmet flooding.

89. **Recommendation # 11** – review human factors in dive training programmes.

Dive Team Performance

90. The Dive team performance was examined by firstly recognising that a small number of Divers[44] cover all aspects of engineering, operations and policy and by observing the changed helmet and other questions confirm a need for more support.

91. The use of AS/NZS 2299.1[45] also provides for the unpredictability inherent in the diving environment and acknowledges that in human physiology terms divers are exposed to risks that cannot be completely avoided by the hierarchy of control.

Pre-dive Briefs

92. The pre-dive brief was reported as including a warning about the dive bell and completed on a whyteboard. The activity summarised in a record, the RNZN 288.

93. The predive brief also ensured that there was SSBA and dive bell AGA safety checks before commencing a dive.

94. One minor aspect identified was that the current Diving Policy[46] contains the older SL 17 and not the current SL 27 model pre-dive checklist.

Diving Policies

95. The RNZN diving policies were considered.

96. A Naval Order[47] states helmet used in conjunction with MAN wet bell system authorised diving to a maximum depth of 50m. This is a contrast with the 54m depth limits outlined in other policy[48] and the 50m found in Chapt 5 of the MAN dive book.

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[43] Blumenberg Michael A (1996). Human factors in Diving Fig 9 page 22, Marine Technology and Management Group, University of California. December 1996.
[44] 16 operational, 4 assigned to a training division and 2 divers assigned to MAN.
[45] NZBR 7 030307. RNZN dive equipment and systems maintained iaw AS/NZS 2299 and OEM.
[46] NZBR 45 Chapt 6 Breathing Apparatus: Drill and Operation. Appendix 6A.
[47] NO 2012:07

97. The authorisation to dive to 56m was attributed to authorisation/waiver and as found in Navy policy[49]. The operational risk management ORM[50] policy is designed to help with decision making and to provide flexibility[51].

98. There is the possibility of inconsistency and a revised policy might better align with other policy[52] examples that do allow for safety policy variation.

99. **Recommendation # 12:** Clarify deep diving authorisation policies.

Certificates of Competency

100. The H&S Regs apply to Diving and include a requirement for all Divers to be medically fit[53]. These requirements are replicated in Navy safety policy[54]

a. Divers to have a current DoL certificate of competency[55].

b. Diving supervisor[56] responsible that each diver has a current certificate of competency and is medically and physically in date.

c. A copy in each divers log and if not in date must report[57].

101. The ADR's and the PODR, dive buddy, were however found to have not completed an on-line assessment. Their dive medicals were therefore not current and this was attributed to a new process, on line, no bring-up or supervisor visibility.

102. The ADR had also completed training iaw NZBR37 but rather than obtaining OSH construction diver part 2 restricted Certificate of Competence MBIE reported the ADR was only holding a SCUBA certificate to 30m.

103. The ADR had not forwarded the required documentation and the dive teams administration spreadsheet was found to not adequately track these areas.

104. **Recommendation # 13** – improve dive medical and training administration.

105. The H&S Regs[58] also require any diver to hold a certificate of competency and to only dive in the category of diving specified within that class of certificate.

106. The classes of competency do not permit SSBA diving below 50m.

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[48] NZBR 45 Section 3 0209 Conduct of diving exercise and operations to depths not exceeding 54m.
[49] NZBR 97 chapt 21
[50] NZBR 97 Chapter 2013 para 6
[51] NZBR 97 Chapter 2106
[52] NZBR 23 Chapter 1832 Supervision in an emergency.
[53] H&S Reg 1995 S49 duty in respect of medical fitness of diver
[54] NZBR 23 page 497 Main areas where RNZN needs to comply/NZBR 45 2 regs sect 1 definitions
[55] NZBR 45 2 regulations section 1 definitions
[56] NZBR 45 0206 page 32/ Guidelines for occupational diving 4.8 page 24.
[57] NZBR 45 0207 page 33
[58] Guidelines to occupational diving 2004/ H&S Regs s27

107. The ADR and PODR therefore appear as diving outside this regulation although and as a contrast Australian Defence High Risk Diving Policy[59] does seem to enable the ADR and other MIL Divers to dive to depths exceeding 50m in Australian waters.

108. This suggests the NZ H&S regulations may need a similar modification and to enable Navy divers to dive on SSBA deeper than 50m within NZ or other waters.

109. **Recommendation # 14** – review need for amendment in H&S Regulations.

Analyses

110. The analysis is composed of elements eg the initial helmet accident, secondly the bell and finally elements such as safety and compliance policy. Within elements there are immediate causes and contributing causes and the analysis is as below

111. Immediate causes of the helmet accident

a. Sea water entry into a SL 27 helmet and with sufficient water to enter the oral nasal area when the head was righted.

112. Contributory causes of the helmet accident

a. The head cushion system along with the KMB stated inversion limitation.

b. Human and other factors possible but not able to be validated range from entanglement, umbilical pinching to impact of nitrogen narcosis.

113. Immediate causes of the dive bell event

a. Inability to obtain breathing air from the AGA mask and attributable to more likely laryngospasm, vomitus, human factors and/or panic.

114. Contributory causes of the dive bell event

a. Primary factors such as the inability to breathe speak or see.

b. Secondary factors such as bell dome and impact of the helmet accident.

115. Safety and compliance

1. The Divers and MAN have taken all practicable steps to prevent harm with a question about classes of certificates of competence, medicals and policy.

2. The dive bell dome was in place on the first ADR dive and was removed prior to the second ADR dive. Human factors may have been a factor.

3. The serious harm and accident artefact policies could be improved.

[59] Australian Defence High Risk Diving Work Statement downloaded from www.comcare.gov.au

Summary

116. The cause and effect below summarises this accident.

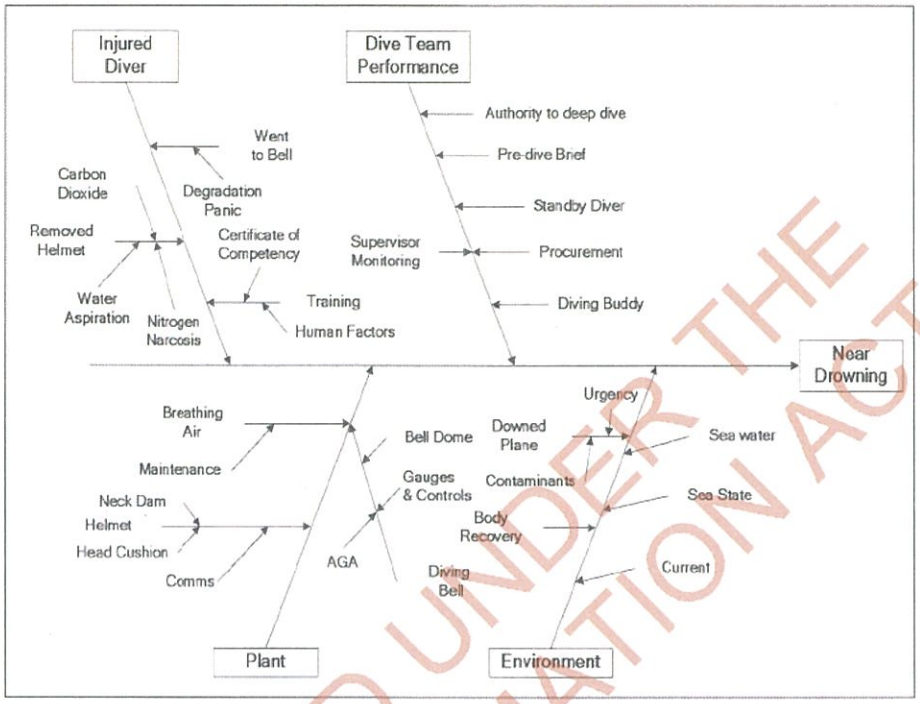

Figure 7: cause and effect diagram

Conclusion

117. While some aspects remain subjective this was a near drowning and a serious harm injury. Sea water entry into a SL 27 helmet and with sufficient water to enter the oral nasal area had occurred. The ADR's dive helmet was found to have an inversion limitation and the head cushion system had been improved and without being made known to Navy. The inability to communicate and to obtain breathing air from a dive bell was most probably attributable to human factors and laryngospasm. There is a need to prevent a recurrence and the number of recommendations simply confirm the need for a higher level of engineering and policy support for Navy Divers.

Y14-000015. LOG & FILE (4)

CHIEF OF NAVY
Te Rangatira o Te Taua Moana
Rear Admiral J.R. Steer, ONZM

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COPY

NHQ 5202-0001 24

13 January 2014

Paul Mitchell
Advisor Registrations
Ministry of Business, innovation and Employment MBIE
PO Box 3705
WELLINGTON

Dear Paul,

OPERATION POSEIDON - NAVY ACCIDENT REPORT

Reference:
A. Report of Serious Harm (ADR [redacted] dated 15 April 2013

1. At the Reference the Royal New Zealand Navy reported a Serious Harm injury in accordance with the Health and Safety in Employment Act 1992. This injury has resulted in a thorough accident investigation and the ongoing application of new systems and operating procedures to mitigate against the potential of this occurring again.

2. Enclosure 1 provides a copy of the MBIE Duty-holder Investigation Report for this accident.

3. MBIE have identified that there is interest in the lessons learnt from this incident. This accident occurred during Operation Poseidon, the NZDF contribution in support of the NZ Police to recover a light aircraft from the seabed. As such we feel that any further release of accident information should be delivered in summary form by MBIE.

J.R. STEER
Rear Admiral
Chief of Navy

Enclosure:
1. Duty-holder Investigation Report dated 06 December 2013.

Ministry of Business, Innovation & Employment | Health and Safety Group

Duty-holder Investigation Report

Section 1:
PEOPLE INVOLVED IN THE HEALTH AND SAFETY INCIDENT

Form completed on:
6 December 2013

Your details	
Business name & address: Navy Occupational Safety and Health Unit (NAVOSH) Royal New Zealand Navy Private Bag 32901 Devonport, Auckland 0744	
Your name: [redacted]	
Your title or occupation: Manager Naval Safety	
Your role: *(eg employer/principal or self-employed)* Employers H&S Representative	
Phone: [redacted]	Email: [redacted]@nzdf.mil.nz
Health and Safety Representative details *(complete if appropriate)*	
Health and Safety Representative name & address (if different from above): As above	
Health and Safety Representative title or occupation: MNS	
Phone: As above	Email: As above
Have you involved the Health and Safety Representative in the review process? Yes	
Have you involved any employees in the review process? Yes - Injured and other Divers	
Victim details *(complete if appropriate)*	
Victim's name & address: LDR [redacted] Royal New Zealand Navy Private Bag 32901, Devonport, Auckland 0744	
Victim's title or occupation: Diver	
Role: *(eg self-employed /employee / contractor/ other)* Employee	
Phone: [redacted]	Email: [redacted]@nzdf.mil.nz
Have you involved the victim in the review process? Yes	

Section 2:
DESCRIBE THE HEALTH AND SAFETY INCIDENT

Provide relevant information

Date of incident: 6 April 2013	Time of incident: 1455 pm

Place and exact location:

1 NM off Gannet Rock, Kawhia Coast, Raglan

Working conditions at the location and time of the incident (e.g. poor lighting, extreme temperature):

The environmental conditions were Sunny 1-1.5m swell, sea state 2; Tide LW 1334, Depth 55.4m; underwater visibility 3m, sandy bottom, hard and compact.

The water temperature reported as 9-10 C. The current as less than 0.5 kt.

Weather conditions at the time of the incident (if applicable):

As above

Describe the details in the order of what happened immediately before, during, and after the incident:

Before:

The injured diver and a buddy diver were working together at 56m on SSBA to place a strop around the port wing of a downed aircraft. They were working from the Dive platform, HMNZS Manawanui and during an operation called Operation Poseidon.

Operation Poseidon 04/13 was the NZDF contribution in support of the NZ Police to recover a light aircraft, the Pilot and one passenger from the seabed off the Kawhia Coast, 1NM off Gannet Rock utilising the dive platform HMNZS Manawanui (MAN).

The diving provisioned by the Royal New Zealand Navy RNZN underwater engineering team whose function includes search operations pertaining to recovery of objects from seabed.

During:

The injured diver stood upright, found that water had entered the helmet and post dive reported he had tried unsuccessfully to flush using a steady flow valve.

After:

The injured diver immediately went back to the bell and arrived with helmet and neck dam in place. He subsequently removed his helmet and attempted to use an alternative breathing air supply on the bell (AGA mask) and at this time, through the open communications system, alerted his buddy and those above that there was an issue. The buddy diver on hearing this proceeded directly to the bell and discovered the diver using the alternative breathing mask but not appearing to be breathing from it. The bell was immediately recovered to the surface during which the standby diver on board HMNZS Manawanui commenced a dive from the surface and met them at a depth of 24m in order to assist the divers on route to the surface.

Immediate first aid actions were undertaken by other divers and the ships emergency medical team to stabilise the diver before he, along with the buddy diver and a Diving Medical Attendant, were put in the on board recompression chamber for therapeutic decompression treatment. After completing the therapeutic decompression treatment the diver was transferred to Auckland Hospital by Westpac Helicopter.

The injured diver was subsequently discharged from hospital, stood down from diving for a 4 week period, and was required to pass a full medical, which occurred 18 April, before returning to diving.

The accident was investigated by a command investigation, a court of inquiry and independently investigated by Manager Naval Safety. A number of safety recommendations

have and are being implemented.
Were there any witnesses to the incident? Yes

Section 2 *continued* – complete if appropriate:
DIAGRAM OF LOCATION OF INCIDENT

Figure 1: photo of recovered plane[1] debris

There is no useful diagram available for the scene at 56m. However Fig 1 does show the state of the damaged plane after it had been recovered.

The source of the photo is NZDF Official.

[1] NZDF Official

Section 2 continued – complete if appropriate:
PHOTO(S) TAKEN

Provide photo taken immediately after incident and/or items directly related to the incident.

Figure 2: HMNZS Manawanui

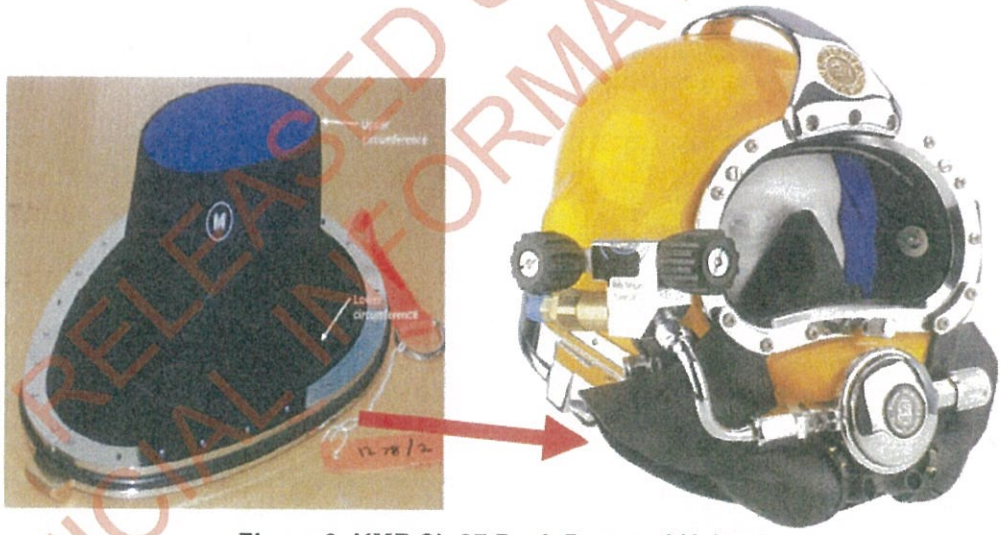

Figure 3: KMB SL 27 Deck Dam and Helmet

Fig 2 shows the RNZN dive platform used, HMNZS Manawanui. Fig 3 shows the helmet worn and the neck dams examined as part of a detailed accident investigation. The position of the oral nasal mask and the dive helmet head cushion can also be seen in the photo.

Section 3:
IDENTIFY IMMEDIATE CAUSE(S):

Your set-up

Location:
Was there anything at/in the location that caused the incident? If so, why was it there and what needs to be done to address this?

No. There are no other contributing items at the scene other than the scene itself.

Plant, Equipment and Substances:
Was there anything dangerous about the plant, equipment and/or substances that were used? If so, why was it unsafe and what needs to be done to make it safe?

No. A post inspection report showed correct maintenance and functionality of the helmet an independent report and undertaken by the Defence Technology Agency[2] reported that the neck dam appeared to be loose. However subsequent contact with the US based supplier shows that the degree of fit and the looseness had remained within safe limits. We were advised that any residual risk can be further reduced by individual fitting of neck dams and head cushions and as a result of this information we are implementing this measure. We were also advised that the supplier had introduced a new head cushion system although this does not appear to have directly contributed to the incident.

Procedures:
Was there anything about the procedures, including those for emergencies that caused the incident? If so, what was it and what needs to be done to correct this?

No the procedures for fitting and testing the equipment pre dive were adequate and are in line with both the manufactures and international best practice for this equipment. This had been recently validated through an extensive operational assessment period undertaken by an external military assessment group (Royal Australian Navy).

People:
Did anyone do anything that contributed to the incident? If so, why did they do it and what needs to be done to correct this?

It is unclear if the buddy diver did anything that directly contributed to the event such as dislodging a component of the aircraft that impacted the diver. While the initial incident that started the chain events was not likely to have been caused by an others contribution the subsequent inability to recover from the situation can be largely attributed to human factors.

Section 4:
IDENTIFY UNDERLYING CAUSE(S)

Your Health and Safety Management System

Hazard Identification:
Was/were hazard(s) previously identified? If not, why not? What needs to be done to manage this hazard?

Hazards were correctly identified and mitigated. The hazard associated with helmet inversion was also addressed and forms part of the training competencies. The potential design limitations and the supplier changes have however been reviewed and in order to further reduce the risk of any further accidents.

[2] DTA technical memorandum C1278/1 Dated 20 May 13

Hazard Control:

Were there enough checks done to ensure the safe use of the premises, plant, substances, and procedures? If not, why not? What needs to be done to ensure premises, plant, substances, and procedures create a safe work environment?

Yes, the dive was adequately resourced, supervised and dives were rotated among the dive team ensuring that there was adequate work-rest breaks. HMNZS Manawanui was also well positioned with three anchors out and that there was very little movement other than possibly up to 2m vertical movement due to swell. At the depth of diving and the use of umbilical this unlikely to have impacted the injured diver.

Other hazards associated with this incident:

Describe how you currently control hazards associated with this incident? If they failed, why did these controls fail? What needs to be done to control this hazard?

The normal control for a flooded helmet is a constantly trained routine whereby the diver uses higher pressure air to expel the water from either the primary (purge or steady flow) or emergency (bail out) air system. The primary air system does not have a recording system but is believed to have been correct and the bailout supply was confirmed as working although not used. There also is a head down position control as this would increase gas flow 10 to 12 Bar to evacuated the water which was not used.

It is probable but not able to be substantiated that there was some human factors associated with inhalation of Sea water. See latter comments.

The divers however are in constant contact with their Supervisor and each other and can be directed in emergencies and as required.

Hazard Management:

Did any of the hazard management systems designed to eliminate, isolate or minimise the risk fail? If so, why and what can be done to prevent this from happening again?

The inversion hazard cannot be fully eliminated. Training is the primary method to minimise the risk and in this case not all procedural steps were undertaken as trained. As a result of this incident, with advice from the manufacturer, additional steps of fitting the neck dam and head cushion to each diver will further minimise the likelihood of this event. This information has also been passed to other navies who use this equipment. The training has been confirmed as being in line with international best practice and the failure to follow the training is largely a result of human factors. To support hazard identification hazard analysis processes are being further refined although not a contributor to this incident.

Health and Safety Standards used:

Describe any best practice or industry standards that are used in your workplace to help manage hazards. Where were they relevant to this incident?

The H&S standards applied are many and include the best practice use of AS/NZS 2299.1 within RNZN dive policies. This provides a suite of standards for the unpredictability inherent in the diving environment and acknowledges that in human physiology terms divers are exposed to risks that cannot be completely avoided by the hierarchy of control.

Supervision:

Was there adequate supervision at the time of the incident? If not, why not? What needs to be done to ensure appropriate and effective supervision?

Yes both the dive planning and subsequent emergency response shows a high level of supervision.

Training:

Was training or instruction in using the equipment, plant, or substance sufficient and effective? If not, why not? What can be done to improve training and/or instructions?

We have undertaken a thorough accident investigation and this reviewed the training and the use of the dive platform and the training availability of the dive platform. The injured diver was not only trained but was a certified KMB helmet maintainer. Training was found to be adequate

although the procedures for a flooded helmet might be further improved but additional focus on human factors and what to do if water is inhaled.

Competence:

Did staff have the right qualification and/or experience to use the tools and procedures for the task they were doing? If not, why not? What can be done to improve competence in using the tools and procedures?

Navy divers have extensive hours diving and have the right experience and this was demonstrated by the recent externally assessed operational assessment of which the injured diver had taken part. The qualifications are also extensive and are based around the requirements of the H&S Act Regulations.

Review:

Is this a repeat of a previous incident? Were corrective actions implemented when there was an incident in the past? If not, why not? What needs to be done to implement corrective actions?

No

Other causes:

If appropriate, advise what other cause(s) contributed to the incident.

Nil.

Section 5: ROOT CAUSE(S) ***Your broader health and safety system***

Root causes:

Why did the immediate cause occur? Why did the underlying cause occur?

The immediate cause was sea water entry into a SL 27 helmet with sufficient water to enter the oral nasal area when the head was righted.

The serious harm injury from unconsciousness can be attributed to Hypoxia (asphyxiation) and due to interruption of the air supply and because of subsequent difficulties in re-establishing a secure air supply that the diver inhaled some seawater. The effect was to induce laryngospasm (where the upper airway reflexly closes to prevent further inhalation of seawater).

The underlying cause was the failure, due to human factors, to be able to appropriately manage the situation as trained by purging the water by either primary or bail out air supply. This led to the injured diver removing the helmet and at a depth of 50m where this became a further accident and injury causation chain.

Section 6
CORRECTIVE ACTIONS TAKEN

In this section, ensure that corrective actions* are put in place to prevent a recurrence. System improvements may include, for example:

- ❑ reviewing and updating your hazard management systems if the **hazards** hadn't been identified or appropriately controlled
- ❑ ensuring **industry standards, best practice guidelines, or company rules** are available to measure your systems against
- ❑ assessing your training methods if **supervision or training** was identified as lacking to demonstrate that your staff are properly trained to do their work, or that untrained staff are competently supervised
- ❑ improving staff inductions to ensure they clearly cover all required information, if lack of **information** was identified as a cause
- ❑ reviewing the supply and use of **Personal Protective Equipment (PPE)** if that was a factor in the incident
- ❑ having a machinery safety audit and improving your maintenance service schedule if there was an identified **poorly maintained piece of equipment**
- ❑ assessing and improving your **employee participation** forum if greater interaction with employees would have reduced the chance of the incident happening
- ❑ reviewing and revising the **health and safety culture** of your organisation.

* All the above actions have been undertaken by the RNZN.

Action: Undertake a detailed accident investigation	Completed on: May 13
Action: Undertake a complex and thorough Court of Inquiry	Completed on: August 13
Action: Apply a number of safety recommendations, inform other Navies, etc	Completed on: Ongoing

Section 7:
LIST ATTACHMENTS HERE

No attachments

Section 8:
SIGN-OFF

Person responsible for report	
Name:	[redacted]
Title:	Manager Naval Safety
Signature:	[redacted]
Date:	6 December 2013

Health and Safety Representative	
Name:	As above
Title:	
Signature:	
Date:	

Duty- holder	
Name:	Rear Admiral Jack Steer
Title:	Chief of Navy, New Zealand Defence Force
Signature:	
Date:	13 January 2014