ROYAL AUSTRALIAN NAVY

Fleet Command- Maritime Safety Bureau

Minute

MSB/OUT/2017/S11853081

COMMHP CAPT Warren Bairstow

For information:
CO HMAS *Maryborough*
CAPTPB CAPT Jason Hunter

MARITIME SAFETY INVESTIGATION – HMAS *MARYBOROUGH* - OHSIR 03/17

References:
A. Sentinel 17050807
B. Instrument of Appointment and Terms of Reference

1. **Background:** Maritime Safety Bureau (MSB) conducted a Maritime Safety Investigation (MSI) into Ref A IAW ref B. The completed report is at Enc 1.

a. **Recommendations:** Detailed recommendations addressing the causal and contributing factors and are contained in the report.

b. Additional technical recommendations are detailed in the Subject Matter Expert (SME) reports, at Annexes C and E.

2. **DMSB Comments:** I support the recommendations made within this report and the annexes.

3. **Way forward:** The investigation report is passed for consideration of the recommendations and flow on actions as a result. It is not the intent for MSB to track or seek updates on the implementation of recommendations that may or may not be accepted subsequent to the investigation. MSB resources are available to provide additional subject matter expertise or support as required.

4. My MSB POC is Kate Campbell, 02 93595188.

[redacted]
T Rayner
CAPT, RAN
Director MSB

Tel: (02) 9359 2203

Enclosures:
1. Maritime Safety Investigation Report- HMAS *Maryborough* - OHSIR 03/17.

NAVY ROYAL AUSTRALIAN NAVY

MSB/OUT/2017/S11853081

CAPTPB CAPT Jason Hunter

For Information:
CO HMAS *Maryborough*
PBSPOD

MARITIME SAFETY INVESTIGATION REPORT - HMAS *MARYBOROUGH* OHSIR 03/17 - DANGEROUS INCIDENT – FIRE IN MAIN ENGINE ROOM 25 MAY 17.

References:

A. Minute: FLEET/S11585792 of 26 May 17 – HMAS *Maryborough* – Maritime Safety Investigation Officer Instrument of Appointment and Terms of Reference
B. ABR6303 Ed 5, Section 5, Chapter 1—*Emergency Response, Incident Investigation and Continuity of Capability*
C. Signal: HMAS *Maryborough* – OHSIR 03/17
D. WHS Act 2011 (Cth)
E. ABR 5476 – RAN Combat Survivability
F. Armidale Class Standing Orders

INTRODUCTION

1. I, Kate Estelle Campbell, was duly appointed at Reference A by Captain A Rayner, RAN, Director Maritime Safety Bureau (DMSB), to conduct a Maritime Safety Investigation (MSI) regarding a fire in the main engine room that occurred onboard *Maryborough* on 25 May 2017.

2. In accordance with References A and B, the purpose of this report is to:

a. Identify any failed or inadequate controls pertaining to the incident and any work being undertaken;

b. Identify any human factors, systemic causal and contributing factors or hazards which directly, or indirectly, contributed to the incident.

c. Determine the adequacy of Orders, Instructions and Procedures (OIP) pertaining to the incident and any work that may have been undertaken.

d. Make recommendations as to corrective actions that will assist to prevent a recurrence of the incident, or occurrence of future safety incidents of this nature.

3. The purpose of this MSI is to determine the circumstances surrounding the incident reported at reference C and to ascertain safety hazards and other factors which may have

contributed to the incident. It is not the purpose of this investigation to apportion blame or liability.

SCOPE OF INVESTIGATION

4. This report covers the following:

a. The timeline of events leading up to, and any significant factors that may have contributed to, the incident;

b. The adequacy or otherwise of related Orders, Instructions and Procedures (OIP) pertaining to the incident;

c. Any human or systemic causal factors;

d. The adequacy and timeliness of Post Incident Reporting; and

e. Any other matter considered relevant discovered in the course of the investigation, including any related incidents of a similar nature.

MARITIME INCIDENT INVESTIGATION TEAM (MIIT)

5. The following personnel made up the MIIT:

MIIT Role	Rank / Name	Designation
OIC MIIT	APS 6 Kate Campbell	MSB Safety Investigator
SME	EL1 Ian Raymond	SME (Fire Safety)
SME	EL2 Ewan Farquharson	SME (Systems Engineering)

SUMMARY OF INCIDENT

6. On Thursday 25 May 17 HMAS *Maryborough* was conducting an independent transit to Darwin via the Vernons with a crew of 31. *Maryborough* was at the most easterly point of east Vernon Island on a course of 255 at 22 knots with both main engines half ahead revolutions 1495 rpm. At approximately 23h38m, a fire occurred on board *Maryborough* in the main engine room and was bought under control and extinguished by members of Ship's Company with no casualties. HMAS *Parramatta* and HMAS *Larrakeyah* provided emergency support and *Maryborough* was towed by *Larrakeyah* to HMAS *Coonawarra*. A Fact Finding was instigated by LEUT T Mobbs, the Commanding Officer, to determine the cause of the incident and the adequacy of the ships response. LEUT JC Chipper, OOW was directed to conduct the Fact Finding and report dated 25 May 17 attached at Annex F.

TIMELINE AND SURROUNDING EVENTS

7. At approximately 23h30m, Maryborough was on course of 255 at 22 knots with both main engines half ahead revolutions 1495RPM, there were no other contacts in the vicinity.

s47F, was the Marinelink operator and was on the bridge.

8. At 23h33m the bleed screw on the fuel system pipe work, on the front of the starboard propulsion diesel engine, came loose, and unscrewed allowing fuel to leak into the bilge.

9. Between 23h34m – 23h36m the fuel pressure dropped from 6.75 bar to 5.5 bar as the bleed screw loosened further until it became completely free and was subsequently blown out by fuel pressure.

10. At 23h37m s47F noted low fuel pressure alarm on Marinelink and shortly afterwards flame and smoke alarms. When he looked at the fitted CCTV he saw fire. Hearing the alarms, the s47F enquired as to the nature of the alarms to which s47F responded "*fire in the engine room*". s47F piped *Safeguard* fire in main engine room across the ship.

11. At 23h37m s47F and s47F set up for BA- Portable attack. s47F entered the Bridge shortly after the fire alarms activated, and took over Marinelink. At this point there was no vision on the engine room CCTV, due to the camera located in the engine room being totally destroyed. Shortly after, the high temperature alarm activated on Marinelink, and the thermo sensor had reached the maximum measureable temperature of 100 degree C, whilst fire temperature was increasing.

12. At 23h38m s47F opened the main engine room hatch, and s47F entered the main engine room with BA- Portable. s47F noticed the deck plates were slippery and believed this to be diesel on the deck plates. He later confirmed this by the smell on his boots. s47F was forced back by heat and thick grey black smoke. He then closed the hatch. No portable extinguishers were discharged as no visible flames could be seen and the origin of the fire was unknown. Visibility in the main engine room at this time was approximately 30cm.

13. Following the attempted entry by BA portable, Marinelink shows smoke spread into number of compartments of the ship. This level of smoke complicated the response to the incident, restricting movement within the vessel and required increased use of breathing apparatus.

14. s47F was on the flag deck at the time of the alarm being raised. He immediately proceeded to Marinelink with DDC being closed up by 23h38m. Due to the speed of the fire growth and reporting from BA-portable, Command by passed BA –hose option. s47F recommended to initiate CO2 discharge and on Command from s47F he pressed button 1 to activate the CO2 release system.

15. At 23h40m CO2 button 1 was pressed and the first CO2 discharge took place. However, Marinelink data indicated an unsuccessful drench as engine room temperatures increased. In addition, crew were unable to confirm full drench as discharge was not heard.

16. At 23h40m CO2 button 2 and 3 were pressed and the second CO2 drench of the engine room took place. Marinelink data confirmed a successful release. After a period of 10 minutes after the initial drench, the engine room dropped in temperature, shortly after Marinelink confirmed an increase in temperature. Subsequently, a manual activation was conducted and observed as a successful drench.

17. Manual activation of the CO2 System was undertaken by s47F Due to the restricted space within the CO2 Locker compartment s47F used an ELRSD instead of OCCABA to access the smoke effected compartment.

18. At 23h45m, the anchor was let go and *Maryborough* anchored in position 12 degrees 05.3'S131 degrees 0926'E in 23 metres of water with 4 shackles on deck.

19. The fire was confirmed extinguished at 01h56m 26 May 17.

INTERVIEWS

20. The following personnel were interviewed/consulted during the investigation process as they were either being directly involved or part of Ships Company.

Rank	Name	Department / Position
s47F		

FACTORS

21. Subject Matter Expert (SME) confirmed that "on entry to the engine room, from the forward hatch, it was immediately obvious that a fuel bleed screw was missing on the pipe work on the front of the starboard propulsion diesel engine. This was the root cause of this fire, which caused uncontrolled escape of combustible fluid."

22. ***Bleed screw*** - is normally only used during significant maintenance such as a W5 overhaul requiring bleeding of this fuel system after removal and replacement of either low or

high pressure pumps. SME confirmed that screws on engines come loose for a number of reasons such as not being sufficiently tightened, over tightened and fractured, incorrect screw material etc. Crew interviewed advised they don't use this screw because they haven't done any high level maintenance requiring them to bleed the system. (the last W5 maintenance was conducted by Penske Power Systems in Jan 17)

23. Once the screw loosened, fuel flowed out of the horizontal bleed drain vent in a downwards arc onto the floor plates and into the bilge. After the screw completely detached fuel pressure remained at 5.5 bar. The majority of the fuel would now have been spraying vertically out instead of sideways. For nearly 4 minutes fuel escaped at 5.5 bar in a vertical stream upwards onto the starboards engines exhaust lagging. The total amount of fuel calculated to flow into the main engine room was approximately 133 litres.

24. ***Fire event*** - the investigation team found two plausible ignition sources. These were, (1) diesel entering the alternator and (2) diesel soaking into the exhaust lagging. A fuel air mix was ignited and this deflagration event subsequently ignited pool sources of marine diesel in the bilge and around the engine. The fire grew and temperatures increased rapidly which resulted in creation of thick black grey smoke.

25. ***Oily Mist Detectors*** – the detectors are situated on the forward and outer edge of each engine and pointed towards the fuel pump. This allowed the oily mist to go undetected, until after deflagration.

26. ***CO2 System*** - upon inspection of the CO2 locker room to confirm if all bottles had been discharged, it was found that the pivotal hose to the fourth CO2 bottle had detached rendering it ineffective. A contributing factor was that many of the CO2 hoses were over ten years old and needed to be replaced as per PBSPO request, see Annex I. Discrepancies between ABR 5225 and OEM requirements - indicate that ABR requirements permit 12 years service life with OEM requirements mandate 10 years usage.

27. PBSPO tasked SERCO in April 17 to undertake a 60M replacement of all synthetic flexible hoses on the CO2 system with a completion date of May 17. The work which was undertaken was a 12M flexible hose survey/inspection. The investigation team highlighted a quality control procedural issue wherein the SPO does not have oversight of the prime contractors work scope or activities. The survey/inspection determined that many of the CO2 flexible hoses had past the 10 year service life, and therefore required replacement. The investigation team found that the CO2 hose which extends from cylinder three and four is over 10 years old and needed to be replaced.

28. ***Emergency generator*** - After main power supply was shut down, the emergency generator was activated, however, it failed immediately after starting due to a cooling fan issue. At 23h42m09s the emergency generator was then manually restarted by crew, but the cooling fan continued to fail. At 00h27m the emergency generator was manually shut down as it was overheating. Interviews confirmed that the generator failed to start due to a lack of coolant. Once coolant was added the emergency generator ran for 11 hours without fault.

29. ***OCCABA*** - at the time of the incident, *Maryborough* had 12 OCCABA in use and 12 spare bottles. At 0049h crew advised Command OCCABA was limited and that there were 2 fully charged OCCABA remaining, and 2 OCCABA in use which were half charged. Subsequently, to conserve OCCABA, the CO approved the use of ELRSD to conduct boundary cooling.

30. The Junior Bauer that is normally used to recharge the OCCABA is powered by the ships main power supply. It was not functional because the system is only connected to the main power supply. Subsequently, the ship had no ability to charge OCCABA once the main power supply was shut down.

31. ***Communications*** - *Maryborough* had limited external communications systems working. Subsequently, this led to the use of the Harris 150 HF and 152 UHF portable radios. The investigation team were informed that the RAN don't provide training on the use of these portable radios. Fortunately, the ship was able to obtain mobile phone reception and contact support.

32. ***Alarms*** – this incident activated various alarms, such as fire alarms and other emergency systems. During interviews it was identified that due to multiple alarms being activated, the plant room crew were unable to communicate with the bridge. This impacted the efficiency of information exchange, particularly due to the difficulty of deactivating alarm systems.

33. ***CCTV*** - visibility of Marinelink CCTV of the main engine room was hampered by the brightness of the bridge lights, resulting in reduced emergency reactions. Situation awareness was reduced when button 1 was pressed as the CCTV system was not connected to the emergency generator. Additionally, the lack of CCTV recording limited the ability to understand the initiation of the fire both during it prosecutions and the safety investigation.

34. ***Situation awareness*** - through out the incident it has been reported that crew were well informed about Command decisions and priorities. Information flow from the bridge worked well with all crew understanding what was happening.

INJURED PERSONNEL

35. All personnel were examined by ships medical staff and subsequently cleared, however one member reported coughing due to smoke exposure. Member was directed to attend Larrkeyah medical centre where the crew member was examined and cleared for duties.

TRAINING

36. The crew interviews noted that the ship had undertaken daily damage control exercises. This provided exceptional response from Ships Company for the prosecution of this incident. The crew interviews noted that there is no formal RAN training for the use of the portable Harris radios as stated in para 31.

37. Considering the urgent nature of the situation, all personnel acted and responded in accordance with RAN policies and procedures.

COMMAND AND CONTROL

38. It was clear from this incident that s47F [redacted] and his Command team operated very effectively. This can be seen by the aggressive and rapid prosecution of the incident as well as the crew being continually updated on the progress and the Command priorities.

POST INCIDENT ACTIONS

39. Once assistance was requested via mobile phone, MAROPOS confirmed that both HMA Ships *Parramatta* and *Larrakeyah* were making way to render assistance.

40. The COs of *Larrakeyah, Parramatta and Maryborough,* discussed and determined that *Larrakeyah* would assume role of on scene Commander and took *Maryborough* under tow at 0758 on 27 May 2017.

41. A lack of generator power supply to the capstan meant that the anchor could not be heaved in, the cable was paid out and disconnected from *Maryborough*

42. Post incident reporting was both adequate and timely. As per WHS reporting requirements, *Maryborough* submitted the OSHIR 03/17 as well as notified Comcare DEFEV17050807 and respective Chain of Command.

43. PB Group requested external a maritime safety investigation to be conducted by MSB as soon as possible. MSB Investigators arrived at HMAS *Coonawarra* Saturday 27 May 17.

44. The investigation team consider the actions of s47F to have been exceptional and in the best traditions of the Navy.

SIMILAR INCIDENTS

45. Although there have been a number of fire incidents reported, there have been no previous reports with the same root cause.

CONCLUSION

46. A detailed examination of the fuel system and calculation of fuel flow confirm that the bleed screw became dislodged causing fuel to spill in to the engine room resulting in the fire.

RECOMMENDATIONS

47. The following recommendations are for your consideration:

a. PBGRP to review the CO2 system and associated PMS to ensure all Armidale-Class CO2 systems are compliant with OEM requirements.

b. PBGRP to review emergency air systems for supporting breathing apparatus.

c. NTB and DSTG to investigate methods to identify improved and enhanced fire fighting systems.

d. PBGRP to review the immediate fire fighting response drills, and determine if additional guidance needs to be provided to personnel on the appropriateness of re-entering compartments using BA Attack.

e. Penske Power Systems to provide PBGRP details regarding improved maintenance procedures for MTU engines, such as, torque settings for bleed screws, lock wire, etc.

f. Penske Power Systems to provide PBGRP an alternative control measure for raising the alarm as a priority so that fuel pressure determines automatic engine shut down.

g. PBGRP to investigate the improvement of visibility of the Marinelink CCTV monitor especially during night operations.

h. PBGRP to investigate the possibility of having the CCTV vision on the Armidale-Class vessels recorded.

i. PBGRP and NTB to review the management of audible alarms during an incident to eliminate confusion. This will improve the ability to manage similar situations better and will support Navy operations including internal communications.

j. PBGRP to review and update ABR 5225 with respect to flexible hoses service life and OEM Standards.

k. PBGRP to review the emergency generator to ensure operational at all times. Review and where appropriate update the associated PM'S and documentation. Conduct periodic audits to confirm its effectiveness.

l. PBGRP to develop training needs analysis and conduct training for the use of the Harris 150 and 152 portable radios and to review the storage location for communication equipment.

m. PBGRP to ensure thermographic surveys are conducted and recommendations are implemented.

n. PBGRP to review the Oily Mist Detectors location and suitability for service.

s22 [redacted]

Kate Campbell
Safety Investigator
Maritime Safety Bureau

17 August 17

Annexes

a. OHSIR 03/17
b. Sentinel Report – DEFEV17050807
c. NTB Engineer SME Report
d. DSTG Minute – Examination and calculation of fuel flow
e. NTB Fire Safety SME Report
f. HMAS Maryborough Fact Finding – dated 25 May 2017
g. Minute – MSB Initial Finding
h. Incident Timeline
i. PBSPO Maintenance Request

Signal Text

DTG: 280918Z MAY 2017
From HMAS MARYBOROUGH
Routine
Action COMAUSMHPFORMAROPS
Routine
Info AIG 3611AUSPBGRPAUSFLTSAFETYDGNAVCERTSAFEPBSPO DARWINFLEET ENGINEERING DIVISIONHQJOCDGMAROPSHQMBCACP 128 Originator: HMAS MARYBOROUGH

I2B
LAL
W2M
HMAS MARYBOROUGH OHSIR 03/17 - MAIN ENGINE ROOM FIRE 25MAY17
A. ABR 6303 SECTION 5 CHAP 1 ANNEX F
B. DGMAROPS I3M/IAD/LAR 120630Z MAY 17
1. HMAS MARYBOROUGH OHSIR 03/17

2. 252337I/K MAY 17 HMAS MARYBOROUGH MAIN ENGINE ROOM FIRE, TOTAL LOSS OF POWER AND INABILITY TO RECHARGE OCCABA CYLINDERS

3. CONDUCTING TRANSIT TO DARWIN EAST OF THE VERNON ISLAND GROUP

4. NOTIFIABLE INCIDENT (DANGEROUS OCCURRENCE) - MAJOR FIRE IN MAIN ENGINE ROOM COMPARTMENT

5. A. MAB COMMENCED FA IAW REF B AND WAS PROCEEDING TO DARWIN VIA THE VERNON ISLANDS GROUP FOR LOGVST IOT MEET MPD COMMITTMENTS. AT 252337I /K MAY 17 MAB EXPERIENCED A FIRE IN THE ENGINE ROOM COMPARTMENT. SHIPS COMPANY REACTED IAW OIP TO EXTINGUISH THE FIRE. ALL PERSONNEL WERE ACCOUNTED FOR AND THERE WERE NIL INJURIES. INCIDENT REPORTING TO OPCON AND TECHON OCCURRED IAW OIP. PERSONNEL ON WATCH AT THE TIME OF INCIDENT WERE THE OOW, AOOW, HELMSMAN, TRAINEE HELMSMAN, MARINELINK OPERATOR AND TRAINEE MARINELINK OPERATOR. SHIPS STO WAS ON THE FLAG DECK AT THE TIME OF THE ALARM. TIME LINE OF EVENTS IS AS FOLLOWS (READ IN TWO COLUMNS):
TIME EVENT
25MAY17
2336 - MARINE LINK ALARM - DAMPER FIRE ENGINE ROOM MID EXHAUST AIR CLOSED
2337 - MARINE-LINK OPERATOR REPORTED A HEAT/SMOKE ALARM, VENTILATION CRASH STOPPED AND REPORTED FIRE VISIBLE IN CCTV
2337 - ENGINE ROOM HIGH TEMP ALARM
2337 - OOW MADE INITIAL PIPE, BME STOPPED
2338 - BA-PORTABLE ON SCENE, BEATEN BACK BY HEAT. CABLE PARTY CLOSED UP
2339 - DCC CLOSED UP, SMOKE BOUNDARY SET ENTRANCES TO MER, PERSONNEL CONFIRMED CLEAR OF THE MACHINER SPACES. BUTTON ONE DEPRESSED (CO2 DRENCH) -FUEL ISOLATIONS, DAMPERS CLOSED AND ELECTRICAL STOP SIGNAL TO DIESEL GENERATORS (DG) AND MAIN ENGINES (ME). EMERGENCY GENERATOR FAILED TO START AUTOMATICALLY AS DESIGNED. SATCOMS FAILED, MOBILE PHONES REPORTED TO BE IN RANGE OF RECEPTION
2339 - PERSONNEL CLEAR, FWD MER DOOR REPORTED CLOSED BY BA-P AND ALL ENTRANCES CONFIRMED CLOSED BY DCC (MARINE LINK). SMOKE IN ONE DECK-SMOKE BOUNDARY SET BRIDGE DOOR AND ENTRANCES TO 1 DECK
2340 - ANCHOR REPORTED READY FOR LETTING GO
2340 - COMMAND APPROVED - DRENCH CO2 TO MER. BUTTON TWO DEPRESSED - CO2 SYSTEM CHARGING. BUTTON THREE DEPRESSED - CO2 SYSTEM ACTIVATED. ANCHOR READY FOR LETTING GO. COMMAND PRIORITIES: 1. DAMAGE CONTROL 2. COMMUNICATIONS
2341 - INDICATIONS OF SUCCESSFUL DRENCH. HEAVY SMOKE CONTINUES TO EMANATE FROM MAIN MAST/ME/DG EXHAUSTS
2342 - EMERGENCY GENERATOR STARTED AND ON LOAD
2345 - ANCHOR LET GO IN POSITION 15 05.3S 131 09.2E
2345 - REPORTS THAT CO2 MANIFOLD SHOW SUCCESSFUL RELEASE
2348 - FIRST BOUNDARY TEMPS REPORTED. THROUGH DECK FITTINGS 34, CO2 ROOM 46, BOARDING PARTY ROOM 27, GYM LOCKER 28, CO FLAT 26
2348-2358 - MARINE LINK INDICATED AN INITIAL DROP IN TEMPERATURE, THEN STABILISED AND STARTED INCREASING
2356 - ALL PERSONNEL ACCOUNTED FOR

2358 - BROKEN CYLINDER ACTIVATION HOSE LINE IDENTIFIED ON PRIMARY CO2 SYSTEM AND INDICATIONS OF PARTIAL CO2 RELEASE (3 OF 5 CYLINDERS) COMMAND APPROVED - MANUAL ACTIVATION OF SECONDARY CO2 DRENCH TO MER
26MAY17
0001 - INDICATIONS OF SUCCESSFUL RELEASE OF SECONDARY CO2 DRENCH TO MER. ON TOP TEMPS CONTINUE TO RISE
0007 - TEMPERATURES STABILIZE THEN START TO FALL
0009 - COMMENCED DE-SMOKING 1 DECK WITH NATURAL VENTILATION (ALL 1 DECK DOORS OPENED)
0028 - EMERGENCY GENERATOR FAILED - OVERHEATED
0034 - YANMAR PORTABLE PUMP SET UP READY FOR START AND CONNECTED TO FIRE-MAIN
0039 - NIL SMOKE VISIBLE EMANATING FROM MAIN MAST
0040 - 1 DECK DE-SMOKING COMPLETE
0042 - COMMENCED DREGAR READINGS TO 1 AND 2 DECK COMPARTMENTS
0054 - NDS UPS EXPENDED, PRIMARY AND SECONDARY NDS FAILED. REMAIN NAVIGATIONALLY SAFE VIA HAND HELD GPS AND NDS PLANNING LAPTOP
0104 - 1 AND 2 DECK O2 SAFE. CIS RETRIEVED PORTABLE HF SET AND COMMENCED ESTABLISHING COMMUNICATIONS WITH DEFCOMMSTA-CANBERRA
0128 - PERSONNEL BOUNDARY SET AUSTERE HATCH
0130 - JUPITER STATE 1 IN FORCE
0131 - FIRST OPREP SUCCESSFULLY PASSED VIA VOICE TO DEFCOMSTA FOR RELEASE UNDER MARYBOROUGH PLA. COMMAND ASSESSED FIRE WAS OUT, MER REMAINED CLOSED TO PREVENT RE-FLASH NOTING NIL FURTHER FIXED FIREFIGHTING SYSTEMS AND TO CONSERVE THE THREE REMAINING OCCABA SETS. COMMAND PRIORITY TO MAINTAIN BOUNDARY MONITORING. OVERHAUL COMMENCED: OVERHAUL PLAN TO ALLOW THE COMPARTMENT TO COOL AND FOR CO2 DRENCH TO SOAK WITHOUT MAKING ENTRY UNLESS TEMPS START TO RISE. TECHON ENGINEERING ADVICE SUPPORTED MAB OVERHAUL INTENT
0522 - TEMP REPAIRS EFFECTED TO EMERGENCY DA, POWER RESTORED TO ESSENTIAL SAFETY SYSTEMS
0535 - HMAS PARRAMATTA ONSTA. PARRAMATTA OSC FOR PROVISION OF SUPPORT TO MARYBOROUGH
0540 - OCCABA CYLINDERS BOAT TX TO PARRAMATTA FOR RECHARGING
0557 - HMAS LARRAKIA ONSTA
0643 - LARRAKEYAH ASSUMED DUTIES AS OSC
0657 - BOAT TX - OCCABA CYLINDERS RETURNED TO MAB
0731 - CDS RECORDED ON 058- TOW FROM ANCHOR IN HIGH TIDAL STREAM. RISK MANAGED SFARP
0809 - ANCHOR BUOYED AND LEFT IN POSITION: 12 05.24S 131 09.42E. MAB UNDER TOW BY LAR
1108 - INCIDENT REPORTED TO COMCARE
1121 - OVERHAUL PARTY RE-ENTERED MER. NIL HOT SPOTS
1135 - FIRE OVERHAULED. PERSONNEL BOUNDARY RE-SET ALL ENTRANCES TO MER, DA ROOM, AUSTERE AND AFT STEERING
1207 - INCIDENT SCENE RELEASED TO RAN BY COMCARE INSPECTOR MS RENAE ROBERTS
1230 - FACT FINDING COMMENCED
1453 - TOW DISCONNECTED FROM LARRAKIA
1529 - FIRST LINE F2A HMAS COONAWARRA. XO AND SWO COONAWARRA ON WHARF WITH PIZZA FOR MARYBOROUGH SHIP'S COMPANY PAID FOR BY COONAWARRA WELFARE FUND. VMT COONAWARRA
1600 - PERSONNEL BOUNDARIES SET, COMMENCED DE-SMOKING/VENTILATION OF MER
27MAY17
1515 - MSB INVESTIGATION TEAM MEMBER INDICATED POSSIBLE PRESENCE OF HYDROGEN CYANIDE (HCN) AS A BYPRODUCT OF THE MER FIRE AND RECOMMENDED NT FIRE SERVICE BE CONTACTED FOR TESTING
1706 - SHIP'S COMPANY DREGAR AND MULTIRAE TESTING COMMENCED MER
1738 - SHIP'S COMPANY DREGAR AND MULTIRAE TESTING COMPLETE
28MAY17
0910 - NT FIRE SERVICE ARRIVED CWA
0945 - NT FIRE SERVICE COMMENCED HCN READING
1000 - NT FIRE SERVICE CONFIRM NIL HCN PRESENT
1022 - MER DECLARED O2 SAFE. END OF INCIDENT
1030 - MSB INSPECTION COMMENCED MER
B. NIL PERSONNEL INJURIES
C. N/A

6. COMMAND ASSESSMENT - CAUSE OF THE FIRE IS UNDER MSB INVESTIGATION AND INTERIM REPORT IS DUE FOR RELEASE 01JUN17. SS SUSPECT CAUSE OF

EMERGENCY GENERATOR FAILURE IS LIKELY A PLC FAILURE AND PBGRP HAS INITIATED A TECHNICAL INVESTIGATION INTO THE CAUSE OF THE FAILURE. THE INABILITY TO CHARGE OCCABA CYLINDERS WAS DUE TO THE LOSS OF POWER TO THE POWER OUTLET
WITHIN THE FWD DC LOCKER USED TO POWER THE JUNIOR BAUER . THE 4A SECONDARY SWITCHBOARD IS NOT SUPPLIED FROM THE EMERGENCY GENERATOR AND DURING A BLACKOUT IS UNABLE TO PROVIDE POWER TO THE JUNIOR BAUER

7. DAMAGE CONTROL IAW OIP TO EXTINGUISH THE FIRE. PERSONNEL ACCOUNTED FOR, NIL PERSONNEL INJURED. OPCON AND TECHON INFORMED WITH REGULAR OPERATIONAL REPORTING PASSED IAW OIP. COMCARE NOTIFIED AND SENTINEL REPORT SUBMITTED. RECOMMEND ALL ACPBS INSPECT INTEGRITY OF PILOT ACTIVATION HOSE LINES AFTER PRIMARY CO2 DRENCH TO ENSURE FULL ACTIVATION AND ACTIVATE SECONDARY MANUAL RELEASE OF CO2 DRENCH IF ANY DOUBT. RECOMMEND CONSIDERATION
BE GIVEN TO PROVIDING A POWER SUPPLY TO THE JUNIOR BAUER FROM THE EMERGENCY GENERATOR OR FOR PROCUREMENT OF ALTERNATE OCCABA CHARGING EQUIPMENT ABLE TO CHARGE
WITHOUT ACCESS TO SHIPS POWER SUCH AS THE DIESEL OPERATED BAUER. INVESTIGATION INTO CAUSE OF FIRE REFERRED TO MSB FOR ACTION. FURTHER ADVICE/INVESTIGATION IS REQUIRED FOR RECOMMENDATIONS IN RELATION TO EMERGENCY GENERATOR FAILURE AND MAIN ENGINE ROOM FIRE

8. A. YES - REF: DEFEV17050807
B. YES - COMCARE NOTIFIED VIA TELECON 2611081/K MAY 17. SITE RELEASED TO RAN FOR INVESTIGATION
C. NO

9. P: 8, F: 8, M: 8, E: 20

10. RISK REDUCED SFARP AS THE FIRE HAS BEEN EXTINGUISHED AND THE COMPARTMENT DECLARED O2 SAFE. AGREEMENT WAS REACHED BY MSB INVESTIGATORS AND SS THAT INTEGRITY OF THE SCENE IS BEING MAINTAINED THROUGH THE CONDUCT OF HOURLY ROUNDS BY SS. COMPARTMENT HAS BEEN ISOLATED AND QUARANTINED PENDING FURTHER INVESTIGATION BY COMBINED MSB AND NTB TEAM.
FUEL REMAINING IN THE BILGE FOLLOWING INCIDENT HAS BEEN REMOVED TO BILGE HOLDING TANK USING FITTED SYSTEMS FOR REMOVAL VIA VACUUM TRUCK FAO

11. P: 14, F: 1, M: 6, E: 20. SHIP IS UNABLE TO SAIL DUE TO DAMAGE TO EQUIPMENT WITHIN THE MER

12. POC: LEUT TB MOBBS (CO) E: THOMAS.MOBBS(AT)FLEET.DEFENCE.GOV.AU M: s22 [redacted]

Additional Signal

DTG: 012215Z JUN 2017
From AUSPBGRP ReleaserSOMSS3/AUSPBGRP
Priority
Action AIG 3611
Routine
Info PBSPO DARWIN PBSPO CAIRNS FLEET ENGINEERING DIVISION MSB/AUSFLTSAFETY COMAUSMHPFOR LDH
13M
HBH
SAFETY SAFETY SAFETY - ACPB ME FUEL SYSTEMA.
0101TL00240_000_MTU12V400OM_16V4000M_MAINT MAN M02010201E.PDF

1. PRELIMINARY MSB INVESTIGATION INTO MAB ENGINE ROOM FIRE IDENTIFIED THE SOURCE OF THE FUEL AS ORIGINATING FROM THE LP FUEL LINE VENT SCREW. ATT IT HAS NOT BEEN ASCERTAINED WHETHER THE SCREW VIBRATED LOOSE OR THE THREAD HAS FAILED

2. IVO OF THE ABOVE SHIP STAFF ARE TO CARRY OUT THE FOLLOWING ACTIONS:

A. CONDUCT A VISUAL INSPECTION OF THE VENT LINE SCREW, IDENTIFIED AS ITEM 15 AT SECTION 3.8.8 PAGE 3-413 OF REF A ENSURING IT IS SUFFICIENTLY TORQUED DOWN FOR A FIRM FIT

B. FIT QUOTE NO SPRAY UNQUOTE OR EQUIVILENT DNV APPROVED TAPE AROUND THE SCREW IN BOTH VERTICAL AND HORIZONTAL PLANES AS WELL AS ALL UNIONS BETWEEN THE LP PUMP AND FUEL FILTER HOUSING. TM200 TO BE RAISED FOR THE PROVISION/REPLENISHMENT OF SHIP STOCK OF TAPE IF REQUIRED

C. CONDUCT A VISUAL INSPECTION OF SPRAY SHIELDING (SOLAS) KIT FITTED TO LP FUEL SYSTEM (PLASTIC CLIPS). ADDITIONAL TM 200 TO BE RAISED FOR FITMENT/REPLACEMENT OF KIT AS REQUIRED

3. IMAGERY OF VENT LINE SCREW AND SPRAY SHIELDING (SOLAS) KIT WILL BE SENT VIA EMAIL TO ALL ACPB STO'S.

4. POC: CPOMT BISHOP (SOMMS2) EMAIL:JAMES.BISHOP@DEFENCE.GOV.AU, MOB: s22

Additional Signal

DTG: 080323Z AUG 2017
From HMAS MARYBOROUGH
Routine
Action AUSPBGRP
Routine
Info AUSFLTSAFETY DGNAVCERTSAFE PBSPO CAIRNS PBSPO DARWIN COMAUSMHPFOR AIG 3611
ACP 128 Originator: HMAS MARYBOROUGH

I2B
LAL
W2M
HMAS MARYBOROUGH - OHSIR CLOSURE AND SITREP JUL 17
A. ABR6303 SECTION 5 CHAP 1
B. HMAS MARYBOROUGH W2M/LAL/I2B 280918ZMAY2017
1. HMAS MARYBOROUGH CONDUCTED A SSET MEETING ON 04AUG17
2. THE FOLLOWING OHSIR REMAIN OPEN:
A. 03/17 - NOTIFIABLE INCIDENT - DANGEROUS OCCURRENCE - MAIN ENGINE ROOM FIRE, TOTAL LOSS OF POWER AND INABILITY TO RECHARGE OXYGEN BOTTLES. AWAITING RELEASE OF FINAL INVESTIGATION REPORT
3. POC PONPC SCOTT FOX EMAIL: SCOTT.FOX(AT)FLEET.DEFENCE.GOV.AU PH :s22

Australian Government
Department of Defence

Event Investigation Report - DEFEV17050807

DEFENCE 100001

SENTINEL

Risk Ranking		Reported By	Mobbs, Thomas Bennett
Occurred Date	25-May-2017 2:07 PM (GMT)	Status	Closed
Reported Date	28-May-2017 3:48 AM (GMT)		
Event Type	Event Type - WHS Event	Location	HMAS Maryborough (G)

Business Unit

Business Unit - HMAS MARYBOROUGH 131885

Contractor Company

Classification

Maritime

Description of Event

On passage to Darwin for LOGVST HMAS Maryborough experienced a major fire in the main engine room (MER). Ship's Company reacted IAW OIP to extinguish the fire. The fitted CO2 drench, primary and secondary cylinder banks were activated after the MER was confirmed clear of personnel. The CO2 drench successfully extinguished the fire. All personnel were accounted for and no personnel were injured during or after the incident. Boundary monitoring continued until personnel in full fire fighting rig overhauled the fire. Only personnel in intermediate fire fighting rig were then permitted into the MER until NT Fire Brigade confirmed no HCN (Hydrogen Cyanide) and Ship's Staff confirmed the compartment was O2 safe using RAN atmospheric testing.

On Tuesday 29 May 17, one member reported coughing due to exposure to smoke. Member was directed to attend the Larrkeyah medical centre where they were examined by the Medical Officer. Individual Sentinel report to be completed by the member.

Immediate Actions Taken

Ship's Company reacted IAW OIP to extinguish the fire. The fitted CO2 drench, primary and secondary cylinder banks were activated after the MER was confirmed clear of personnel. The CO2 drench successfully extinguished the fire. All personnel were accounted for and no personnel were injured during or after the incident. The ship went to anchor East of the Vernon islands due to the loss of propulsion and main power generation. Boundary monitoring continued until personnel in full fire fighting rig overhauled the fire. Only personnel in intermediate fire fighting rig were then permitted into the MER until NT Fire Brigade confirmed no HCN (Hydrogen Cyanide) and Ship's Staff confirmed the compartment was O2 safe using RAN atmospheric testing. Ship's Staff reported the incident to the Operational Control and Technical Control throughout using Operational Reports and Telecon messages.

InvestigationTeam

Workplace Supervisor	Hunter, Jason Clarke
Approving Authority	Rudolf Francisco Wagemaker
Investigator	John Christopher Chipper
Team	Kate Estelle Campbell. Ewan Farquharson. Josip Kosic. Ian Reynolds. Peter James Strzelecki.

People Involved

Name	s47F	**Severity**	Dangerous Incident
Person Type	Employee		
Role(s)	* s47F 00514419 (Job Title)		
Mechanism of Injury	Exposure To A Traumatic Event		
Object Causing Injury	Fire,Flame And Smoke		
Activity performed	Firefighting		

Name	s47F	**Severity**	Dangerous Incident
Person Type	Employee		
Role(s)	* s47F 00514431 (Job Title)		
Mechanism of Injury	Exposure To A Traumatic Event		
Object Causing Injury	Fire,Flame And Smoke		
Activity performed	Firefighting		

Name	s47F	**Severity**	Dangerous Incident
Person Type	Employee		
Role(s)	* s47F 00514411 (Job Title)		
Mechanism of Injury	Exposure To A Traumatic Event		
Object Causing Injury	Fire,Flame And Smoke		
Activity performed	Firefighting		

* Acting Role

Investigation Findings

MSB Investigators have concluded that the cause of the fire was the detachment of a bleed screw on engine one between the low pressure fuel pump and secondary filters which caused about 4 minutes of fuel leakage into the engine space before ignition occurred. Examination of Marinelink data suggests the following sequence of events:
a. Leaking fuel initially was horizontally through the sampling tube until the screw became completely detached at which time the discharge would have become vertical.
b. This discharge would have generated a mist cloud between both engines but predominately most of the discharge remained a stream into the bilge as well as covering the deck plates and surroundings.
c. The ignition of the fire was due to the deflagration of the oily mist. The activation of this deflagration has not been specifically determined and this may not be possible. The leading likely causes for this activation is either from the alternator igniting fuel which had ingress into it or fuel absorbing into the exhaust lagging heating up to generate combustion.
d. Principally the bilge combusted, generating large amounts of flame and massive amounts of smoke, this lead to fault failures on engine one as well as the fire detectors activating.

Supporting Information

Involved Item Type	Involved Item Name	Template Name	Status
Event	DEFEV17050807	Event Additional Questions (Supervisor to Complete)	Finalised

Section: 5	
Initial Assessment	
Did the Event occur whilst on duty doing Defence Work	YES
Was the Involved Person a visitor to Defence Property	NO
Does the Event involve workplace bullying/harassment?	NO
Did the Event occur during ADF organised sports?	NO
Section: 22	
Did the Event occur whilst on a declared Defence Operation?	NO
Section: 31	
Event did not occur on declared Defence Operation	
Did the Event involve a person who suffered a Fatality, Serious Injury or Illness or was it a Dangerous Incident as defined in the WHS Act 2011?	YES
Section: 32	
What action was taken immediately following the incident to prevent a recurrence of a similar incident-or to minimise any risk to health and safety that was present because of, or in aftermath, of the incident?	The engine was shut down and the vessel proceeded to anchor. The fire was extinguished and the compartment was sealed to personnel that were not in the appropriate Personnel Protective Equipment and the vessel towed to port from her position at anchor.
Section: 33	
Has this Event been notified to Comcare previously, by telephone or writing?	YES
Section: 34	
Reason for subsequent notification	Required by Comcare
Section: 35	
Specify Other Here	
Section: 37	
Method of first notification to Comcare	Telephone
Section: 39	
Specify Other Here	
Section: 41	
If by phone, who did you speak with?	s47F [redacted]

Section: 44

Comcare reference number (if provided)

First notification to Comcare

Table Row: 1 Date

Table Row: 1 Time (24hrs HHMM)

Table Row: 1 Comment

Section: 50

Event Details - Additional Questions

Indoor or Outdoor Location?	INDOOR
Provide the specific location of where the Event occurred? (eg Gymnasium, Desk, BP 35-5-001, Officer's Mess)	Main Engine Room (MER)
What, if any, plant, vehicles, equipment, substances or things were involved in the incident?	Starboard Main Engine Fuel Fire within the Main Engine Room

Section: 52

Describing the Event - Additional Questions

Was the Event a result of an Estate Management Issue (EMI)?	NO
Has another type of report been created or raised in addition to this WHS Event that is related to the Event?	YES

Section: 54

Additional report(s) raised

Table Row: 1 Select the report raised:	Keyword: OHSIR
Table Row: 1 Specify if Other	
Table Row: 1 Reference/Work Order Number	
Table Row: 1 Comments	In Draft at time of Sentinel Report
Table Row: 2 Select the report raised:	Keyword: Other
Table Row: 2 Specify if Other	Defence Incident Report
Table Row: 2 Reference/Work Order Number	02/17-001
Table Row: 2 Comments	Includes Operational Reporting Messages embedded within the form
Table Row: 3 Select the report raised:	Keyword: Other
Table Row: 3 Specify if Other	Defence Incident Report
Table Row: 3 Reference/Work Order Number	02/17-002
Table Row: 3 Comments	Includes Operational Reporting Messages embedded within the form

Section: 90

Has the site where the event occurred been disturbed?	NO

Section: 92

Section: 92

Has a Comcare Inspector arrived at the site or authorised disturbance of the Event site?

Section: 93

Inspector's Name

Date authorised

Time authorised (24hrs HHMM)

Section: 94

Has the Event site been disturbed for one of the reasons set out in section 39 (3) of the WHS Act?

Section: 109

Primary reason for disturbance:

How was the site disturbed?

Section: 125

Radiation Event Details

Did the Event involve a radiation source?	NO

Section: 127

Was the Event caused by a controlled source under the ARPANS Act?

Section: 129

Is this a Radiation Accident as defined within the Defence Radiation Safety Manual, Chapter 3, Notification and Reporting?

Section: 131

Hazardous chemicals, materials or substance

Did this Event occur at a major hazard facility?	NO
Did the Event involve hazardous chemicals, materials or substance?	NO

Section: 132

Select the Chemical/Substance from this list

Section: 133

Specify 'Other chemical/substance' here

Section: 134

Is the material or substance involved registered on ChemAlert?

Section: 135

Was the Safety Data Sheet (SDS) available and viewed?

Section: 137

Attach a copy of the SDS here

Involved Item Type	Involved Item Name	Template Name	Status
Event	DEFEV17050807	WHS Event – Initial Assessment (Investigator to Complete)	In Progress

Section: 1

WHS Event – Initial Assessment

Confirm that the facts of the WHS Event as reported by the Injured Person and Supervisor accurately reflects what happened	There were no injuries to personnel and no exposure to potentially harmful chemical or organic elements
Confirm the nature of any injuries and the status of Involved Person(s) reported at the time of the WHS Event	No injuries to personnel. Incident occurred in HMAS Maryborough, a Navy Patrol boat
Confirm that the reported actions were taken and the status of those actions (Immediate Actions; investigations by armourers, ADF Investigative Service etc)	All Actions reported were taken to successfully extinguish the fire in the MER and then overhaul and reclaim the compartment
Review the risk assessment for any associated hazards or risks, and the controls in place to prevent a WHS Event of this type	OIP, training and SRP were reviewed and remain appropriate.
Assess what contributed to this WHS Event and select causal factors from the Root Cause list	Analysis Factor: Equipment / Material Unsuitable
Recommend measures to eliminate or minimise the chance of such a WHS Event recurring, and/or to minimise adverse outcomes should there be recurrence.	DSTG to examine lagging samples for signs of hydrocarbon and combustion. DSTG to examine the bleed screw assembly to further understand why the bleed screw dislodged. NTB to facilitate further electrical forensic investigation of the alternator. Provision and review of supporting information from the PBSPO/PBGRP Alternate power supply for the junior bauer to be investigated Further investigation into initial CO2 partial release Provision of final report and recommendations to COMMHP

Key Learnings

Workflow

Date (GMT)	Comments By	Comments
2/Jun/2017 2:10 AM	Hunter, Jason Clarke	Further details based on the initial MSB/NTB investigation are to be included and report attached with actions developed to reflect the findings and recommendations.
16/Jun/2017 4:10 AM	Wagemaker, Rudolf Francisco	Incident reviewed and root cause of the fire was identified. Actions have been initiated and completed across the ACPB fleet to prevent reoccurence.
24/Jul/2017 1:07 AM	Hunter, Jason Clarke	No additional information. Only requires closing due to amendment to generate written notification to COMCARE
24/Jul/2017 2:08 AM	Wagemaker, Rudolf Francisco	All actions complete.

Keywords

WHS Management System, Operations, General Keywords

Attachments

Type	Details	Date Attached (GMT)
File	SMABRCL0117052909320.pdf	30/05/2017 1:58:46 AM
File	SMABRCL0117052909321.pdf	30/05/2017 1:59:15 AM
File	SMABRCL0117052909330.pdf	30/05/2017 1:59:44 AM
File	280918Z MAY 17 W2M-LAL-I2B MAB OHSIR MER fire.txt	30/05/2017 2:00:21 AM
File	DIR 02-17-002 - Major Fire MER May 17.pdf	30/05/2017 2:01:04 AM
File	DIR 02-17-001 - Major Fire MER May 17.pdf	30/05/2017 2:01:18 AM
File	MAB-Fact finding-MER-27May17.pdf	30/05/2017 2:02:39 AM
File	280918Z MAY 17 W2M-LAL-I2B MAB OHSIR MER fire.txt	30/05/2017 2:38:02 AM
File	DGMAR SIGNAL PAR ASSIST.txt	30/05/2017 2:38:10 AM
File	LAR ASSIST.txt	30/05/2017 2:38:20 AM
File	LKA OPREP TOW.txt	30/05/2017 2:38:28 AM
File	MAB JUPITER STATE 1:txt	30/05/2017 2:38:43 AM
File	MAB OHSIR 02-17 MER FIRE FINAL.txt	30/05/2017 2:38:52 AM
File	MAB OPREP INI.txt	30/05/2017 2:39:03 AM
File	MAB OPREP TOW.txt	30/05/2017 2:39:16 AM
File	PAR OPREP FINAL.txt	30/05/2017 2:39:57 AM
File	PAR OPREP ONSTA.txt	30/05/2017 2:40:06 AM
File	MAB OHSIR 02-17 MER FIRE FINAL.txt	30/05/2017 2:56:38 AM
File	HMAS Maryborough initial report_fire in main engine room.pdf	02/06/2017 4:48:20 AM
Text	To Review written notification to COMCARE	24/07/2017 1:02:42 AM

End of Report

PDE Low Pressure Fuel Bleed Screw

References:

A. DST Minute AV14921984 "EXAMINATION AND CALCULATION OF FUEL FLOW DURING FIRE INCIDENT OF THE STARBOARD MAIN ENGINE OF HMAS MARYBOROUGH ON 25 MAY 2017" dated 6 July 2017.

B. Two pages from document S9234-AD-MMO-050/LM2500 with Views 1–24 of examples of lock wiring on the GE LM2500 gas turbine.

C. Example brochure of external multiple tab washer: http://www.nationalengfasteners.com/products/category/162-multiple-external-tab-washer

Introduction

C.1 I attended HMAS Coonawarra patrol boat base in Darwin NT from Saturday 27 to Wednesday 31 May. This included visits into the engine room on Sunday and Wednesday. On my first entry to the engine room from the forward hatch it was immediately obvious that a fuel bleed screw was missing on pipework on the front of the starboard propulsion diesel engine (PDE). This was the root cause of this fire, uncontrolled escape of combustible fluid.

C.2 This paper focusses on the root cause and not related aspects such as the oil mist detectors not picking it up, the CCTV camera vision, hot spots identified in earlier thermography not being rectified, fuel pressure drop not raising an alarm, etc.

C.3 During the response to the incident the SOLAS emergency generator failed due to overheating from its cooling fan not running. MT sailors are pointing at the PLC and the VSD that control the fan as the likely cause. This issue requires further investigation especially if future navy ship acquisitions follow commercial maritime practice rather than more robust navy electrical power generation standards.

Description of Event

C.4 The fuel source for the fire was the bleed arrangement on the high point of the low pressure fuel line between the low pressure pump discharge and the secondary filters on the way to the high pressure pump[1] suction. The bleed screw in this assembly is vertical and at the front left side of the starboard engine. Marinelink[2] shows that at 23:33:02 hours pressure began to fall from

[1] There have been many fuel leaks from common rail high pressure pump failures on these patrol boat propulsion engines, but this was not one of them.
[2] Marinelink is the patrol boats machinery monitoring and control system via desktop computer screens and logs a certain amount of data.

6.75 bar to 5.5 bar over about 20 seconds as the bleed screw loosened until completely free and blown out by the fuel pressure. During this time fuel would have been flowing out of the horizontal bleed drain vent in a downwards arc onto the floor plates and into the bilge. It could also have been dripping onto the engine's small auxiliary alternator, just below deck level at the front of the engine. After the screw completely detached fuel pressure remained at 5.5 bar until 23:37:11. The majority of the fuel would now have been spraying vertically out of the vacated bleed screw bore instead of sideways through the vent drain. For nearly 4 minutes fuel escaped at 5.5 bar in a vertical stream upwards onto the starboard engine's exhaust lagging (insulation), some soaking in, the majority falling into the bilge. Note that 5 bar is the maximum recommended domestic water pressure however it's sometimes higher. So this leak would have been equivalent to a strong garden hose, clearly capable of travelling quite some distance in a stream. There was likely spray associated with the escaping fuel, enough to form a mist cloud between the two engines but closer to the starboard engine. Reference A indicates approximately 133 litres of fuel escaped from the bleed assembly over the 4 minute period with a velocity of about 76 m/s or 270 km/h.

C.5 Diesel is a difficult fuel to burn especially when it is in pools. Liquids have to be vaporised before they can be ignited, it is gas that burns, not liquid. Pooled liquid diesel that we use (F-76 and DMA) does not vaporise in an ignitable quantity unless heated well above 60 degrees Celsius. Being in a fine spray lowers this temperature considerably. Once flammable vapour is present, all that is needed is an ignition source of which there are several possibilities in an engine room: various electrical fittings (lights, switches); hot exhaust system surfaces underneath insulation; and a small on-engine auxiliary alternator also at the front of the engine and below the bleed point. As mentioned there was fuel soaked exhaust pipe insulation above the bleed point. The temperature of the exhaust pipe underneath this lagging was certainly above the fuel's flashpoint (generation of flammable vapour) and possibly above its ignition temperature.

C.6 At just over 4 minutes from the beginning of the fuel leak the mist cloud ignited[3] at ~23:37 hours, fire alarms activated and engines were shut down at 23:37:11. The fireball has scorched the front three cylinder head covers on the left bank of the starboard engine, much blackening of components on the top front half of the engine, destruction of most of the left paper air filter element and lesser damage to the other three engine air intake filters indicates the location of the fire ball. This was followed by fuel in the bilge igniting, this fuel being the majority of the fuel that had escaped from the bleed point. This fire has damaged electrical wiring on the front left end of the engine and the electronic control module. It was the fire that the first CO2 discharge failed to extinguish.

Most Likely Cause of Bleed Screw Coming Free

[3] In the HMAS Westralia tragedy a cloud of fuel mist formed from a spraying burst hose. In this instance only 30 litres of fuel escaped.

C.7 Screws on engines come loose for a number of reasons: not sufficiently tightened; over tightened and fractured; incorrect screw material and poor coefficient of friction with the mating thread material; missing spring or lock washers; thermal cycling causing gradual loosening by expansion and contraction; vibration; etc.

C.8 This screw is normally only used during significant maintenance such as a W5 overhaul requiring bleeding of this fuel system after removal and replacement of either low or high pressure pumps. Available information suggests it was Penske that likely last tightened this bleed screw at a W5 service. The boat's crew said they don't use it because they haven't done any high level maintenance requiring them to bleed (vent) that system. It should be noted that it would be a convenient point to take fuel samples; the crew said they use a point elsewhere for that purpose. This fuel bleed screw and a nearby lubricating oil bleed screw were not wrapped with anti-spray tape. Tape was probably thought to interfere with bleeding operations too much and is typically used on more permanent joints to convert spray leaks from threads and unions into dripping. Tape is not primarily intended to stop a screw coming loose.

C.9 The usual cause of screws coming loose is insufficient tightening to a correct torque when assembling or maintaining an engine. Forgetting to finally tighten happens due to tiredness, overload, confusion, interruption or distraction after repeated bleeding operations when trying to get an engine running. The bleed screw has a conical end that mates with a hard seat thus only needs a little bit of movement to come loose. Once that happened with the thread in good condition and lubricated by fuel, assisted by the fuel pressure and vibration, it unscrewed until completely free. Reference A states that the threads, sealing seats, and screw hex flats are in good condition indicating that the screw didn't come loose due to damage or overuse. It doesn't discount the likelihood that the bleed screw wasn't sufficiently torqued.

Mitigations

C.10 A number of options are available to secure screws from coming loose. Some are listed below in descending order of effectiveness. It should be noted that these often serve as a mental jog to conduct final torqueing after bleeding has been completed. Final torqueing with a torque wrench to within the specified torque range usually prevents fasteners coming loose. The problem is there is no positive physical evidence that this has actually been done. Neither has a recommended torque for this screw been sighted during the investigation.

C.11 Lock wiring:
Aviation and motorsport engines routinely have screwed fasteners lock wired after finally torqueing to ensure they don't come loose. In aviation there is the obvious safety requirement of engine reliability, in motorsport it is to prevent engines dumping oil creating a slippery track and causing an accident. The GE LM2500 aero-derivative gas turbine has lock wired fasteners, illustrated in Reference B.

C.12 Multiple external tab washer:

Tab(s) are bent up onto hex flats of the screw head; other tabs are bent down onto flats on the assembly thus locking the screw in position. Reference C is an example brochure. Many other types are available.

C.13 Nylok thread:
Similar to above it should prevent the screw from vibrating completely loose.

C.14 Anti-spray tape:
Applied over the screw and body of the bleed assembly. Whilst not capable of preventing the screw coming loose, it would serve as a reminder to finally torque up and would prevent the screw completely unthreading reducing the leakage rate and restricting it to the drain vent.

C.15 Lock wiring or tab washers are the desirable long term solution.

Recommendations

C.16 This event suggests that the configuration of the bleed assembly is not compliant with the intent of the WHS legislation. Penske should be asked to provide a solution, possibly by issuing a service bulletin modification to these MTU engines.

C.17 Penske could be made aware, if not already so, that lock wiring is used by GE on our LM2500 gas turbines in FFG, FFH and LHD classes, Reference B. The assembly the screw is threaded into, Figure 1 in Reference A, is itself threaded into a fitting welded on the pipe. Both the screw and assembly would require lock wiring. Penske may suggest an alternative such as raising the alarm priority of this fuel pressure to automatic engine shut down. As this does not directly address the root cause, the screw coming loose, it would need to be supported by a hazard risk assessment including false alarms causing an unnecessary loss of propulsion.

C.18 There are other threaded fasteners on the propulsion diesel engine that should also be reviewed by Penske for WHS hazard risk such as an identical design lubricating oil bleed screw located nearby to this one.

C.19 MT sailors or the boat's outfit should be issued with a torque wrench for occasions they are required to perform emergency maintenance at sea.

C.20 Penske should provide recommended maximum and minimum torque figures for fasteners where not readily available in existing documentation.

Ewan Farquharson

Propulsion & Manoeuvrability Cell Lead
Naval Technical Bureau

Department of Defence, Navy Strategic Command, Navy Engineering Division
Campbell Park Offices CP4-5-031, PO Box 7913, Canberra BC ACT 2610

13 July 2017

Australian Government
Department of Defence
Science and Technology

Minute

[AV14921984]
Mr Ewan Farquharson – Propulsion & Manoeuvrability Cell Lead

For information:
Mr Grant Gamble – Defence Scientist –Fire
Ms Zenka Mathys – GL Naval Platform Survivability

EXAMINATION AND CALCULATION OF FUEL FLOW DURING FIRE INCIDENT OF THE STARBOARD MAIN ENGINE OF HMAS MARYBOROUGH ON 25 MAY 2017

References:

A. Email correspondence: Mr Ewan Farquharson to Dr James Harris: "*Re: HMAS Maryborough Items*", Friday, 23 June, 2017, 3:23 pm
B. Email correspondence Mr Ewan Farquharson to Dr James Harris: "*Re:Re: Request for Fuel System Data*", Wednesday, 7 June 2017, 10:44 am.
C. Email correspondence: Mr Ewan Farquharson to Dr James Harris, "*Re: HMAS Maryborough Items*", Tuesday, 4 July, 2017, 3:54 pm.
D. Email correspondence: Dr David Evans to Dr James Harris: No Title, Wednesday, 5 July, 2017, 2:07 pm.
E V.L Streeter and E.B Wylie: *Fluid Mechanics* 1st Metric Ed (1981) McGraw -Hill

1. The following are results of examination of the fuel line vent positioned between the low pressure and high pressure fuel pump of engine number 1 (starboard main engine) of HMAS Maryborough as a result of the reported fuel fire on this engine on 25 May 2017 at approximately 2337 hours. The complete assembly is seen below in Figure 1. A request by Mr Ewan Farquharson was made to examine the vent assembly components (Ref A) and secondly approximate the volume of fuel likely to have flowed from the opened vent.

Figure 1 Fuel vent assembly HMAS Maryborough - engine number 1

2. Optical microscope examination of the vent sealing surfaces shows both the non-ferrous seat (Figure 2) and steel spindle (Figure 3) to be in serviceable condition. Some minor non-critical corrosion is apparent on the spindle above its sealing surface. From Figure 1 it can also be ascertained that the hexagonal flats are in good condition.

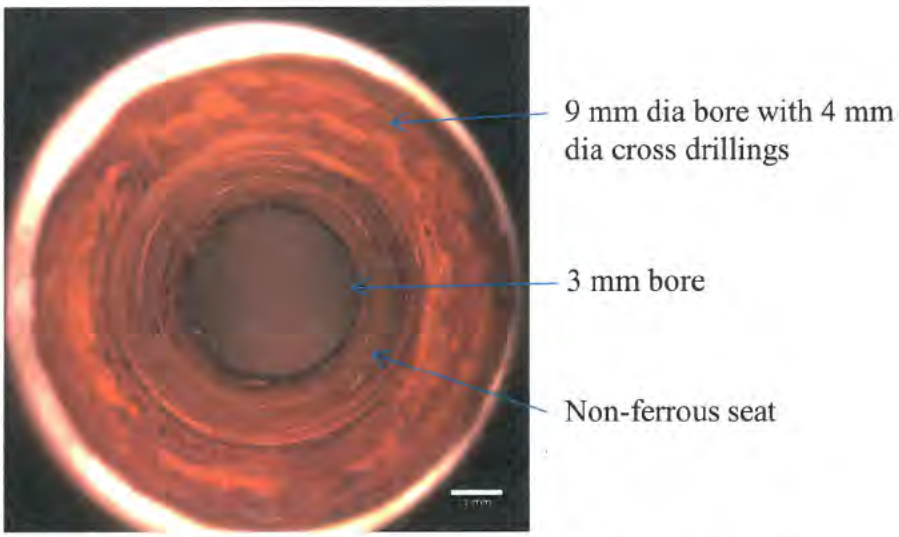

Figure 2 View of non-ferrous seat as seen from above (image courtesy of Mr Stephan Toman AD – AFE)

Figure 3 Steel spindle seat and minor corrosion above sealing surface

3. On assembly by DST of the vent screw into the vent line body, it was found that the thread was an apparent snug fit and did not exhibit significant looseness. The hexagonal top was in good condition. DST has not measured either the internal or external M10 x 1 mm pitch thread.

4. Calculation of the flow of fuel from this fuel line vent is contained in Appendix A. Using data and figures provided by References A to E the analysis found:

(a) The fuel was calculated to exit the three millimetre bore of the vent with a maximum speed of 76 ms^{-1} once the steel spindle was fully removed.

(b) With the spindle totally removed from the vent line body this fuel velocity would be sufficient for the fuel to reach the height of the lagging reported in Ref C.

(c) The total amount of fuel calculated to flow into the main engine room over the indicated event time of 248 seconds was found to be approximately 133 litres which is excess of the

volume reported in Reference A but likely to be a maximum possible value as calculations ignore minor losses.

Dr James Harris
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Defence Science and Technology Group
506 Lorimer Street, Fishermans Bend, Victoria 3207
Australia
Ph 03 96267604
Mob s22 [redacted]
06/07/2017

Appendix A

Calculation of fuel flow from main engine fuel vent line

1. **Defining Event Duration and Conditions**

Using Figure A1 the total logged time for reducing (highlighted by blue arrow) and reduced fuel pressure (highlighted by black arrow) is given by:

23:37:13
\- 23:33:05
00:04:08 or 248 seconds

Which represents the amount of time fuel was available to exit the opening/opened fuel vent.

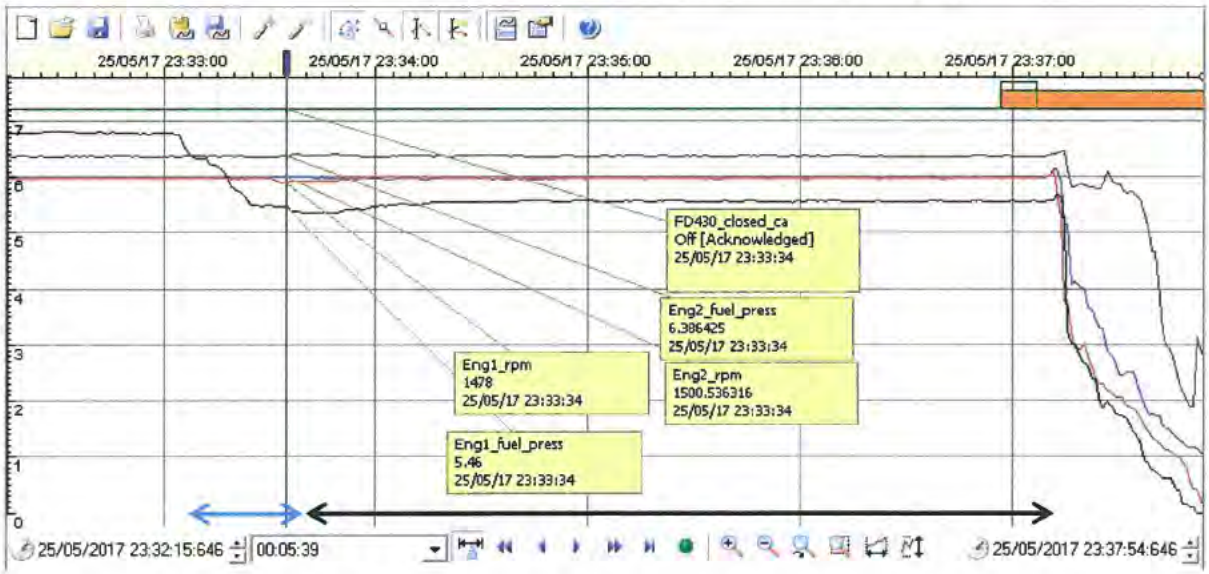

Figure A1 Marinelink record of HMAS Maryborough main engine RPM and fuel pressure at the time of engine shutdown on 27-May 2017

Other measurements

(a) Bore at base of non-ferrous sealing seat = 3.0 mm diameter x 20 mm long (see Figure 2)

(b) Vent body internal diameter above seat = 9.0 mm diameter (see Figure 2)

(c) Vent spindle diameter above seat = 5.88 mm (see Figure 3)

(d) Venting cross drillings above sealing seat = 2 holes x 4 mm diameter

(e) F76 fuel viscosity (γ) = 2.694 mm^2s^{-1} (using Draft 2015 F76 PQIS data – Reference D)

(f) F76 fuel density (ρ) 837.2 kg m^{-3} (using Draft 2015 F76 PQIS data – Reference D)

2. **Flow conditions**

Determine most constricted point of flow within vent assembly

This will occur either at

- Base of sealing seat $(= \pi\frac{3^2}{4} = 7.06\ mm^2)$

or

- Between top of sealing seat and spindle $(= \pi\frac{(9^2 - 5.88^2)}{4} = 36.4\ mm^2)$

Hence the 3 mm diameter x 20 mm long bore at base of sealing seat most constrictive to flow of fuel once vent valve fully opened

3. **Assumptions**:

- There is no loss at exit from 3 mm bore and no flow losses from other minor features thereafter
- Pressure at entry to 3 mm bore is held at a constant 5.6 bar
- Flow is likely to be turbulent through 3 mm bore, assume Reynolds No. (Re) $\approx 10^5$
- Pipe roughness in 3 mm bore is 0.02 mm

4. **Flow Calculation**

(a) Using Darcy-Weisbach Equation (derived from Reference E):

$$\Delta P = f_b \frac{\rho V^2}{2} \frac{L}{D} \qquad \text{Eq. 1}$$

where ΔP = pressure change across the orifice

f_b = friction factor (of orifice)

ρ = density of fluid

V = velocity of fluid

L = length of orifice

D = diameter of orifice

(b) Calculating friction factor f_b

Assuming Re = 10^5 and pipe roughness factor = $\frac{0.02}{3} = 0.0067$

Using Moody Diagram in Appendix B, then at first iteration $f_b = 0.034$

(c) Therefore using Eq. 1

$$V = \sqrt{\frac{2\Delta PD}{f_b L \rho}} = \sqrt{\frac{2x5.6x10^5x0.003}{0.034x0.02x\,837.2}} = 76.8 \approx 76\ m/s$$

(d) To check first iteration

$$Re = \frac{VL}{\gamma} = \frac{76.8 \times 0.02}{2.694 \times 10^{-6}} = 570{,}155$$

When plotted back onto Figure B.1 this compares well with the initial prediction hence predicted F76 velocity of 76 ms^{-1} at bore exit is reasonable.

(e) Total Fuel Loss

Total (maximum) volume leaked =Time x 76 x $\left(\pi \frac{0.003^2}{4}\right)$ = 0.1332 m^3 or **133 litres total**

Appendix B

Moody Diagram (Ref. E)

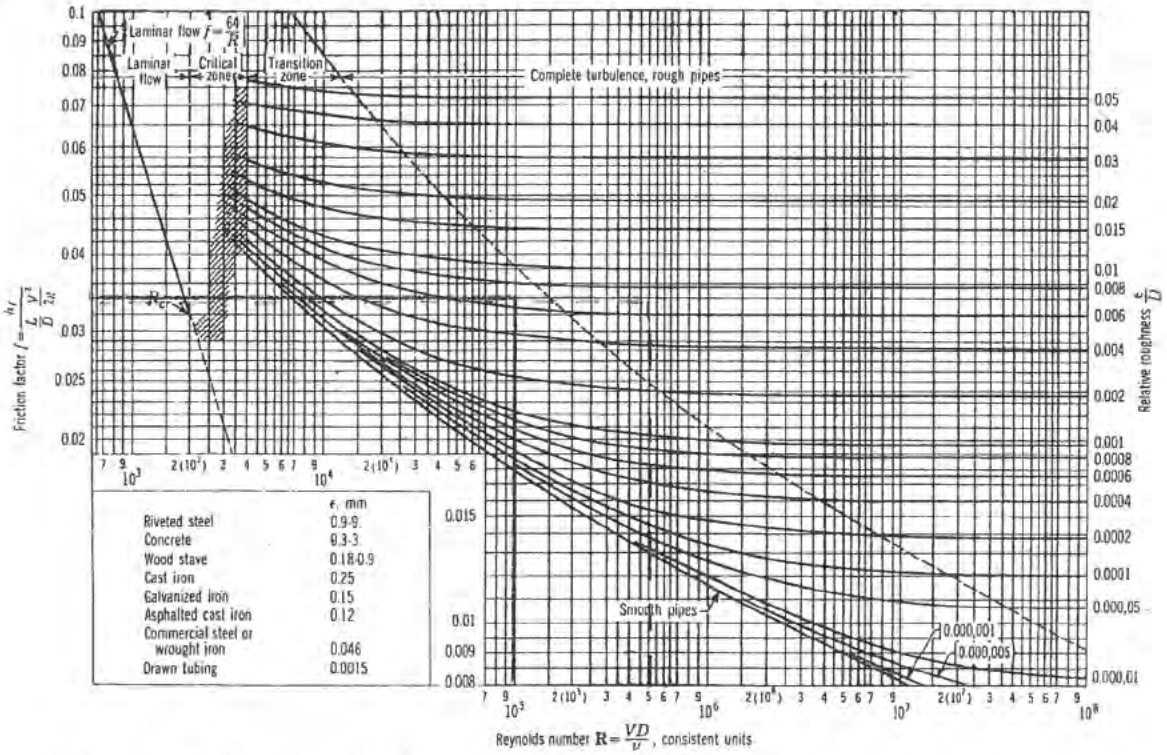

Figure B.1 Moody diagram with first and second iteration plots (source Ref. E)

Fire Event and Incident Response Report into the HMAS MARYBOROUGH Fire by Mr Raymond, Navy Fire Safety Manager Naval Technical Bureau, Navy Engineering Division

1. This report covers the fire event, the response preformed by the crew of HMAS Maryborough to this fire, and the associated issues encountered during this response. This report therefore follows on from the previous material which covered the loss of control which generated the marine diesel spread around and on the forward inner part of engine one (STBD).

2. The following presents the critical elements of the fire event and response. These were deemed critical elements by the investigation and is not a complete break down of all elements that occurred during the period 2337 25 May 2017 to 1129 26 May 2017.

Fire Event

3. As mentioned previously in the entire material, the loss of control was the detachment of the bleed off screw from the assembly, as shown in Figure 1. Figure 2 presents a schematic of this assembly and its associated pipework. The nominal condition for this assembly can be seen at Figure 3, which was present in Engine 2 during the investigation.

4. With the detachment of the bleed screw, marine diesel was being discharged near the forward inward side of engine one of the bilge and deck plates, as well as a mist cloud forming between the two engines. A mist cloud sized to support a deflagration event was able to develop due to the engine being at approximately 1500 rpm (with only one turbo charger running) which leads to almost static air conditions within the main engine room.

Figure 1: Bleed off assembly for engine 1 missing its bleed screw, within the red circle. Additionally, note the colour of the vent line, which indicates that a fire likely occurred within and around it.

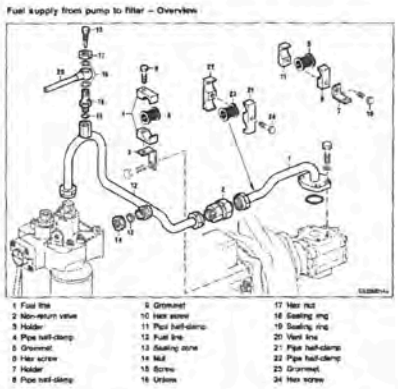

Figure 2: Schematic of the pipework and bleed off assembly

Figure 3: Bleed off assembly for Engine 2, showing the nominal condition.

5. From the review of the evidence it has been deduced that the pool sources of marine diesel ignited after the fuel air deflagration. As discussed in more detail below, the fuel air deflagration caused the mid forward main engine room damper to closed. The ignition of the oily mist cloud could have been from many sources with this engine room. The following three sources have been considered:

Backfire from the engine turbo charger

6. One potential ignition of the oily mist cloud could be that some of the oily mist cloud ingressed into the engine(s) turbo charger. This would have lead to an over rich combustion, which increases the engines rpm and may also generate a backfire which could ignite the oily mist cloud. Figure 4 presents the closing of the mid forward engine room damper and for each engine low fuel pressure reading plus the rpm for each engine. As can be seen in Figure 4, the rpm were steady around the time of the damper close, although there is a small spike just before engine shut down. This rules out a backfire as a possible ignition source.

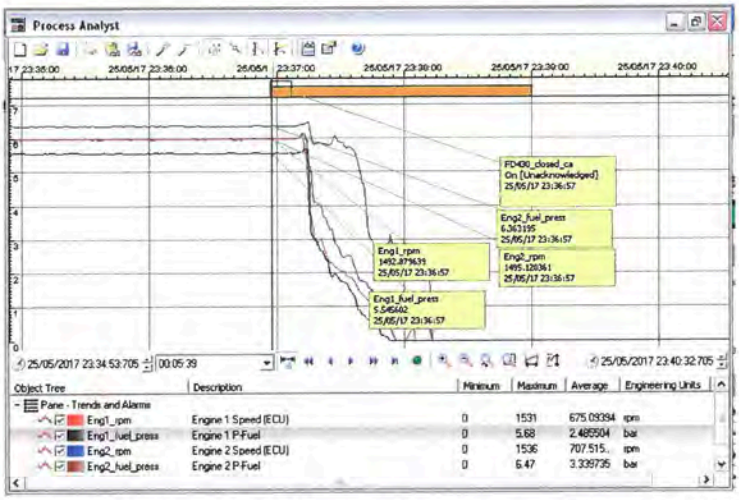

Figure 4: Marinelink display of mid forward engine room damper close and for each engine the rpm and low fuel pressure reading.

Engine one alternator

7. It is plausible and supported by evidence that liquid and mist diesel entered engine one alternator. As the alternator was in use and is not a brushless configuration it could have ignited the diesel, which would have travelled rapidly to the oily mist cloud via the vapour which is expected to have existed between the alternator and the main oily mist cloud. Figure 5 shows the alternator in its standard position post fire. This position is below the bleed off assembly and as can be observed from Figure 5 that combustion has occurred below and within the alternator. Figure 6 shows the alternator removed from the engine and there are clear signs of fuel ingress and combustion.

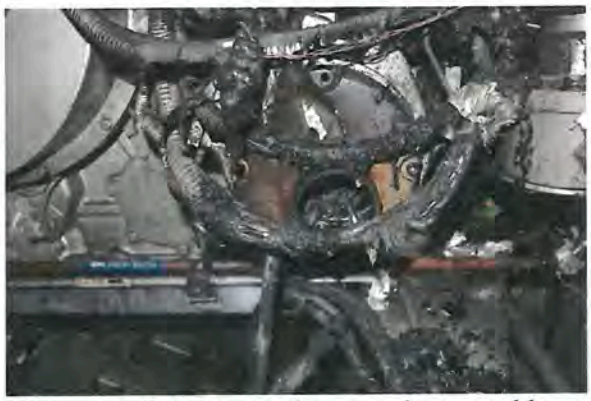

Figure 5: Alternator fitted to engine one, impacted by combustion

Figure 6: Removed alternator with signs of fuel ingression and combustion

Exhaust lagging

8. From the inspection of the site, it was observed that much of the lagging at the forward part of the engine room has absorbed significant marine diesel. Figure 7 shows part of this exhaust lagging above the forward part of engine one. There are signs of flash burn marks on the outer layer of the lagging. Samples have been sent to DSTG for analysis.

Figure 7: Exhaust lagging above the forward end of engine one, where an inner and outer lagging samples where collected and sent to DSTG

9. From discussions and review of maintenance records for HMAS Maryborough Reference 1 was found. At Reference 1 it is noted that in Apr 16 thermography survey of HMAS Maryborough engine room was undertaken. From this survey it was shown that there were parts of the exhaust trunking covered in lagging had temperature significantly above the approved temperature, i.e. greater than 200°C. Specifically image file FLIR0127.jpg is in the location were ignition of the fuel air mix could have occurred.

10. Reference 2, presents the risk in the PBSPO hazard tracking system. Specifically, it states "Risk of a fire occurring due to atomised flammable liquid becoming exposed to exhaust duct surface temperature > 220 °C, due to insufficient lagging". It notes the need for a temporary fix to the lagging and re-surveying. Of concern are the HRI, which were developed:

a. For the Environment a 19 was presented, which seems appropriate,
b. For Fitness for Service a 10 was presented, which considering the damage which generally occurs in an engine room fire seems under stated. The

damage from an engine room fire minimally should be expected to be Critical if not Catastrophic.

c. For Safety of Personnel a 14 was presented, which was for two scenarios. For the scenario that someone touches a hot surface and burns themselves, this HRI seems appropriate. Noting HMAS Westralian fire if personnel were caught up in the resulting fire then the consequence of Catastrophic has to be accepted.

11. It is noted that Reference 2 did not provide any direction to the ship about taking any additional measure if lost of fuel control occurred. As the main engine rooms have oily mist detectors and this hazard was present guidance about the heighten risk of fire / explosion should have been included and therefore limit the deployment of personnel into that situation.

Recommendation 1: NTB to investigate monitoring system of hazardous environments, such as oily mist and their response options
In this incident if the fuel spray had been detected then the fire may not have occurred. What options and capability exist to detect and respond to the hazardous environment to prevent it becoming worst, such as a fire.

12. References 3 and 4, demonstrate that temporary repairs had been undertaken to the lagging within the main engine room. Due to FSU-North thermo-imaging camera needing to be calibrated no thermographic re-surveying had occurred, although planed for post MP1-17 (after 12 Feb 17). HMAS Maryborough's crew had done some checks with the Flute and had low confident in the temporary repairs. It was planned for apply the permanent fix to HMAS Maryborough lagging during her remediation work, which was planned to start in Mid Jul 17.

Recommendation 2: PBGRP to resolve the main engine room lagging issue
Noting that the exhaust lagging issue was a contributing factor to this fire incident the PBGRP is to seek a permanent solution as soon as practical. In the mean time the following actions to be considered:

d. Application of temporary lagging,
e. Regular thermographic survey's – If FSU-North unavailable NTB has a FLIR and qualified personnel, and
f. Update the hazard log – NTB is available to support.

13. Noting the above, it is considered that the lagging issue within HMAS Maryborough main engine room was the most likely ignition source for the oily mist deflagration, although this cannot be proven unequivocally. Even still it is considered that this lagging issue was a contributing factor to the overall incident.

14. By Marinelink timing, at 23:36:57 the Mid (forward) damper in the engine room closed, shown in Figure 8. It appears that the control mechanism to this fire damper was blown off, but there is also clear evidence of thermal damage. This implies a deflagration event roughly positioned under this point.

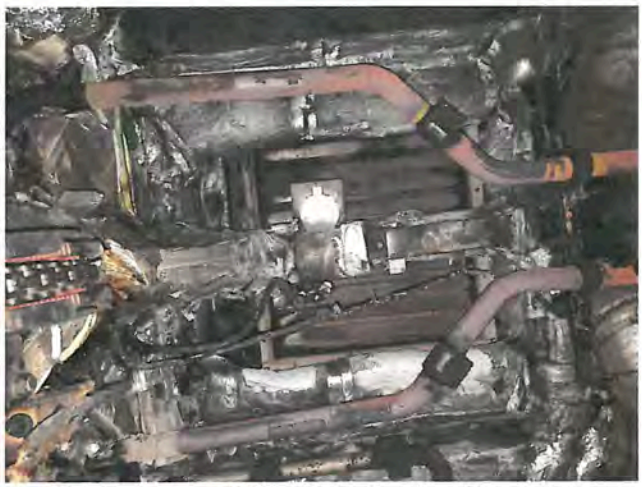

Figure 8: Mid Damper of the Main Engine Room in closed state

15. Further evidence to support a deflagration event is shown in Figures 9 to 12. Specifically, the level of lagging damage and its scattering around the engine room as can be seen. This lagging damage ranges from outer layer blown off, to the entire lagging torn away. Additionally, the light fitting in between the two engines is hanging by its wires with no real signs of combustion. This suggests it was knocked out of its fitting before combustion had taken hold. All of this implies an over pressure (air) event and within the scope of the event and evidence that fuel air deflagration is the most likely course.

Figure 9: Between both engines looking aftwards. Significant damage to the lagging as well as the deck covered is bits of lagging. Near the king post the light fitting is being held up by its wires.

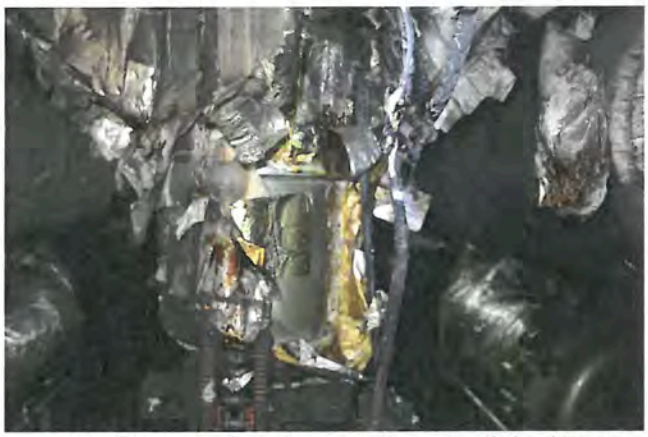

Figure 10: Damage lagging on the top of the king post.

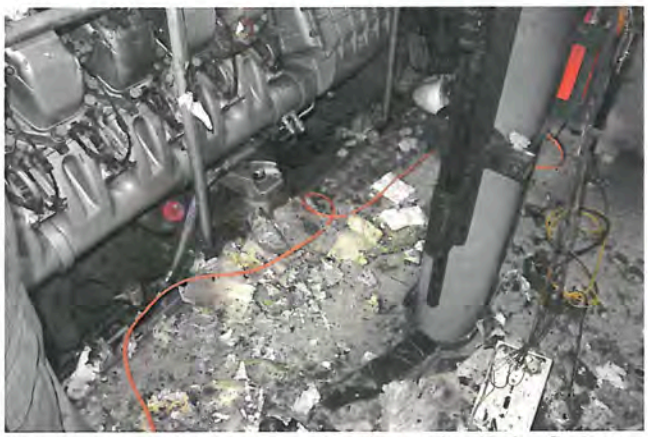

Figure 11: Deck plate around the king post, where the light fitting and lagging can be observed.

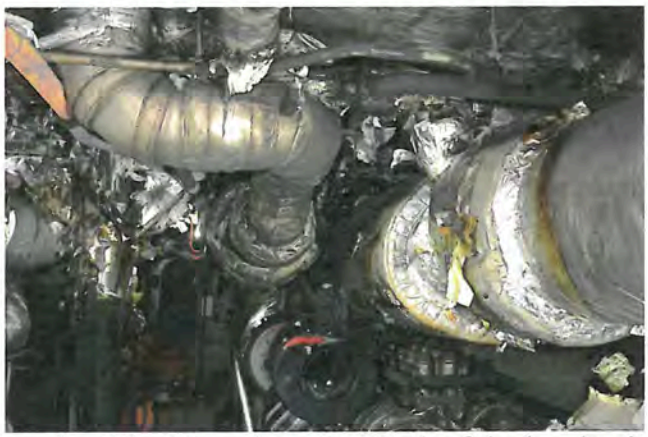

Figure 12: Above engine 2 looking aftwards. Much of the lagging has been torn up as well as pieces of lagging on the engine. The yellow brownish marks on the exhaust lagging are signs of where marine diesel has absorbed into the lagging.

16. The pools of marine diesel, mostly on the deck plates and in the bilge, would have combusted due to the fuel air deflagration. Figure 13 shows the small pools of marine diesel that developed. These various pools combusting lead to the following:

a. Rapidly raised the air temperature within the space, as noted on Marinelink and the thermal damage throughout the compartment,

b. Used up oxygen supply, which would lead to ventilation restricted combustion and therefore generate a massive amount of thick black / grey smoke, and
c. Ongoing evaporation of the marine diesel developing condition for a flashover or backdraft if sufficient air was reintroduced to the compartment when concentrations enter the flammability range.

17. Beyond the deflagration and combustion damage at forward and between the two engines, the remaining main engine room shows damage up high from smoke and heat, with limited deflagration damage, and no signs of combustion. As an example Figure 14 shows the port deck plates pass engine two.

18. The engine room and generator room share common air inlet trunking, which the fire dampers closed off. From Marinelink, at 23:37:27 the smoke detectors in the generator room activated. From inspection of the generator room there are no signs of combustion or thermal loading. Therefore the smoke spread from the forward part of engine one to the aft air inlet of the engine room through the trunking to the generator room and then onto the smoke detector. This was achieved in fewer than 30 secs, which further demonstrates the speed of the fire growth and associated temperature change as well as the amount of smoke which was generated.

Figure 13: Pool of diesel below two filters of engine one.

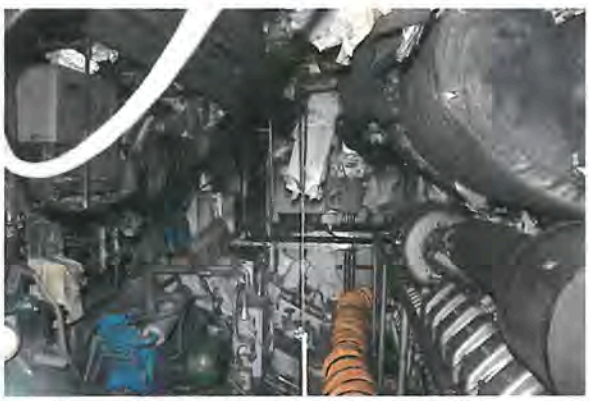

Figure 14: Looking forward on the outer side of engine two. There are signs of components been blown off as well as smoke and thermal damage up near the deckhead. There is no event of combustion in this area of the engine room.

Fire Fighting and Associated Systems

19. The following reviews specially elements of the fire fighting response and associated systems.

Command and Control

20. From MarineLink the first fire alarm activated at 23:37:08. The MarineLink operator s47F was delayed in checking the CCTV monitor due to the brightness being set low so to not impact bridge operations. The MarineLink operator saw rolling smoke and limited fire. Noting that much of the fire was in the bilge and forward of engine one and that the camera is situated on the deckhead between the two engines and at the aft end of the engine room this is expected. With fire confirmed, s47F , piped the SAFEGUARD message, which woke most of the crew.

21. The Commanding Officer, s47F came to the bridge and assumed command, by which time s47F had taken over MarineLink, so that BA-Portable could dress and set off. When s47F checked the CCTV monitor all he could see was fire rollover, which was so great that the two engines and the king post could not be seen.

22. The control of BA-Portable entering the engine room was hampered by the alarm noise within the plant room, which also lead to the BA-Portable team providing their communication in person on the bridge. Noting the vision on the CCTV monitor and the movement towards the activation of button one, closure control over BA-Portable may have meant no enter and the subsequence smoke spread on main deck.

23. Due to the speed of the fire growth and the report back from BA-Portable, command bypassed BA-Hose and Fire/Support Parties and went directly to CO2 discharge.

24. Throughout the incident it has been reported that the crew were well informed about the Command Aims and Priorities. Information flow on the bridge worked well with limited other talking occurring.

25. Situational awareness was reduced when button one was pushed as the CCTV system is not connected to the emergency generator nor has its own UPS. Better situational awareness could have been achieved with additional camera, as well as if there were trackable and hardened. Additionally, the lack of CCTV recording, limits the ability to understand the initiation of the incident both during its prosecution and investigation.

26. The photographs of the incident board show a clear track of the event as well as scale of the event. The scale of this event was enlarged by the associated issues and failures of systems.

Recommendation 3: PBGRP to investigate CCTV system connected to the emergency power

The advantage of having the CCTV systems connected to the emergency power system is so that though an incident this remote sensing is available to support command decisions.

Recommendation 4: PBGRP to investigate the ability to provide greater situational awareness of high risk spaces via the CCTV
Greater coverage of high risk spaces by the camera would provide the situational awareness potential need to support command decision during an incident. This greater coverage could be achieved via trackable cameras, more cameras, and hardened / survivability cameras.

Recommendation 5: FCCD to investigate remote sensing input into command decisions
With support from the Combat Survivability Working Group, review, and if appropriate update, how remote sensing can be used to support command decision during an incident. Specifically, consider what level of situation awareness would be required.

Recommendation 6: PBGRP to investigate the management of CCTV monitor brightness during night operations
Considered the use of a curtain or shroud for the CCTV monitor, so that the brightness can be maintained at a usable level whilst not impact bridge operations.

Recommendation 7:PBGRP to investigate the ability of having the CCTV vision on the Armidale-Class record
The ability to record the CCTV, via a loop duration, would be a significant benefit to post incident reviews, as well as potentially training.

BA-Portable

27. Using MarineLink, the incident board, and witness statements, it was determined that s47F undertook a door opening to the main engine room at approximately 23:38:00. s47F then entered the main engine room. Both members noted the thick black grey smoke and that visibility was best out to 30 cm. s47F also noted the deck plates were slippy, he believed this to be diesel. This was later confirmed by the smell on his boots as well as during the inspection. The air temperature within the engine room was too great and so BA-Portable pulled back and closed the door. No portable extinguishers were discharged as no visible flames could be seen and the seat of the fire was unknown.

28. Due to the alarm noise within the plant room they were unable to determine if there reports were going to the bridge.

Recommendation 8:STG-MWV, FCCD, and NTB to jointly review manual fire fighting on small vessels
A review of manual fire fighting on small platforms would make sure system, procedures, and crew size are optimised to the threat and realistic. It would support Armidale-Class as well as other class currently and into the future. As such the outcomes would impact ABR 5476 and DEF(AUST)5000 Vol7 Pt2. Specifically, this work should focus on:

a. *Use of BA-Portable for where flashover or backdraft is highly likely,*
b. *Use of inline inductor systems,*
c. *The abilities of indirect attack, and*
d. *Crew response and formation of the RMA.*

Scene Incident Controller and Boundary Cooler / Monitor

29. After completing his involvement as part of BA-Portable, s47F initially was both scene I/C and boundary monitor. Once the bridge became aware of this multi-tasking he was relieved of the boundary monitoring role.

30. During the incident there was no need to conduct boundary cooling, although hoses were set up. The boundary monitors focussed on obtaining temperature readings from pipework as these elements were hotter than the deck / bulkheads due to the main engine room being covered in fire insulation.

31. Communications with the bridge whilst wearing fully structural fire fighting rig, including OCCABA, was difficult due to the interface between the radio and OCCABA mask.

Recommendation 9: PBGRP to consider aligning the Scene incident controller to a day hand position
Making the scene incident controller a day hand position would lower the likelihood that the member doing BA-Portable and then boundary cooling / monitoring would also fill this role.

Recommendation 10: MCPSPO to improve communication capability in SCBA
The ability to communicate via the current DC radio whilst wearing the SCBA was limited during the incident. A more integrated communication system into the SCBA could overcome this issue. Noting the SCBA is planned to be replaced in 2022, this should be included in this replacement.

Smoke Spread

32. Following BA-Portable entrance and exit of the engine room, MarineLink shows the following smoke spread:
a. 23:38:11 – Smoke detected in plant room,
b. 23:41:51 – Smoke detected at the boarding party room,
c. 23:42:21 – Smoke detected at Main deck Aft,
d. 23:42:33 – Smoke detected at Main deck mid,
e. 23:43:07 – Smoke detected at Junior Sailors Mess, and
f. 00:01:33 – Smoke detected in the Garbage Store.

33. These reading are supported by crew observation and incident board actions. This spread of smoke complicated the response to the incident in several ways, including restricting movement within the vessel and when the portable external radios where required their retrieval had to be done by a member in full structural fire fighting rig.

Recommendation 11: NTB to set a requirement that access points to engine rooms to be under positive pressure at all times within DEF(AUST)5000

This measure would assist in making sure that smoke and associated by-products from an engine room fire does not spread outside that space. This could also be applied across all high fire risk compartments. This to be included in the next release of DEF(AUST)5000 Vol7 Pt2.

OCCABA, ELSRD, and Junior Bauer

34. The incident board notes that at 00:49 RMA had no ability to recharge OCCABA. This was due to the fact that the junior Bauer is not on the emergency generator circuit. Part of the management of this limitation was to use ELRSD wherever possible instead of OCCABA.

35. Even if the junior Bauer had been available it is unable to support the recharging of OCCABA at a rate which is required during an incident, Reference 5.

Recommendation 12: PBGRP to investigate the availability of OCCABA during an incident

The Junior Bauer is currently unable to support OCCABA recharging during an incident due to it not being connected to the emergency generator circuit and the time it takes to refill the air cylinders. This issue could be resolved by fitting a stand alone diesel air compressor or sufficient air bottle in the forecastle as a reservoir charging system.

CO2 Discharges

36. At approximately 23:40 the first CO2 discharge occurred. This occurred with command approval and after confidence was gained no one was in the engine room or generator room[1]. The discharge of CO2 was heard and felt by crew members. After discharge, the temperature reading continued to rise.

37. Between 23:46:30 and 23:47:02 (based on MarineLink times) the CO2 locker was checked to confirm if all bottles had been discharged. On inspection it was found that the pivotal hose to the fourth CO2 bottle had detached, see Figures 15 – 16. This was reported to the command who endorsed manual action of the 2nd CO2 discharge.

38. The second discharge occurred at approximately 23:49. As the space is too tight, s47F used an ELRSD instead of OCCABA to undertake this evolution, see Figure 17. After this the temperature reading started to decrease.

[1] The CO2 system is set up such that both the engine room and generator room can only be done together, which in this situation means that the engine one fire lead to the main generator been taken out of action as well.

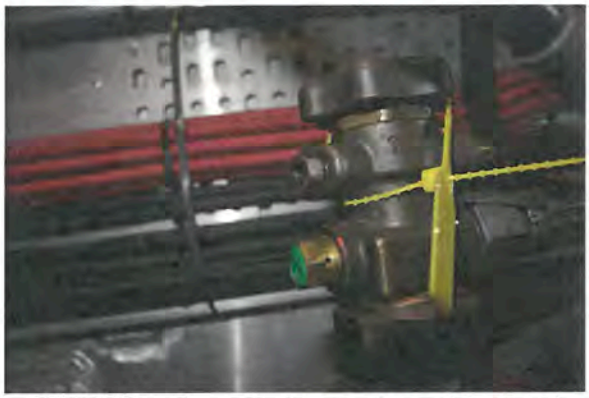

Figure 15: The fourth CO2 bottle activation value with the pivotal hose missing.

Figure 16: The pivotal hose detached from the fourth CO2 bottle.

Figure 17: CO2 locker on HMAS Maryborough.

39. The hose detachment with respect to the first CO2 discharge was investigated. At Reference 6 the PBSPO tasked SERCO to undertake a 60M replacement of all synthetic rubber flexible hoses on the CO2 which were over 10 years old. The work instruction which was undertaken, as shown at Reference 6, was a 12 M Flexible Hose – Survey / Inspect. This highlighted that many of the CO2 flexible hoses were over ten years old and need to be replaced. With discussions with the crew, there understanding was that it was acceptable as ABR 5225 permits 12 years service life and therefore no risk. This is incorrect, in that ABR 5225 states a maximum of 12 years service life but in accordance with OEM requirements, which for this CO2 system is 10 years[2]. The pivot hose that goes from cylinder 3 to 4 has an id of 333-

[2] It is noted that the ABR 5225 does not require all flexible hoses for fire safety system to be considered critical.

199. This hose was noted at Reference 6 as being over 10 years old and need to be replaced. It should be noted that under the arrangements between PBSPO and SERCO, there was a significant delay between work being conducted and the relevant OQE being developed to the PBSPO. In this situation Reference 6 was supplied to PBSPO only after the fire.

40. Reference 7, relates to an accidental CO2 discharge on HMAS WOLLONGONG earlier this year. It notes that maximum life of the cylinder head valve is 10 years. The age of the cylinder head valve on cylinder 4 is unknown, but could have been a contributing factor to the hose detachment.

41. The failure of the first CO2 discharge lead to a further approximately 9 minutes of fire before the second CO2 discharge occurred which extinguished the fire. This would have coursed greater damage to have occurred throughout the space.

Recommendation 13: PBGRP to review the CO2 system and associated PMS
Noting the pivotal tube detachment all of the Armidale-Class CO2 system must be checked. As an initial step it is suggested that all Armidale's have there flexible hoses and cylinder head valves updated to make sure none are 10 years old or old. Consideration should be given to undertake a few discharges on CO2 systems with old hoses and valves, say greater than 7 years. The PMS for the CO2 system needs to be updates to confirm hose and valve replacement by 10 years of service life.

Recommendation 14: PBGRP to review understanding and application of ABR 5225 with respect to flexible hose service life by crew members
RAN personnel need to understand that ABR 5225 permits flexible hoses service life out to 12 years, but where OEM has a shorter duration this takes precedence.

Recommendation 15: PBSPO to confirm work instruction before work undertaken
The PBSPO should have oversight of the work instruction so that there can be confirm to meet the tasking that the PBSPO has contracted to be undertaken.

Recommendation 16: NTB and DSTG to investigate methods to confirm gaseous fire fighting system activation and agent storage
In recent years several new methods to confirm gaseous system charge level and activation have become available. These systems to be evaluate for naval platform usability.

Emergency Generator

42. Once button one was activated and the main generators shut down the emergency generator was supposed to start to supply emergency power. This did not occur due to a cooling fan issue. At 23:42:09 the emergency generator was manually restarted, but the cooling fan issue was not resolved. At 00:27 the emergency generator was manually shut down when it was realised by ship staff that it was close to overheating.

43. The non-operation of the cooling fan related to its control system. The control system had been upgraded over the service life of HMAS Maryborough which led to the manual onboard being out of date and unable to provide guidance on the specific error code. This lead to ship staff using their mobile phone to Google the error code.

In the end the crew bypassed the control system and forced the cooling fan on at full speed.

44. With the emergency generator not functioning many critical systems also become non functional, such as the fire pumps, navigation lights and the like. The period of complete power loss was great enough to go beyond most UPS onboard.

Recommendation 17: PBGRP to review the emergency generator system
Noting the failure of the cooling fan of the emergency generator, confirm across the class that all emergency generators will start fully and operate for at least 1 hour. Review and where appropriate update the associated PMS and documentation.

Internal Alarms and MarineLink Display

45. During the interviews the following two issues were noted:
   a. With all the audible alarms going off it become very difficult to effectively communicate in various locations through the vessel, and
   b. The volume of message, alerts, and alarms presenting on MarineLink made it hard to find the critical issues, such as the shutdown of the emergency generator.

Recommendation 18: PBGRP and NTB to review the management of audible alarms during an incident
PBGRP to investigate the ability to rapidly and simply shut down audible alarms during an incident. NTB when developing detection and monitoring system requirements to include the ability to manage these alarms in away which will support navy operations including internal communications.

Portable Lighting

46. The Armidale class DC warrant does not include lanterns or similar items. This left chemoluminescent glow sticks to be used to light the weather deck and similar areas.

Recommendation 19: FCCD to investigate improvements to portable lighting capabilities
During this incident the lose of power impacted internal lighting as well as navigation lighting. With the support of the Combat Survivability Working Group investigate portable lighting requirements and options for consideration to be applied across the fleet.

Yanmar Portable Pump

47. With the emergency generator not functioning this left the ships Yanmar portable diesel pump to be the sole source of fire fighting water, if required. By 00:34 the Yanmar had been connected to the firemain, which was primed by 00:41. Although this would have been a viable solution for boundary cooling, fire fighting via this supply would have been very difficult. The Yanmar support approximately 200 lpm at 2 bar. Although this flow rate is inline with the current RAN inline inductor the pressure is below that which it can operate within. As such the inline inductor would

not have drawn up AFFF concentrate and so the crew would have only had sea water hose line to fight a hydrocarbon fire. Although not impossible via an indirect steam attack, this is a difficult tactic which is not currently taught to RAN sailors.

Recommendation 20: MCPSPO to investigate a common portable diesel pump across the fleet

Armidale Class platforms have only the salvage portable (Yanmar) diesel pump, which was used to charge the firemain. A common portable diesel pump across the fleet which can support both a fire hose and salvage would have significant benefits to small vessels as well as recoverability capability across the fleet.

External Communications

48. HMAS Maryborough had gone to sea without all of its external communication systems working. This was further complicated by the smoke spread on main deck and the loss of power. This led to the need to use the Harris 150 (HF) and 152 (UHF) portable radios. Currently, these radios are stored in the communication room. Additionally, at the time of the incident navy has no training programs for the Harris radios. s47F had been able to gain limited understanding of how to use these radios via discussions with an Army signalmen who have been onboard previously as part of the TSE.

49. HMAS Maryborough had come to rest in a location with mobile phone reception. Communication of the incident with command and MAROPS was therefore undertaken via a combination of mobile phone and limited use of the Harris 150.

Recommendation 21: FCCD to review the usability of the on Harris 150 and 152

The Harris 150 and 152 are the portable external radios provided within the RAN to communicate back to command when the fitted systems are lost. Currently, there is no formal training on there use for the CIS. Additionally, the use of the Harris portable external radio need to be included in at least some DC exercise as ongoing confirmation on the ability to use this system.

Recommendation 22: PBGRP to review the storage location of the Harris radios

Currently on the Armidale-Class the Harris radios are stored in the communication room. This has a limitation when the communication room is surrounded by smoke or not available for some other reason. Noting the bridge is the DCC it would seem to be a more appropriate location.

Reference:

1. Cutts, M., and Strickland, B., "Starboard Main Engine Baseline Exhaust Thermography Report", HMAS Maryborough, 9 Apr 16
2. TR2869, PBSPO/01532 – Exhaust Thermal Lagging
3. D0085444 – Exhaust Lagging Port Main Engine – Temporary Repairs conducted Oct 16
4. D0085445 – Exhaust Lagging Stbd Main Engine – Temporary repairs conducted Oct 16
5. DNPS/OUT/2012/335 Armidale Class Fire Fighting – Junior Bauer Air Compressor, 23 May 12

6. AMPS Job No M0034929/0, SIMR – 60M Replace Synthetic Rubber – Critical – Flexible Hoses, 7 Mat 17
7. Jerrett, J. LCDR, "Report on Technical Investigation into CO2 System Activation and Release – HMAS WOLLONGONG", 7 Jun 17

Additional Recommendation:

Recommendation 23: NTB to undertake a recoverability assessment of the Armidale Class to confirm systems and procedures are in accordance with ConOps
With the support of STG-MWV and FCCD review the potential recoverability operations that an Armidale is expected to be able to achieve. Then assess the systems and procedures to confirm this is achievable. If need propose changes to the systems and procedures.

Recommendation 24: MSB and NTB to formalise technical investigation capability
Noting that technical investigations are becoming more common and using fire safety as a starting point develop and implement the following:

a. *Education and skill sets,*
b. *List of experts external to defence who can assist,*
c. *Systems and equipment to support investigation including the collection of evidence, and*
d. *Investigation procedure and reporting structures.*

Recommendation 25: CSWG and PBGRP develop a video presentation of this incident
Produce a training video to demonstrate how fast the fire event occurred, the crews responses and the benefit regular damage control exercises.

Australian Government
Department of Defence
Defence Science and Technology Group

Minute

AV15030532

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For Information

Zenka Mathys	**GL Naval Platform Survivability**
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HMAS MARYBOROUGH EXHAUST LAGGING ANALYSIS

1. A request from Navy Technical Bureau for DST Group to provide assistance in examining exhaust lagging taken from HMAS Maryborough post fire investigation. HMAS Maryborough reported a fuel fire in the engine room on 25 May 2017.

2. It was requested the lagging be examined to determine if the inner layer of lagging had been exposed to diesel fuel or other hydrocarbon type materials.

3. Samples of lagging were received without any identifying label or location descriptions. The samples were examined as four discrete samples and identified as;

(1) Bag 1, Sample 1, inner 'wool'

(2) Bag 1, Sample 2, inner foil (weave)

(3) Bag 2, Sample 3, outer foil

(4) Bag 2, Sample 4, outer fabric

4. The samples were examined by two independent analytical techniques, and a hydrocarbon consistent with weathered/heated diesel fuel was found on all samples using a Solid Phase Micro Extraction (SPME) technique, but only on samples 3 and 4 using a solvent extraction technique. This result suggests the hydrocarbon had not saturated the inner lagging but was found in low concentration in discrete regions of the lagging. The areas containing the hydrocarbon had obviously been sampled for the SPME analysis, but not for the solvent extraction technique.

5. The solvent extraction technique was found to also extract other non-fuel type residues. The other materials were possibly glue/adhesives residues from other materials present on the lagging.

6. A chromatogram generated using the SPME technique showing an overlay of diesel fuel with the lagging sample is given in annex B. The lagging sample has weathered, that is it has lost its more volatile components probably during the fire or from heating by the exhaust system. This is consistent with other post fire hydrocarbon analysis of diesel fuels by DST Group.

Conclusion

7. The exhaust lagging samples received for analysis showed the presence of weathered diesel fuel. The inner lagging had not been saturated with fuel but did contain small local regions of fuel contacted area.

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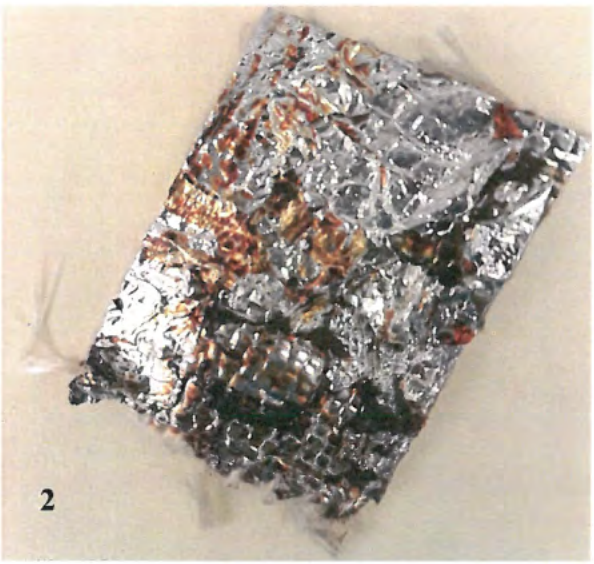
15 Aug 17

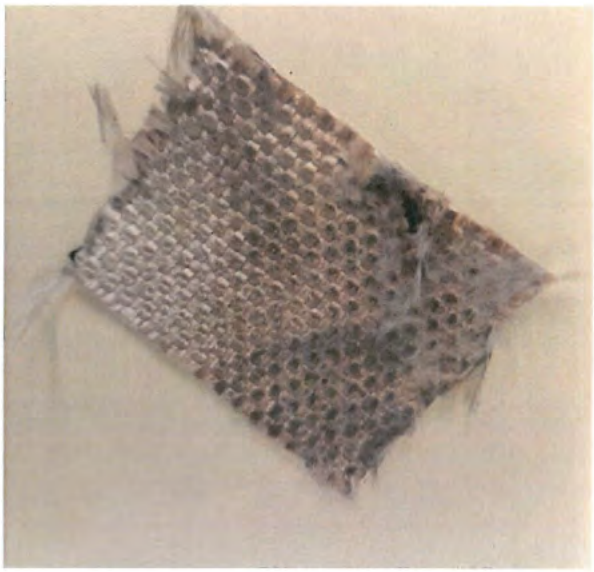
Annex A

1. Sample descriptions and images

Bag 1

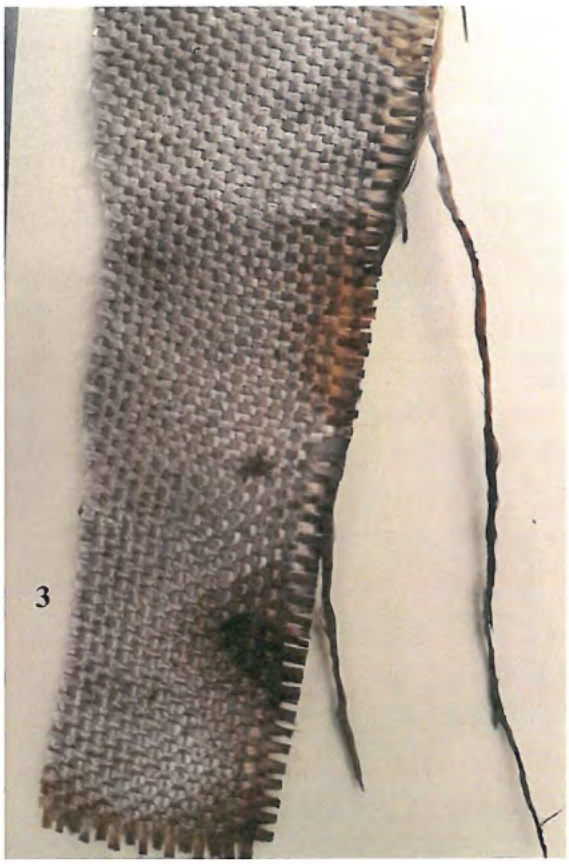
Sample 1, inner wool, back and front sides



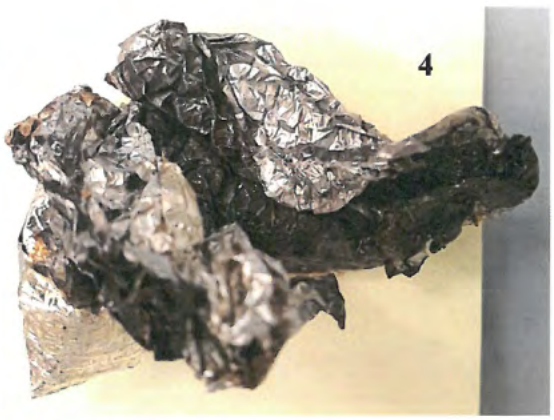


Sample 2 Image of front and back sides

Bag 2



Sample 3



Sample 4

Image of samples in dichloromethane solvent for extraction

Annex B

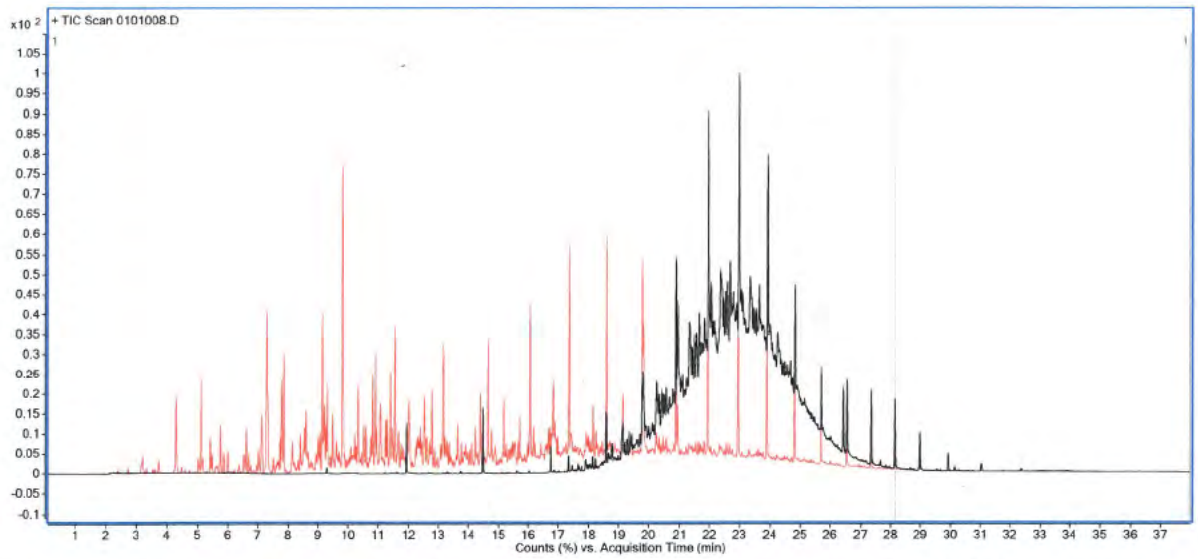


Figure 1. Gas Chromatogram over lay of diesel fuel (red) versus sample 1 SPME extract. Note alignment of major n-alkanes

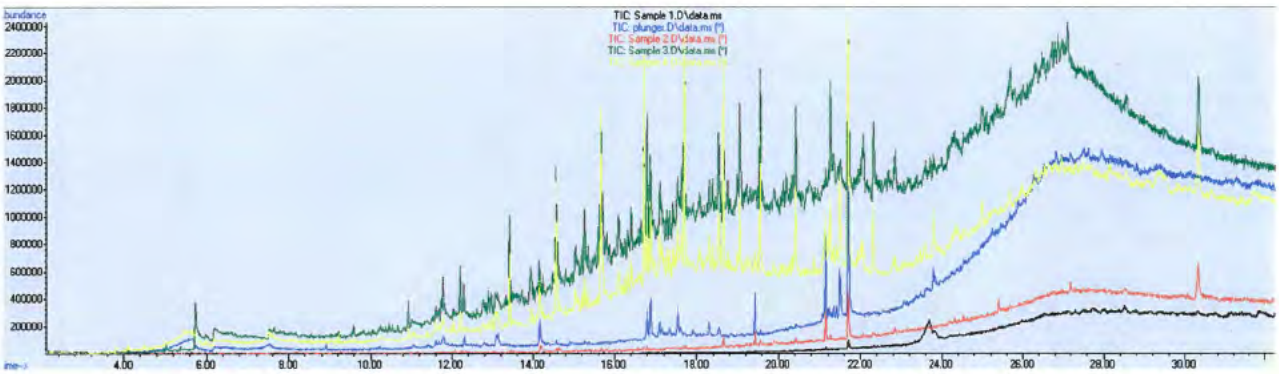


Figure 2. Gas Chromatogram overlay of solvent extract of samples, note;

- Sample 1 and 2 have no obvious fuel trace.
- Sample 3 and 4 have obvious fuel trace.

NAVY ROYAL AUSTRALIAN NAVY
HMAS *Maryborough*

Minute

Commanding Officer

HMAS MARYBOROUGH MAIN MACHINERY SPACE FIRE FACT FINDING—25 MAY 2017

References:

A. Armidale Class Standing Orders – Bridge Cards
B. ABR 5476– RAN Combat Survivability
C. AFTP 4(J)

Introduction

1. I, LEUT JC Chipper, RAN, have been appointed as the Investigation Officer to conduct fact finding into the Main Machinery Space fire on 25 May 17 by the Commanding Officer HMAS *Maryborough*, LEUT TB Mobbs, RAN. The purpose of this minute is to ascertain and confirm the facts surrounding the events that took place onboard *Maryborough* from 2335 on 25 May 17 and to make recommendations on subsequent reporting and investigations.

2. All timings are in I/K (-9.5) unless otherwise stated.

Summary

3. At 2335, *Maryborough* was on a course of 255 at 22 knots with both main engines half ahead revolutions 1495RPM. *Maryborough* was in position 115 at 2.5NM from the Easternmost point of East Vernon Island conducting independent transit to Darwin via the Vernons. There were no other contacts in the vicinity. The bridge team at the time of the event is listed below:

a. s47F [redacted]
b.
c.
d.
e.
f.

4. At 2337, s47F [redacted] noted a low fuel pressure alarm on Marinelink. As the ANS was about to respond to the alarm and report to the OOW, he saw flame and smoke alarms and looked at the fitted CCTV and saw fire. Hearing the alarms, the s47F [redacted] enquired as to the nature of the alarms to which s4 [redacted] responded "fire in the engine room". On hearing this, the OOW immediately piped

"Safeguard, safeguard, safeguard, fire, fire, fire, fire in the Engine Room, Standing Sea Fire and Emergency Party muster and investigate" twice over the main broadcast. Actions IAW reference A were conducted by the OOW following the pipe. The order to stop both engines was given. The crew of *Maryborough* commenced closing up at their respective emergency station.

5. s47F immediately crash stopped ventilation and proceeded to the flag deck to prepare to enter the compartment as BA-P with s47F (On-watch helmsman).

6. s47F and s47F both proceeded to the flag deck, dressed IAW reference B to make an entry into the compartment.

7. Cable party was closed up and with the anchor ready for letting go.

8. BA-P entered the compartment at 2338 and were beaten back by too much heat.

9. s47F was on the flag deck at the time of the alarm being raised. He immediately proceeded to Marinelink with DCC being closed up by 2338. Button 1 on the CO2 release system at 2339 and crash stopped the engines and on sighting flames on CCTV, immediately set CO2 Drench preparations as the priority.

10. At the pressing of button 1, all emergency stops were triggered. The emergency generator failed to start resulting in the ship going dark. Systems with a fitted uninterruptable power supply (UPS) reverted to that state of power supply. Initial defect investigation found that the emergency had start and I/O faults. These faults were cleared and the generator started. At 0027 the generator overheated and shutdown. It was found that the cooling fan was not running. Investigations found that the variable speed drive (VSD) had no errors but was not sending a run signal to the fan. The fan could not be manually started. Ship's Staff hardwired the fan to the VSD input IOT source power. This meant that the fan could only operate at one speed, however it commenced cooling and remained operational until shutdown alongside.

11. On pressing of button 1, the black rack in the communications centre (COMCEN) lost power. This is examined further in section Effects on Communications. Given that 1 deck was not O2 safe, communications equipment could not be used. The proximity to Darwin, it was found that *Maryborough* was in an area of mobile phone reception. Mobile phones were utilised to establish contact with the HQMBC watchkeeper to inform them of the event.

12. At 2340 the CO2 button 2 was pressed. At 2341 Command Approval was given for a CO2 drench of the Engine Room and button 3 was pressed. Indications from the CO2 bottles and the sounds associated (heard from the bridge) were of a successful release. After a period of 10 minutes, the initial drops in temperature observed started to increase. It was found that the pilot line from the third bottle had failed resulting in a partial CO2 drench from bottles one through three, with four and five not activating. A manual activation was conducted and observed as a successful drench.

13. Given that *Maryborough* was initially proceeding at 22kn combined with the tidal stream being encountered within the Vernons, it took 7 minutes for the speed to reduce to a speed appropriate for anchoring. Once the speed had reduced below 4kn, the Navigating Officer recommended to the Commanding Officer that Maryborough anchor in her present

position. At 2345, the anchor was let go and *Maryborough* anchored in position 12° 05.3'S 131° 0926'E in 23m of water with 4 shackles on deck.

14. RMA reported to the bridge at 1249 that they had lost the ability to recharge OCCABA bottles, resulting in efforts being made to conserve stocks in preparation for a potential re-entry. With the junior bauer power supply in forward DC sourcing power from the 4A secondary switchboard, no power could be provided as there is no redundant supply.

15. At 0128, MAROPS confirmed that both HMA Ships *Parramatta* and *Larrakia* were making way at best speed to render assistance.

16. At 0130, Jupiter state 1 was officially implemented through formal signalling.

17. The fire was confirmed extinguished at 0156 26 May 17.

18. *Parramatta* arrived on scene at 0535 and assumed Command as On Scene Commander. Once communications had been established, *Maryborough* requested low grade codes IOT maintain encrypted communications, food and assistance in recharging OCCABA bottles. A boat transfer was conducted utilising *Parramatta's* seaboat at 0540.

19. *Larrakia* arrived on scene at 0557. After discussing with COs of *Parramatta*, *Larrakia* and *Maryborough*, *Larrakia* assumed the role as On Scene Commander

20. *Larrakia* took *Maryborough* under tow at 0758. A lack of generator power supply to the capstan meant that the anchor could not be heaved in. At 0809, the cable was paid out, the cable disconnected at the bitter end left in position 12° 05.3'S 131 ° 09.26'E. Once the tow was successfully rigged, *Parramatta* was detached to proceeded IAW previous orders.

21. A soak time of 12 hours was utilised to ensure the fire could not reignite. The compartment was re-entered at 1129 and overhauled by 1135. The Engine Room is still not O2 safe and remains out of bounds.

22. *Maryborough* was secured alongside post side to HMAS *Coonawarra* berth Fremantle 2 at 1529.

23. On arrival alongside, sentries were posted to restrict access to the effected areas.

24. The full sequence of events can be found at enclosure 1. Photographs of the Damage Control plotting board can be found at enclosure 4.

Personnel state

25. Prior to sailing, *Maryborough* had three personnel deficiencies. The deficiencies for the LSBM and ABMT positions were filled, however the XO deficiency remained. These deficiencies did not impact the capability to respond to the incident.

Backup Power

26. One pressing of button 1, the emergency stops is triggered and the emergency generator brought online. This did not occur in this incident.

Effect on Communications

27. The pressing of button 1 means that all ship's systems not on UPS will immediately lose power. This is expected and trained for through continuation training as per reference C. The loss of power throughout *Maryborough* had a significant impact on the ability to report to OPCON and all aspects of the ship borne communications outfit.

28. *Maryborough* had redundant methods of communications. They were HF voice through the Harris 150 radio, Iridium satellite phone and mobile phones (only due to the proximity to Darwin). On piping of the incident and the presence of smoke through 1 deck, the Harris radio and satellite phone were inside the COMCEN.

29. HF voice was used to dictate signals for release through DEFCOMMSTA-Canberra.

30. Voice recordings from the bridge are collected through DVRS, a system located in the COMCEN. At the time of the incident, *Maryborough* had a known defect on DVRS, first reported 12 Aug 15. The defect pertains to obsolesce issues within the equipment. At the pressing of button 1, DVRS is to source power from UPS. The bridge DVRS UPS was not connected and could not source power from the internal batteries. This defect requires Repair Agent support as rectification for this system falls outside of the scope of Ship's Staff who are not trained to repair the equipment.

31. As per the required COMCEN outfit, the PD router that is hardwired into the black rack. The operation of the PD router is essential to maintaining external communications for both secret and restricted ICT networks. When the blackrack lost power external connectivity was lost. This meant *Maryborough* did not have the ability to report to OPCON via military formal signalling methods.

32. Power to GMDSS remained for the duration of the incident.

Personnel of Interest

33. The following is a list of personnel of interest and their roles during the incident:

a. s47F

b.

c.

d.

e.

f.

g.

h. s47F [redacted]

Actions conducted

34. The following actions have been conducted:

a. Damage Control to extinguish the fire.

b. *Maryborough* towed to Darwin and secured alongside HMAS *Coonawarra*.

c. COMCARE notified by LEUT Mobbs and CAPT Hunter in his capacity as the Captain Patrol Boats.

d. Scene released from COMCARE by s47F [redacted] to the RAN for investigation.

e. Scene integrity maintained for handover to Maritime Safety Bureau for investigation.

f. OPCON reporting requirements via military formal signalling found at enclosure 4.

Findings

35. The crew of *Maryborough* conducted all damage control procedures IAW Orders, Instructions and Procedures, with initial procedures being conducted well within fleet standard times.

36. There was a partial failure of the CO2 release from the bridge. This required a manual release.

37. Failure of the emergency generator which complicated and hampered the response.

38. The UPS for communications systems failed resulting in a loss of external communications.

39. The loss of power to the bauer meant that OCCABA bottles could not be recharged.

40. Positional deficiencies did not have any effect on the overall response.

Recommendations

41. Through this fact finding, the following recommendations are made:

a. The matter be referred to the Maritime Safety Bureau for investigation

b. A technical and safety investigation be conducted into the source of the fire in the main engine room

c. A technical and safety investigation be conducted into the initial failure of the CO2 remote release that prompted the manual release

d. A technical and safety investigation into the Emergency generator failure throughout the incident

e. This matter be referred to an independent authority for investigation into the lifecycle and replacement of obsolete equipment within the ACPB communications outfit

f. A redundant bauer power supply or method of charging OCCABA be found to facilitate recharging of spent bottles

g. s47F and s47F be commended for their actions as first responders in their roles as BA-P

h. Command review Honours and Awards in order to recognise the collective efforts of the crew in limiting damage to *Maryborough*

s22

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LEUT, RAN
Navigating Officer
HMAS *Maryborough*

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27 May 17

Enclosures:

1. ON 015 – HMAS Maryborough Ship's Log May 2017
2. ON 058 – Officer of the Watch Notebook 03/17
3. Photographs – HMAS *Maryborough* Damage Control board
4. Formal Military Message signals (OPREPS)
5. Marinelink screen captures

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NAVY **ROYAL AUSTRALIAN NAVY**
Maritime Safety Bureau

Minute

COMMHP

For information:

CAPT PB
PDNSECP

MARITIME SAFETY INVESTIGATION (MSI) - OHSIR 03/17 HMAS MARYBOROUGH – FIRE IN MAIN ENGINE ROOM – INITIAL FINDINGS

1. MSB commenced a Maritime Safety Investigation into a fire in the main engine room on board *HMAS Maryborough* on 27 May 17. Investigators focused on, the sequence of events, the contributing factors and the response to the event. RAN crew and 1 Fisheries member who were on board at the time of the incident have been interviewed and the on site investigations have concluded. The objective of this initial report is to provide a précis of findings, at this point, which will be more fulsomely expanded in the final report.

Background

2. The fire occurred on *Maryborough* in the main engine room between approx 2337 and 0000 on the 25-26 of May 17. At the time of the incident *Maryborough* was 2.5NM from the eastern part of East Vernon Island. The fire caused damage at the front and inboard sections of engine one (starboard main engine). There is clear evidence of a fuel explosion between both engines at approx 2 metres aft of the forward main engine room door.

Fire Causal Factors and Initiation Sequence

3. MSB Investigators have concluded that the cause of the fire was the detachment of a bleed screw on engine one between the low pressure fuel pump and secondary filters which caused about 4 minutes of fuel leakage into the engine space before ignition occurred. Examination of Marinelink data suggests the following sequence of events:

a. Leaking fuel initially was horizontally through the sampling tube until the screw became completely detached at which time the discharge would have become vertical.
b. This discharge would have generated a mist cloud between both engines but predominately most of the discharge remained a stream into the bilge as well as covering the deck plates and surroundings.
c. The ignition of the fire was due to the deflagration of the oily mist. The activation of this deflagration has not been specifically determined and this may not be possible. The leading likely causes for this activation is either from the alternator igniting fuel which had ingress into it or fuel absorbing into the exhaust lagging heating up to generate combustion.

d. Principally the bilge combusted, generating large amounts of flame and massive amounts of smoke, this lead to fault failures on engine one as well as the fire detectors activating.

Fire Response

4. a. Initial atack was undertaken by BA-Portable through the forward main machinery door but was subsequently beaten back from the heat. During this entry smoke escaped and propagated along the main deck through to the junior sailor mess.
b. The fixed CO2 system was subsequently activated via the panel on the bridge.
c. Remote activation had not been completely successful as the activation line had separated causing the last two cylinders not to activate. This initial CO2 discharge failure extended the period of combustion within the main engine room.
d. A second CO2 discharge, via the manual activation, extinguished the fire.

Compounding Factors

5. Emergency Generator
a. Activation of the CO2 system isolated fuel, air and power to the main engine room and generator room. Additionally it activated the emergency generator.
b. In this situation the emergency generator initially started, but due to a cooling fan fault it shut down. This resulted in the platform operating on UPS which limits recoverability options, such as fitted fire pumps. The crew manually re-started the emergency generator which provided power during the CO2 discharges.
c. Shortly after this the crew realised that the cooling fan was not operating and the emergency generator was close to over heating. It was then shut it down and the cooling fan was restored. After which, the emergency generator operated for approximately 11 hours without fault.

6. OCCABA
a. Although the response to this fire was predominately through the CO2 system, the vessel significantly depleted OCCABA availability. At the end of the incident the crew barely had four OCCABA for a support party.

Initial Findings and Way Forward

7. Initial Findings
a. Ship responded well to recover from the circumstances presented by the fire.
b. The failure of the CO2 system has been passed to CAPT PB for further technical analysis and potential actions arising from this analysis.
c. A revision of the securing method used on the fuel system bleed screws has been passed to CAPT PB with the expectation that change management to the current configuration will result in the near term.
d. OCCABA recharge or embarked stowage capacity of spare bottles has also been passed to CAPT PB for problem resolution.
e. No other immediate actions have been identified at this stage.

8. Investigation Team Next Steps
a. DSTG to examine lagging samples for signs of hydrocarbon and combustion.
b. DSTG to examine the bleed screw assembly to further understand why the bleed screw dislodged.

c. NTB to facilitate further electrical forensic investigation of the alternator.
d. Provision and review of supporting information from the PBSPO/PBGRP
e. Provision of final report and recommendations to COMMHP

9. Noting that all relevant evidence has been obtained from *Maryborough* including the main engine room, the vessel is formally released from MSI to COMMHP. Notwithstanding this recovery of the grub screw would be beneficial to the investigation analysis should it be located.

10. My POC is Kate Campbell on s22 [redacted] or kate.campbell2@defence.gov.au.

tony.rayner

Digitally signed by tony.rayner
DN: c=AU, o=GOV, ou=DoD, ou=PKI, ou=Personnel, cn=tony.rayner
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Tel 02 9359 2203 **Mob** s22 [redacted]

Timeline

Timeline is supported by Marinelink data, reports, and crew statements.

Time	Action	Comment
23:33:01	Low pressure fuel starts dropping on Engine 1	Bleed screw comes loose and starts unscrewing, fuel flowing out of vent line mostly into bilge.
23:33:34	Pressure stabilised on Engine 1 low pressure fuel system	Bleed screw fully gone and fuel discharging vertically up at a very much greater rate, mist cloud started to form
23:36:57	Damper Fire Engine Room Mid Exhaust Air Closed	Controller blown / melted off leading to damper close and Marine link detected the closure, mist cloud must have fire balled by this stage to have damage the controller
23:37:05	Temperature began to rise from 40°C	Thermocouples often have a delay and are also dependent on location. The temperature rise is mostly due to the fuel air deflagration because the diesel bilge fire was a consequence of the fire ball.
23:37:08	Fire alarm general for the main space activated	
	Oily mist detector for main engine room activated	These have a delay and are very dependent on air currents, the blast may have pushed residual mist into them
23:37:09	Fire alarm fwd for the engine room activated	
	s47F noted low fuel pressure alarm and fire damper closed to s47F Following the fire alarm and the CCTV vision called Fire, Fire, Fire. s47F piped the Safeguard Fire in main engine room message across the ship. s47F and s47F set up for BA-Portable attack. s47F entered the Bridge just after the fire alarms activated and took over	

	Marinelink. From this he saw only roll over and no vision of engines or the Kingpost.	
23:37:11	Main Engine high temperature alarm	
23:37:18	Fire detected starboard side of main engine room	
23:37:19	Thermo-sensor maxed out at 100°C, whilst still clearly increasing	This means that in 14 secs the front atmosphere in the engine room increased by 60°C.
23:37:21	ESD Hull Ventilation Activated + ESD A/C Vent All Accom Area Activated from Bridge	Ventilation shutdown on Marinelink
23:37:23	Fire detected port of Main Engine Room	
23:37:27	Fire detected port side of the Auxiliary Engine Room	This is the Generator room. This shows that the exhaust trunk which connects both the main engine room and the generator room was still open and that smoke was flowing through.
23:37:35	Damper Fire Engine Room Port Supply Air Closed	Most likely due to loss of air pressure
23:37:41	Damper Fire Engine Room Stbd Supply Air Closed	Most likely due to loss of air pressure
23:37:52	Fire Detection Heat/Smoke Detector Stbd Auxiliary Engine	
23:37:53	Engine 1 HI leak fuel level	Localised failure
23:37:59	Engine 2 SS Safety System Stop	Localised failure
	BA-Portable entered and existed the Main engine room	This gives duration for BA-Portable to dress and enter the main engine room between 45 – 60 secs.
23:38:10	ESD Engine Room Activated from CO2 panel	Button 1 activated
23:38:11	Engine 1 SS emergency stop	
23:38:11	Fire Detection Smoke Detector Machinery Void 5	Smoke in Plant Room due to BA-Portable entrance
23:38:11	Fan Emergency Genset A416 VSD FIPIO Network Fault	
23:38:12	Fire Pump 1 and 2 Power Fail	
23:38:12	Emergency Generator Battery Charger No.1 + No. 2	
23:38:12	Emergency Switchboard Supply From MSWBD-A Failure + Emergency Switchboard 4A Power Failure +	

	Emergency Switchboard 240Volt Power Failure	
23:38:13	Sprinkler Pump VSD FIPIO Network Fault	
23:38:20	Damper Fire Aux Engine Room Mid Exhaust Air Closed	
23:38:21	Damper Fire Aux Engine Room Port Supply Air Closed	
23:38:25	Emergency Generator Fan Not Running	Emergency generator failed due to cooling fan
23:38:26	Emergency Generator started and stopped	
23:38:27	Sprinkler Valve Main Position Fault + Sprinkler Valve to A/C Plant Position Fault + Sprinkler Valve Magazine Position Fault + Sprinkler Valve Main Deck Accom. Position Fault	
23:38:28	Sprinkler Valve Austere Accom Position Fault + Sprinkler Valve Lower Deck Accom Position Fault + Sprinkler Valve Garbage Store Position Fault + Sprinkler Valve Galley Position Fault + Sprinkler Valve Canteen/Damage Ctrl Position Fault + Sprinkler Valve Cos Cabin Position Fault	
23:38:30	Emergency Generator Sensor Fault + Emergency Generator Common Shutdown	
23:38:33	Damper Fire Aux Engine Room Stbd Supply Air Closed	
23:38:33	Access Hatch Austere Accom Open	
23:40	CO2 discharge one undertook by depressing button two and three	
23:41:27	Access Door Emergency Genset Room Opened	
23:41:51	Fire Detected Smoke Detector Main Deck Boarding Party	
23:42:05	Emerg. Gen Start Volts No. 1 OFF	
23:42:09	Emergency Generator Fan Not Running	Emergency generator restarted but cooling fan did not start.
23:42:14	Emergency Generator Abnormal Frequency	
23:42:21	Fire Detector Smoke Detector Main Deck Aft Passage	
23:42:33	Fire Detector Smoke Detector Main Deck Mid Passage	
23:43:07	Fire Detector Smoke Detector Main Deck Junior Sailor….	

23:44:05	Fire Detector Smoke Detector Steering Flat	
23:45	Anchor released, HMAS Maryborough position at 12° 05.3'S 131° 0926É	
23:46:30	Access Door CO2 Room Open	CO2 discharge 1 check
23:47:07	Access Door CO2 Room Open	CO2 discharge 1 check
23:49:13	Access Door Emergency Genset Room Open	
23:49:33	Access Door CO2 Room Open	CO2 discharge 2 via manual, after command approval
00:01:33	Fire Detector Heat Detector Main Deck Garbage Store	
00:03:10	Emergency Generator Sensor Fault + Emergency Generator Common Alarm	
00:27	Emergency Genset found to be about to overheat and therefore shut down	
00:34	Yanmar set up	
00:41	Yanmar primed	
00:49	RMA reported no ability to recharge OCCABA and their conserving stores	
01:28	MAROPS confirmed HMA Ships Parramatta and Larrakia were on way to assists	
01:56	Fire confirmed extinguished	
04:32:41	Emergency Generator Not Ready	
05:33:47	Emergency Generator Fan Not Running	Emergency generator restarted successfully with fan after this. MT sailor's hard wired fan to bypass its VSD.
05:35	HMAS Parramatta arrived and rendered assists	
05:57	HMAS Larrakia arrived on scene and assumed command	
06:19:37	Access Door Emergency Genset Room Open	
06:56:05	Access Door Emergency Genset Room Open	
11:29:09	Access Door Aft Main Engine Room Open	Re-entry and initial video

JM 7/5/19

ACPB Job Control Sheet

This is not a Purchase Order

DMS MARITIME a serco company

Vessel: PB95 **AMPS Job No: M0034929 / 0**

Standard Activity No: A0100061 **Est. Hours:** 0.0

Facility Code: PB95-10FF01 **Facility Item:** 1005 CO2 SYSTEM

Work Package : 364 - 2017 95 MARYBOROUGH MP-02

Start Date : 17-Apr-2017 **Completion Date :** 07-May-2017

Assigned To: DMS MAIN

DMS Maritime Contact Name & Phone No. :

Maintenance Type: 12 Regulatory

Job : SIMR - 60M REPLACE SYNTHETIC RUBBER - CRITICAL- FLEXIBLE HOSES

Job Instructions &/or Description: **Item Serial No:**

Standard Requirements:

1. All works shall be conducted to AS/NZ ISO 9001:2000, DNV Class, AMSA, and RAN Standards as applicable.
2. Job Safety and Environment Analysis (JSEA) and Risk Analysis to be completed for work to be undertaken.
3. Contractors and technicians are to notify the Ships Technical Officer before commencing any work.
4. All contractors and technicians are to report to the bridge on boarding a vessel for a security pass.
5. Any Additional work above the quoted price or specification is to be approved in writing by the Ship Manager or BU Engineer before commencement of the additional work.
6. Acceptance of this job by a contractor or technician is confirmation that instructions are clear and understood.

OQE Deliverables to be attached:

Completed & Signed JCS		Completed Opening Report		Test & Trials Report	
Certificates		Completed Closing Report		-	

Authorised To Issue

DMS Ship Manager	Name	Signature	Date
			28/03/2017

Pre Job Start Check List: Note: All boxes must be filled prior starting work with either Y=Yes, N=No or N/A =Non Applicable

JSEA Completed & Approved		Technical Information Provided		Ships STO Notified	
Inspection Test Plan Provided		Isolations/Tag Out Completed & logged		Spares Available	

Job Completion and Signoff

This is not a Purchase Order

Vessel:	AMPS Job No.: M0034929 / 0
Job: SIMR - 60M REPLACE SYNTHETIC RUBBER - CRITICAL- FLEXIBLE HOSES	

1. Job Feedback Circle Appropriate Boxes

MAINTENANCE TIME							
CORR	Correct	LESS	Took Less Time	MORE	Took More Time		
MATERIAL AVAILA LE							
CORR	Parts & Tools Correct	PART	Part Not Available	TOOL	Tools Not Available	PATO	Neither Available
DOCUMENTATION							
CORR	MSDS & Manual Correct	MSDS	MSDS Not Available	MANU	Manual Incorrect	MSMA	Neither Correct
CORRECTIVE ACTION							
NONE	None	INST	Instructions Required	TRAN	Training Required		
		MAIN	Maintenance Required	DESI	Redesign Required	ITEM	Parts/Tools Required

2. Checklist Items:

#	Checklist Prompt	Response
2	Cert Item: PB95-333-187 - SHORE REPLACE	FAIL
3	Cert Item: PB95-333-188 - SHORE REPLACE	"
4	Cert Item: PB95-333-189 - SHORE REPLACE	"
5	Cert Item: PB95-333-190 - SHORE REPLACE	"
8	Cert Item: PB95-333-194 - SHORE REPLACE	"
9	Cert Item: PB95-333-195 - SHORE REPLACE	"
10	Cert Item: PB95-333-196 - SHORE REPLACE	"
11	Cert Item: PB95-333-202 - SHORE REPLACE	"
14	Cert Item: PB95-333-264 - SHORE REPLACE	"
15	Cert Item: PB95-333-265 - SHORE REPLACE	"

3. Job Completion Remarks: (Mandatory)

Counter Hours	Man Hours	Name	Sign	Date
		CRAIG ANDERSON	s22 [redacted]	27-4-17

4. Commonwealth Rep Acceptance

Maintenance Completed: Date: Time:

Job completed IAW schedule of repairs ☐ | System Test and Verification Recorded ☐ | **Completed Pending Sea Trial** ☐
Isolations/Tagouts Removed and logged ☐ | ITP Completed ☐ | System Function Test Complete ☐

Organisation	Name	Sign	Date
MAB	M. Morales	s22 [redacted]	27-4-17

5. Contractor /Technician Completion of Certification and Documentation Sign Off (Check All)

Opening Report Completed and Attached ☐ | Final Mandatory OQE ☐ | System Test and Verification Recorded ☐
Closing Report Completed and Attached ☐ | Job completed IAW schedule of repairs ☐ | Isolations/Tagouts Removed and logged ☐

Company	Name	Sign	Date
NORSHIP	G. MCSWEEN	s22 [redacted]	27/4/17

6. Ship Manager Certification and Verification of Job

DMS Ship Manager	**Name** K BOYD	**Signature** s22 [redacted]	**Date** 22/5/17	**This job is a RECHARGE**	**YES** / **NO**

Date Entered in AMPS

STANDARD ACTIVITY

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ACPB PROJECT

Standard Activity Title	Standard Activity No:	CI No:	Version:
12M Flexible Hose – Survey/Inspect	A0100083	10.00	1.1

Annex A – Flexible Hose Survey Results

REPORT OF MAINTENANCE ACTIVITY OUTCOMES

HMAS: (Vessel Name) MARYBOROUGH	**AMPS Job No:** (Transcribed from the JCS) M0034929
Ships Hose ID: (Transcribed from the JCS) 333-265	**Pass** / **Fail** (Circle) — Fail
Replacement Recommended: (Circle) **Within 6 Months** — No	**Immediately**

Criteria	Outcome (circle)
Hose - Leakage	Yes / No — No
Hose - Cracks	Yes / No / Hose not visible — No
Hose - Cuts	Yes / No / Hose not visible — No
Hose - Abrasions or Chafing	Yes / No / Hose not visible — No
Hose - Kinks / Distorted / Stresses	Nil / Kinks / Distorted / Stressed / Hose not visible — Nil
Hose - Blistering	Yes / No / Hose not visible — No
Hose - Poorly Supported	Yes / No — No
Hose - Non uniform bulges in cover	NA / Yes / No — No
Hose – Paint Presence	Nil / Drops/Spots / Excessive — Nil
Hose PTFE – Total Number of external Wire braid broken or corroded	NA / 0 / <10 / >10 / >20 — 0
Hose PTFE - 4+ braids adjacent cut/broken	NA / Yes / No — NA
Hose/Fitting Interface - Corrosion	No / Yes — Yes
Fittings - Corrosion	None / Surface Spots / Heavily Corroded — Surface Spots
Fire Sleeve	N/A / Not Fitted / Cuts / Tears / Good — N/A
Fire Sleeve Tape	N/A / Not Fitted / Good — N/A
Identification Tag (Tally)	Not accessible / Not Fitted / Fitted Incomplete / Fitted Complete — Fitted Complete
Record any discrepancies between tag data and record data provided on the JCS:	
Remarks:	10 YEARS UP ON CERT TAG

STANDARD ACTIVITY

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ACPB PROJECT

Standard Activity Title	Standard Activity No:	CI No:	Version:
12M Flexible Hose – Survey/Inspect	A0100083	10.00	1.1

Annex A – Flexible Hose Survey Results

REPORT OF MAINTENANCE ACTIVITY OUTCOMES

HMAS: (Vessel Name) MARYBOROUGH	**AMPS Job No:** (Transcribed from the JCS) M0034929
Ships Hose ID: (Transcribed from the JCS) 333-264	Pass / **Fail** (Circle)
Replacement Recommended: (Circle) **No** / **Immediately** / **Within 6 Months**	

Criteria	Outcome (circle)
Hose - Leakage	Yes / **No**
Hose - Cracks	Yes / **No** / Hose not visible
Hose - Cuts	Yes / **No** / Hose not visible
Hose - Abrasions or Chafing	Yes / **No** / Hose not visible
Hose - Kinks / Distorted / Stresses	**Nil** / Kinks / Distorted / Stressed / Hose not visible
Hose - Blistering	Yes / **No** / Hose not visible
Hose - Poorly Supported	Yes / **No**
Hose - Non uniform bulges in cover	NA / Yes / **No**
Hose – Paint Presence	**Nil** / Drops/Spots / Excessive
Hose PTFE – Total Number of external Wire braid broken or corroded	NA / **0** / <10 / >10 / >20
Hose PTFE - 4+ braids adjacent cut/broken	**NA** / Yes / No
Hose/Fitting Interface - Corrosion	No / **Yes**
Fittings - Corrosion	None / Surface Spots / **Heavily Corroded**
Fire Sleeve	**N/A** / Not Fitted / Cuts / Tears / Good
Fire Sleeve Tape	**N/A** / Not Fitted / Good
Identification Tag (Tally)	Not accessible / Not Fitted / Fitted Incomplete / **Fitted Complete**
Record any discrepancies between tag data and record data provided on the JCS:	
Remarks: 10 YEARS UP ON CERT TAG FITTING BADLY CORRODED	

STANDARD ACTIVITY

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ACPB PROJECT

Standard Activity Title	Standard Activity No:	CI No:	Version:
12M Flexible Hose – Survey/Inspect	A0100083	10.00	1.1

Annex A – Flexible Hose Survey Results

REPORT OF MAINTENANCE ACTIVITY OUTCOMES

HMAS: (Vessel Name) MARYBOROUGH	**AMPS Job No:** (Transcribed from the JCS) M0034929
Ships Hose ID: (Transcribed from the JCS) 333-202	**Pass** / **Fail** (Circle) — Fail
Replacement Recommended: (Circle) **Within 6 Months** — No	**Immediately**

Criteria	Outcome (circle)				
Hose - Leakage			Yes	No	
Hose - Cracks		Yes	No	Hose not visible	
Hose - Cuts		Yes	No	Hose not visible	
Hose - Abrasions or Chafing		Yes	No	Hose not visible	
Hose - Kinks / Distorted / Stresses	Nil	Kinks	Distorted	Stressed	Hose not visible
Hose - Blistering		Yes	No	Hose not visible	
Hose - Poorly Supported			Yes	No	
Hose - Non uniform bulges in cover		NA	Yes	No	
Hose – Paint Presence		Nil	Drops/Spots	Excessive	
Hose PTFE – Total Number of external Wire braid broken or corroded	NA	0	<10	>10	>20
Hose PTFE - 4+ braids adjacent cut/broken		NA	Yes	No	
Hose/Fitting Interface - Corrosion			No	Yes	
Fittings - Corrosion		None	Surface Spots	Heavily Corroded	
Fire Sleeve		N/A	Not Fitted	Cuts	Tears	Good
Fire Sleeve Tape		N/A		Not Fitted	Good
Identification Tag (Tally)	Not accessible	Not Fitted	Fitted Incomplete	Fitted Complete	
Record any discrepancies between tag data and record data provided on the JCS:					
Remarks: 10 YEARS UP ON CERT TAG					

STANDARD ACTIVITY

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ACPB PROJECT

Standard Activity Title	Standard Activity No:	CI No:	Version:
12M Flexible Hose – Survey/Inspect	A0100083	10.00	1.1

Annex A – Flexible Hose Survey Results

REPORT OF MAINTENANCE ACTIVITY OUTCOMES

HMAS: (Vessel Name) MARYBOROUGH	**AMPS Job No:** (Transcribed from the JCS) M0034929
Ships Hose ID: (Transcribed from the JCS) 333 - 196	Pass / (Fail) (Circle)
Replacement Recommended: (Circle) (No) / Immediately / Within 6 Months	

Criteria	Outcome (circle)
Hose - Leakage	Yes / (No)
Hose - Cracks	Yes / (No) / Hose not visible
Hose - Cuts	Yes / (No) / Hose not visible
Hose - Abrasions or Chafing	Yes / (No) / Hose not visible
Hose - Kinks / Distorted / Stresses	(Nil) / Kinks / Distorted / Stressed / Hose not visible
Hose - Blistering	Yes / (No) / Hose not visible
Hose - Poorly Supported	Yes / (No)
Hose - Non uniform bulges in cover	NA / Yes / (No)
Hose – Paint Presence	(Nil) / Drops/Spots / Excessive
Hose PTFE – Total Number of external Wire braid broken or corroded	NA / (0) / <10 / >10 / >20
Hose PTFE - 4+ braids adjacent cut/broken	(NA) / Yes / No
Hose/Fitting Interface - Corrosion	No / (Yes)
Fittings - Corrosion	None / (Surface Spots) / Heavily Corroded
Fire Sleeve	(N/A) / Not Fitted / Cuts / Tears / Good
Fire Sleeve Tape	(N/A) / Not Fitted / Good
Identification Tag (Tally)	Not accessible / Not Fitted / Fitted Incomplete / (Fitted Complete)
Record any discrepancies between tag data and record data provided on the JCS:	

Remarks:

10 YEARS UP ON CERT TAG

STANDARD ACTIVITY

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ACPB PROJECT

Standard Activity Title	Standard Activity No:	CI No:	Version:
12M Flexible Hose – Survey/Inspect	A0100083	10.00	1.1

Annex A – Flexible Hose Survey Results

REPORT OF MAINTENANCE ACTIVITY OUTCOMES

HMAS: (Vessel Name) MARYBOROUGH	**AMPS Job No:** (Transcribed from the JCS) M0034929
Ships Hose ID: (Transcribed from the JCS) 333-195	Pass / **Fail** (Circle)
Replacement Recommended: (Circle) **No** Within 6 Months	**Immediately**

Criteria	Outcome (circle)
Hose - Leakage	Yes / **No**
Hose - Cracks	Yes / **No** / Hose not visible
Hose - Cuts	Yes / **No** / Hose not visible
Hose - Abrasions or Chafing	Yes / **No** / Hose not visible
Hose - Kinks / Distorted / Stresses	**Nil** / Kinks / Distorted / Stressed / Hose not visible
Hose - Blistering	Yes / **No** / Hose not visible
Hose - Poorly Supported	Yes / **No**
Hose - Non uniform bulges in cover	NA / Yes / **No**
Hose – Paint Presence	**Nil** / Drops/Spots / Excessive
Hose PTFE – Total Number of external Wire braid broken or corroded	**NA** / 0 / <10 / >10 / >20
Hose PTFE - 4+ braids adjacent cut/broken	**NA** / Yes / No
Hose/Fitting Interface - Corrosion	No / **Yes**
Fittings - Corrosion	None / **Surface Spots** / Heavily Corroded
Fire Sleeve	**N/A** / Not Fitted / Cuts / Tears / Good
Fire Sleeve Tape	**N/A** / Not Fitted / Good
Identification Tag (Tally)	Not accessible / Not Fitted / Fitted Incomplete / **Fitted Complete**
Record any discrepancies between tag data and record data provided on the JCS:	
Remarks: 10 YEARS UP ON CERT TAG	

STANDARD ACTIVITY

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ACPB PROJECT

Standard Activity Title	Standard Activity No:	CI No:	Version:
12M Flexible Hose – Survey/Inspect	A0100083	10.00	1.1

Annex A – Flexible Hose Survey Results

REPORT OF MAINTENANCE ACTIVITY OUTCOMES

HMAS: (Vessel Name) MARYBOROUGH		**AMPS Job No:** (Transcribed from the JCS) M0034929			
Ships Hose ID: (Transcribed from the JCS) 333-194		Pass		(Circle)	Fail
Replacement Recommended: (Circle) Within 6 Months	No	Immediately			
Criteria	**Outcome** (circle)				
Hose - Leakage		Yes	No		
Hose - Cracks	Yes	No	Hose not visible		
Hose - Cuts	Yes	No	Hose not visible		
Hose - Abrasions or Chafing	Yes	No	Hose not visible		
Hose - Kinks / Distorted / Stresses	Nil	Kinks	Distorted	Stressed	Hose not visible
Hose - Blistering	Yes	No	Hose not visible		
Hose - Poorly Supported		Yes	No		
Hose - Non uniform bulges in cover	NA	Yes	No		
Hose – Paint Presence	Nil	Drops/Spots	Excessive		
Hose PTFE – Total Number of external Wire braid broken or corroded	NA	0	<10	>10	>20
Hose PTFE - 4+ braids adjacent cut/broken	NA	Yes	No		
Hose/Fitting Interface - Corrosion		No	Yes		
Fittings - Corrosion	None	Surface Spots	Heavily Corroded		
Fire Sleeve	N/A	Not Fitted	Cuts	Tears	Good
Fire Sleeve Tape	N/A	Not Fitted	Good		
Identification Tag (Tally)	Not accessible	Not Fitted	Fitted Incomplete	Fitted Complete	
Record any discrepancies between tag data and record data provided on the JCS:					
Remarks: 10 YEARS UP ON CERT TAG					

STANDARD ACTIVITY

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ACPB PROJECT

Standard Activity Title	Standard Activity No:	CI No:	Version:
12M Flexible Hose – Survey/Inspect	A0100083	10.00	1.1

Annex A – Flexible Hose Survey Results

REPORT OF MAINTENANCE ACTIVITY OUTCOMES

HMAS: (Vessel Name) MARYBOROUGH	**AMPS Job No:** (Transcribed from the JCS) M0034929
Ships Hose ID: (Transcribed from the JCS) 333 - 190	**Pass** / **Fail** (Circle) — Fail
Replacement Recommended: (Circle) **Within 6 Months** — No	**Immediately**

Criteria	Outcome (circle)
Hose - Leakage	Yes / No
Hose - Cracks	Yes / No / Hose not visible
Hose - Cuts	Yes / No / Hose not visible
Hose - Abrasions or Chafing	Yes / No / Hose not visible
Hose - Kinks / Distorted / Stresses	Nil / Kinks / Distorted / Stressed / Hose not visible
Hose - Blistering	Yes / No / Hose not visible
Hose - Poorly Supported	Yes / No
Hose - Non uniform bulges in cover	NA / Yes / No
Hose – Paint Presence	Nil / Drops/Spots / Excessive
Hose PTFE – Total Number of external Wire braid broken or corroded	NA / 0 / <10 / >10 / >20
Hose PTFE - 4+ braids adjacent cut/broken	NA / Yes / No
Hose/Fitting Interface - Corrosion	No / Yes
Fittings - Corrosion	None / Surface Spots / Heavily Corroded
Fire Sleeve	N/A / Not Fitted / Cuts / Tears / Good
Fire Sleeve Tape	N/A / Not Fitted / Good
Identification Tag (Tally)	Not accessible / Not Fitted / Fitted Incomplete / Fitted Complete
Record any discrepancies between tag data and record data provided on the JCS:	
Remarks: 10 YEARS UP ON CERT TAG	

STANDARD ACTIVITY

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ACPB PROJECT

Standard Activity Title	Standard Activity No:	CI No:	Version:
12M Flexible Hose – Survey/Inspect	A0100083	10.00	1.1

Annex A – Flexible Hose Survey Results

REPORT OF MAINTENANCE ACTIVITY OUTCOMES

HMAS: (Vessel Name) MARYBOROUGH			**AMPS Job No:** (Transcribed from the JCS) M0034929		
Ships Hose ID: (Transcribed from the JCS) 333-189			Pass		(Fail) (Circle)
Replacement Recommended: (Circle) Within 6 Months	(No)		Immediately		
Criteria	**Outcome** (circle)				
Hose - Leakage			Yes	(No)	
Hose - Cracks	Yes	(No)	Hose not visible		
Hose - Cuts	Yes	(No)	Hose not visible		
Hose - Abrasions or Chafing	Yes	(No)	Hose not visible		
Hose - Kinks / Distorted / Stresses	(Nil)	Kinks	Distorted	Stressed	Hose not visible
Hose - Blistering	Yes	(No)	Hose not visible		
Hose - Poorly Supported		Yes	(No)		
Hose - Non uniform bulges in cover	NA	Yes	(No)		
Hose – Paint Presence	(Nil)	Drops/Spots	Excessive		
Hose PTFE – Total Number of external Wire braid broken or corroded	(NA)	0	<10	>10	>20
Hose PTFE - 4+ braids adjacent cut/broken	(NA)	Yes	No		
Hose/Fitting Interface - Corrosion		(No)	Yes		
Fittings - Corrosion	(None)	Surface Spots	Heavily Corroded		
Fire Sleeve	(N/A)	Not Fitted	Cuts	Tears	Good
Fire Sleeve Tape	(N/A)	Not Fitted	Good		
Identification Tag (Tally)	Not accessible	Not Fitted	Fitted Incomplete	(Fitted Complete)	
Record any discrepancies between tag data and record data provided on the JCS:					
Remarks: 10 YEARS UP ON CERT TAG					

STANDARD ACTIVITY

serco
ACPB PROJECT

Standard Activity Title	Standard Activity No:	CI No:	Version:
12M Flexible Hose – Survey/Inspect	A0100083	10.00	1.1

Annex A – Flexible Hose Survey Results

REPORT OF MAINTENANCE ACTIVITY OUTCOMES

HMAS: (Vessel Name) MARYBOROUGH	**AMPS Job No:** (Transcribed from the JCS) M0034929
Ships Hose ID: (Transcribed from the JCS) 333-188	Pass / **Fail** (Circle)
Replacement Recommended: (Circle) **No** / Within 6 Months	Immediately

Criteria	Outcome (circle)				
Hose - Leakage			Yes	**No**	
Hose - Cracks		Yes	**No**	Hose not visible	
Hose - Cuts		Yes	**No**	Hose not visible	
Hose - Abrasions or Chafing		Yes	**No**	Hose not visible	
Hose - Kinks / Distorted / Stresses	**Nil**	Kinks	Distorted	Stressed	Hose not visible
Hose - Blistering		Yes	**No**	Hose not visible	
Hose - Poorly Supported			Yes	**No**	
Hose - Non uniform bulges in cover		NA	Yes	**No**	
Hose – Paint Presence		**Nil**	Drops/Spots	Excessive	
Hose PTFE – Total Number of external Wire braid broken or corroded	NA	**0**	<10	>10	>20
Hose PTFE - 4+ braids adjacent cut/broken		**NA**	Yes	No	
Hose/Fitting Interface - Corrosion		**No**	Yes		
Fittings - Corrosion	**None**	Surface Spots	Heavily Corroded		
Fire Sleeve	**N/A**	Not Fitted	Cuts	Tears	Good
Fire Sleeve Tape	**N/A**		Not Fitted		Good
Identification Tag (Tally)	Not accessible	Not Fitted	Fitted Incomplete	**Fitted Complete**	
Record any discrepancies between tag data and record data provided on the JCS:					
Remarks: 10 YEARS UP ON CERT TAG					

STANDARD ACTIVITY

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ACPB PROJECT

Standard Activity Title	Standard Activity No:	CI No:	Version:
12M Flexible Hose – Survey/Inspect	A0100083	10.00	1.1

Annex A – Flexible Hose Survey Results

REPORT OF MAINTENANCE ACTIVITY OUTCOMES

HMAS: (Vessel Name) MARYBOROUGH	**AMPS Job No:** (Transcribed from the JCS) M0034929
Ships Hose ID: (Transcribed from the JCS) 333-187	**Pass** / **Fail** (Circle) — Fail
Replacement Recommended: (Circle) **Within 6 Months**	No / Immediately

Criteria	Outcome (circle)				
Hose - Leakage			Yes	No	
Hose - Cracks		Yes	No	Hose not visible	
Hose - Cuts		Yes	No	Hose not visible	
Hose - Abrasions or Chafing		Yes	No	Hose not visible	
Hose - Kinks / Distorted / Stresses	Nil	Kinks	Distorted	Stressed	Hose not visible
Hose - Blistering		Yes	No	Hose not visible	
Hose - Poorly Supported			Yes	No	
Hose - Non uniform bulges in cover		NA	Yes	No	
Hose – Paint Presence		Nil	Drops/Spots	Excessive	
Hose PTFE – Total Number of external Wire braid broken or corroded	NA	0	<10	>10	>20
Hose PTFE - 4+ braids adjacent cut/broken		NA	Yes	No	
Hose/Fitting Interface - Corrosion		No	Yes		
Fittings - Corrosion		None	Surface Spots	Heavily Corroded	
Fire Sleeve		N/A	Not Fitted	Cuts	Tears	Good
Fire Sleeve Tape		N/A	Not Fitted	Good	
Identification Tag (Tally)	Not accessible	Not Fitted	Fitted Incomplete	Fitted Complete	

Record any discrepancies between tag data and record data provided on the JCS:

Remarks: 10 YEARS UP ON CERT TAG

~~FOUO~~

ROYAL AUSTRALIAN NAVY

Patrol Boat Group Head Quarters

Minute

PB GRP HQ/OUT/2017/M7957230

MINUTES OF MEETING - MARYBOROUGH MSB INVESTIGATION REPORT RECOMMENDATIONS

1. A meeting was held 3 Oct 17 to review the recommendations contained within the MSB investigation report into the Maryborough engine room fire. COMMHP, Captain Warren Bairstow, dialled-in from Sydney for the meeting. Key PBGRP attendees were as follows:

   a. COS PBGRP CMDR Woodham
   b. SO1 Policy and Plans CMDR Barton
   c. PB CLEO CMDR Fullick
   d. PBGRP SOMMS LCDR Wagemaker
   e. PB Sw Materiel Delivery Manager LEUT Adams

2. Proposed actions/dispositions determined at the meeting for each of the report recommendations are listed in the following paragraphs.

a. *PBGRP to review the $C0_2$ system and associated PMS to ensure all Armidale-Class $C0_2$ Systems are compliant with OEM requirements.*

   A CO_2 system OLM PMS review was conducted and it was found that the weekly SA was active across ACPB Fleet however on a few vessels it was found that the monthly SA was inactive. The monthly SA has since been re-activated in AMPS and all vessels have completed the SA.

   Action – Closed. Accepted and actioned

b. *PBGRP to review emergency air systems for supporting breathing apparatus*

   There is no emergency air system on board ACPB. Rather the DC warrant requires 100% change-out of BA cylinders which all ACPB have and STG scenarios cover. The Junior Bauer compressor on board is to enable PM to be conducted and to support crew training evolutions. Unlike MFU compressors the Junior Bauer is not designed or capable of supporting a continuous rolling response to an incident. A compressor that would be capable would be significantly larger & heavier such that the weight, power supply and required space would exceed that available on an ACPB.

   Action – Closed. Reviewed but not supported

c. *NTB and DSTG to investigate methods to identify improved and enhanced firefighting systems.*

   The design of the ACPB and the associated safety systems comply with the established SOI and Safety Case, both of which are certified by DNV and meet

SOLAS requirements. The report does not specify where the concern with the firefighting system is but rather is a catch-all statement.

Action – Closed. Reviewed but not supported

d. *PBGRP to review the immediate firefighting response drills, and determine if additional guidance needs to be provided to personnel on the appropriateness of re-entering compartments using BA Attack.*

Firefighting doctrine is promulgated in ABR 5476 where it mandates a rolling aggressive attack. As part of the doctrine it appears that all steps must be followed by rote and whilst this interpretation may be suitable for personnel at the lower levels of the command chain there is scope for a review of the training and implementation at the Leadership and Command decision points.

On the day there was ample evidence of a large B class fire via fire alarms, CCTV, compartment remote temperature readings and temperature alarms. This was all within the first minute of the event that could have prompted a Command decision to proceed straight to activation of fitted systems. By opening the compartment it increased the danger to the ship and personnel by providing oxygen to the fire, the loss of additional compartments due to the spread of smoke and put the available BA resources under significant strain.

Action – Accepted. Open actions for PBGRP include

- Initiate engagement with CST STG-MWV to review training procedures for Ship's Command Organisation in C2 procedures, especially with regards to junior officer training.
- Update SOP to include early activation of fitted firefighting systems on confirmation of fire should be the default action.

e. *Penske Power Systems to provide PBGRP details regarding improved maintenance procedures for MTU engines, such as, torque settings for bleed screws, lock wire, etc.*

Action – Accepted. Open action for PBSPO to raise RPR and liaise with Penske to update SA/Work Instruction in order to develop a means of mitigation.

f. *Penske Power Systems to provide PBGRP an alternative control measure for raising the alarm as a priority so that fuel pressure determines automatic engine shut down.*

The existing alarms and shut-down devices worked as designed on the day. The gradual nature of the leak as the bleed-screw progressively loosened led to the build-up of fuel on the deck plates and in the bilge area. However the low pressure fuel alarm functioned as designed and therefore there does not appear to have been a failure of alarms or safety mechanisms.

The recommendation does not relate to any specific shortfall or systemic failure but rather appears to be a catch-all statement.

Action – Closed. Reviewed but not supported

g. *PBGRP to investigate the improvement of visibility of the MarineLink CCTV monitor especially during night operations.*

As MarineLink is co-located on the bridge the brightness of the screen hinders the night vision of the OOW and helmsmen. To alleviate this ships turn down the brightness of the MarineLink screen as much as possible whilst still being visible. Time was lost due to the need to increase the brightness of the screen for improved visibility during the incident.

Action – Accepted. Open action for all each ship's SE sailors to raise a TM200 to have a Velcro black-out flap manufactured.

h. *PBGRP to investigate the possibility of having the CCTV vision on the Armidale Class vessels recorded.*

An ECP has been raised for an alternate power supply and provision of a recording capability for the CCTV.

Action – Accepted. Open action for PBSPO to progress ECP

i. *PBGRP and NTB to review the management of audible alarms during an incidents to eliminate confusion. This will improve the ability to manage similar situations better and will support Navy operations including internal communications.*

The alarms are there to alert command to hazards and systems operating outside of design. The alarms operated as designed; it was the nature of the incident that multiple systems went into alarm concurrently. Any ECP to co-locate all alarms to a single location e.g. MarineLink screen would be a significant undertaking and not feasible noting the limited in service life remaining for the Armidale class.

However the number of alarms increased as the UPS system's remaining power drained and previously acknowledged system faults re-entered the alarm state. The UPS system functioned as designed and there is an ECP in progress to address obsolescence issues. However there is an additional need to re-assess the functional baseline of the UPS system in order to provide a greater capability.

Action – Recommendation raised in report reviewed however not supported in current state. The recommendation to be reframed; UPS system's functional capability to be reviewed such that it will provide sufficient power to critical systems in the event of primary and secondary power generation failures. Therefore accepted and PBGRP to raise RPR.

j. *PBGRP to review and update ABR 5225 with respect to flexible hoses services life and OEM standards.*

ABR 5225 is not a PBGRP sponsored document. Additionally ABR 5225 is not the parent document for the management of flexible hoses but rather takes its guidance from DEF(AUST)5000. However the standards for flexible hoses on board ACPB are taken from DNV. This has created confusion as incorrect standards are being

applied. The actual issue WRT flexible hoses is the incorrect maintenance baseline and incorrect management of the flexible hoses.

Action – Recommendation raised in report reviewed however not supported in current state. The recommendation to be reframed; the management and maintenance of ACPB flexible hoses are to be revised. Action is therefore accepted and closed as it is already incorporated as part of the PBSPO's ongoing remediation of flexible hose maintenance for ACPB.

k. *PBGRP to review the emergency generator to ensure operational at all times. Review and where appropriate update the associated PM's and documentation. Conduct periodic audits to confirm its effectiveness.*

There are already comprehensive planned maintenance checks and assurances in place for the emergency generator. These include OLM and ELM maintenance, SA in AMPS, SwMA, Basin Trial, DSOTS etc. During the incident an immediate defect developed on the thermostatic cut-in/cut-out switch for the radiator cooling fan. Once ship's staff had time to conduct fault finding on the emergency generator they were able to identify the defect and return it to service.

Action – Closed. Reviewed but not supported

l. *PBGRP to develop training needs analysis and conduct training for the use of the Harris 150 and 152 portable radios and to review the storage location for communication equipment*

This recommendation needs to be split into two areas. Firstly the radios have been issued fleet wide and a training need has already been identified however PBGRP is not the appropriate authority to be developing and providing that training. Instead the Defence Force School of Signals – Maritime Wing have developed the training and are planning to be incorporated it into the CIS intermediate course. Formal and informal training on the radios has been provided to the CIS's in Darwin including personnel embarked on board MWV's.

The second issue is the location of the radios on board the ACP. The Harris radios and satellite phone need to be on the bridge at sea and this issue needs to be taken for further action.

Action – Recommendation raised in report reviewed however not supported in current state. The recommendation is to be reframed; PBGRP to investigate the storage location of the radios and the OIP when boats are underway. Therefore accepted and action for PBGRP to progress.

m. *PBGRP to ensure thermographic surveys are conducted and recommendations are implemented.*

Thermographic surveys are a 12 monthly ELM task triggered in AMPS. Also there are defect records raised for any defect and these are with PBSPO sustainment for

action. There is also an RPR in the system to review the standard and type of lagging design used in the ACPB for the diesel engine exhaust systems that is with the PBSPO for progression.

Action – Closed. Accepted and actioned

n. *PBGRP to review the Oily Mist Detectors location and suitability for service.*

The fitted oily mist detectors performed its function as designed. The system installed is directed to cover the area around the fuel oil purifiers which is considered to be the high risk area and the most likely location to cause an atomised fuel leak within the engine room. The oily mist detector did alarm at the time of the incident however the alarm activated almost simultaneously with the initiation of the fire. An RPR has been raised for the oily mist detector to be upgraded to cover the whole engine room space and to address obsolescence issues.

Action – Closed. Accepted and actioned

3. The meeting was closed at 1134I/K.

4. A formal minute will be forwarded to COMMHP advising CAPT-PB's proposals with regard to the recommendations from the MSB report.

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Oct 17