OPERATION SILENT ANZAC

INTERIM REPORT ON THE MARITIME ARCHAEOLOGICAL ASSESSMENT 2014

HMAS AE2

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Interim Report MAA14

Figure 1 Among the first views inside AE2's control in 99 years: Elliot Brothers of London Patent Ship's Speed Indicator and Log

Project Silent Anzac
Maritime Archaeological Assessment 2014
Interim Report

Background

1. Project Silent Anzac is being undertaken by the AE2 Commemorative Foundation (AE2CF) Ltd, established by the Submarine Institute of Australia to protect, preserve and tell the story of the World War I Australian submarine, HMAS AE2.

2. Following an Assessment Phase completed in mid-2008, the AE2CF developed a Joint Proposal setting out a plan to implement the agreed measures including an Education Program for delivery in Australia. These proposals were accepted by the Australian and Turkish Governments and formally approved by a Ministry of Foreign Affairs note in February 2014. [1] Subsequently the Turkish Ministry of Culture and Tourism approved the AE2CF's Archaeological Permit Application in April 2014. [2]

3. The AE2CF assembled a team of volunteers with expertise in submarine engineering, afloat operations, maritime archaeology, naval history, conservation of steel shipwrecks, marine science and remotely operated underwater vehicles (ROV) from Australia, USA and Turkey.

4. The Project was largely funded by an Australian Government grant announced in the May 2013 Federal Budget as part of the Anzac Centenary Program 2014-2018, administered by the Department of Veterans' Affairs. The US ROV supplier, SeaBotix and the Defence Science and Technology Organisation (DSTO) also provided a significant amount of in-kind sponsorship and support.

MAA Overview

Contracting Phase

5. A decision was made to engage a Turkish company to provide all offshore services; three companies were approached and contributed to the development of a budget for the work and Request for Tender. Bids were sought and the company DEEP Offshore was selected. A contract was awarded on 12 February 2014.

Mission Rehearsal and Training Exercise Phase 1&2

6. Operating cameras and instrumentation to record the conditions inside the submarine lying at 73m in the Sea of Marmara required development of specialised cameras, lighting, instrumentation and techniques. These

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[1] Ministry of Foreign Affairs Third Party Note 2014/46373548-KUGY/4259662 dated 10 February 2014

2 Ministry of Culture and Tourism letter reference- 94949537-163.99 72221 dated 11 April 2014

developments were undertaken by a team from the DSTO laboratories at Fisherman’s Bend in Melbourne, working in concert with the US ROV supplier SeaBotix and Turkish offshore specialists.

7. The equipments were prototyped by DSTO using a replica of the conning tower and a section of the control room, including some trials in the test tank at Fisherman’s Bend. A Divers’ Support Platform [DSP] to provide a safe and stable working area around the fin was also designed and manufactured in Melbourne.

8. The second phase of training and rehearsals were untaken in 12m of water in Corio Bay, Geelong using the RAN’s Diving Team (ANRDT6) from Melbourne. DEEP and SeaBotix personnel attended to add their expertise to the further development of the arrangements for cameras, rigs for inserting them and mounting the cameras, instrumentation and ROVs. The Geelong replica is now to become an exhibit at the Holbrook Submarine Museum.

Figure 1 Replica and DSP at Corio Bay, Geelong

9. The lessons learnt from the Geelong MRTE were incorporated into the construction of modified DSP and replica in preparation for the third phase of MRTE to be held in Turkey in June.

10. Letters providing 15 days’ notice of commencing the MAA were sent to the Ministries listed in the Ministry of Culture and Tourism’s approval, Attachments 1-7 refer. Advice of the approval was also passed to the Coastguard (Attachment 9 refers).

<u>Mobilisation</u>

11. The AE2CF team started assembling at Tuzla, Turkey from the 29 May as required to undertake preparations. A list of team members is provided at Annex A.

12. The Diving Support Vessel [3] began a 4 day mobilisation period on 31 May 14, converting the large, empty deck space into an expedition site. The following containerized facilities were fitted:

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[3] Kapitani Deriya-2, IMO number: 9503756, displacement 1,339 T

- Workshop/store,
- ROV and camera Operations Centre,
- An accommodation module,
- Diving Bell,
- Diving Operations control centre,
- Two double chamber Recompression Chambers,
- Compressor and electrical workshop, and
- Twenty quad packs of Gas mixture.

A temporary navigation buoy and the ground tackle [including a 9 tonne clump weight] to anchor the buoy was loaded as well as three 7 tonne anode pods for the Cathodic Protection System [CPS].

Figure 2 MV Kapitani Derya-2 Loading Temporary Buoy

Figure 3 Diving Bell Training and Deck Layout

13. The final two days of the mobilisation were very busy for the ship, DEEP Offshore and DSTO teams as equipment was unpacked and set to work. To facilitate safe operations video feeds from the ROV and diver's helmet cameras were available at both control sites.

Figure 4 Diving Control Centre and ROV Ops Room Preparations

Mission Rehearsal and Training Exercise Phase 3.

14. A three day rehearsal was undertaken to familiarize the Turkish diving team with all equipments and to practise inserting the equipment into the replica in 12m of water. This was very beneficial; the diving team became involved in optimizing the equipment and familiar with its function.

Figure 5 Briefing Divers on camera mounting arrangements

Figure 6 Replica and DSP MkII launch for MRTE Phase 3

<u>Maritime Archaeological Assessment</u>

15. The full AE2CF team for the MAA assembled at Sarkoy on Saturday, 7 Jun 14. The DSV had transited from Tuzla overnight. Plans to position the ship over AE2 and lay the buoys were delayed whilst the ship waited at Karabiga for a final clearance from the Harbour Master.

16. The ship was positioned early on Sunday and four mooring buoys were laid in a square around the site to enable the ship’s position to be finely adjusted. This proved to be a very robust and practical arrangement. The moment critique arrived at 1400 when the first ROV serial entered the water and located AE2 as predicted. An attempt to position the DSP around the conning tower of AE2 failed, as the crane was unable to plumb the position sufficiently to enable the DSP to be lined up, despite deploying a diver to assist; the ship’s position required further adjustment.

Figure 7 Laying the DSV moorings.

17. The MAA Diary and Photo Log at Annex B provides details of each day’s activities; a short daily summary will be provided here for continuity.

18. Monday 09 Jun 14. The weather was too rough for crane operations, preventing a second attempt to install the DSP.

Figure 8 First view of AE2 fin

The ROV completed an external survey; good imagery was obtained and no major changes to AE2’s appearance from the 2007 and 2013 surveys were noted. A diving medical emergency evacuation exercise was held, followed by a dive to clear away debris from around the hatch to avoid this entering the submarine during future serials.

Figure 9 Conning Tower Hatch on first approach and forward periscope pedestal

19. Tuesday, 10 Jun 14. The weather was perfect for the installation of the DSP, using an ROV to guide the crane operations and act as a tug to align the DSP in the final, delicate stages. During the first dive the upper conning tower hatch was inspected using the diver's helmet camera, three corrosion meter readings, a concretion sample and fluid sample from underneath the hatch were obtained. Cleaning around the hatch continued. An attempt to insert the drop camera during the second dive was unsuccessful, the opening was slightly too narrow, exacerbated by the camera assembly encountering a strengthening web not shown on the submarine construction plans and out of sight on the hatch. The two stirrups holding the hatch open as arranged by LCDR Stoker when abandoning the submarine were partially cut through before the diver ran out of time.

Figure 10 DSP in position. Taken on final flyover, shows CP connections in place with ROV grabber in foreground.

20. Wednesday 11 Jun 14. The stirrups were cut through and the hatch opened 3cm by hand, enabling the drop camera to be inserted during the second dive serial. Good images were recorded in the control room however visibility in the conning tower was poor due to the disturbance caused by the cutting and insertion. The drop camera was left inside the SM overnight in the hope of better visibility in the morning.

Figure 11 Drop camera illumination showing remaining hatch stirrup in place

21. Thursday, 12 Jun 14. Visibility in the control room was much improved, however the drop camera suffered a power failure due to flooding in one of the connectors and limited imagery was recorded – always a risk at 73m! The midships CPS pod was laid, using the ROV to position it 5m off the Port side of the SM, abeam the fin. The hatch was opened using a hand operated jack: much to the consternation of the resident conger eel, 'Bunts'.

Figure 12 Bunts the conger eel emerges

During the final dive for the day the hatch was opened to the near upright angle of 85 degrees using a chain block and secured in this position. A build-up of silt, shells and concretion obstructed further movement. This opening proved adequate to insert the ROV, avoiding the need to cut the hatch away. It is a testament to the submarine's designers, the ship builders and the Engine Room Artificer responsible for the maintenance of equipment outside the pressure hull adherence to the maintenance routines that the hatch bearings operated correctly after 99 years on the seabed!

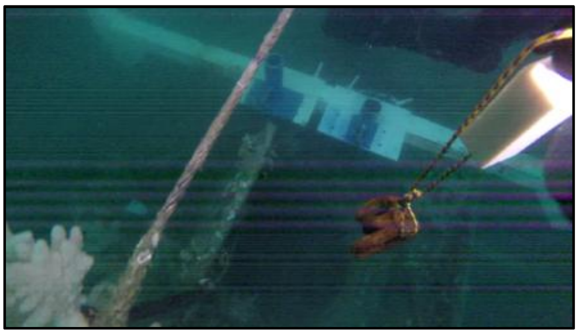


Figure 13 ROV being inserted into open hatch. Shows instrument mount in place and ROV weights

22. Friday, 13 Jun 14. Whilst the pole camera was being repaired following the earlier connector flooding, the opportunity was taken to position the ship and insert the after CPS pod 5m off the port after hydroplane, using the ROV's sonar to guide the crane. The ship then moved back to position the diving bell beside the DSP and the first diver cleared the area and set up the brackets to secure the pole camera with ROV observation to assist. A meeting with the Acting Director General Coastal Safety reached agreement regarding the Turkish ownership of the interim and final navigational buoys to be laid over AE2 (Attachment 10 refers).

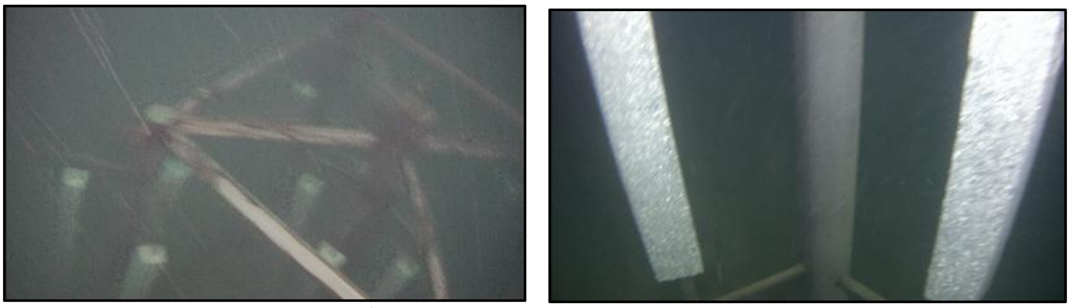


Figure 14 Anode pod in position. Same pod after 48hour connection showing depletion initiation has taken place.

23. Saturday, 14 Jun 14. In an effort to recover some lost time we proceeded with insertion of the modified SeaBotix vLBV ROV, in lieu of the pole camera. The ROV was a tight fit and required much manipulation to fit through the upper conning tower hatch. Visibility in the tower was poor because of the disturbed silt, however visibility rapidly improved and many details became evident as we waited for the next diver serial. Divers attempted to insert the ROV into the Control Room using a specially fitted aluminum pole, however the ROV became jammed due to a concretion build up that reduced the clearance and some unexpected lugs. Plans for a third dive serial were abandoned when a diver from the second serial suffered joint pains and underwent precautionary therapeutic treatment in the RCC.

Figure 15 ROV and Aris sonar

24. Sunday, 15 Jun 14. The planned rest day was abandoned to try and make up for lost time. Despite all efforts the ROV remained jammed in the lower conning tower hatch. The DEEP/DSTO team regrouped and provided the diver with an improvised boat hook fitted with camera and light to enable the diving supervisor to guide the diver's actions. After some practice on deck hooking the other modified ROV he descended into the depths and, working by feel, managed to dislodge ROV from lower conning tower hatch.

The ROV, now free to move around the conning tower, was able to conduct a detailed survey whilst waiting for extraction by the third dive serial. Once recovered normal pulse/breathing rates returned to the team above.

Figure 16 Spare ROV being used by the diver to rehearse using the 'boat hook' to extract the stuck ROV

25. Monday, 16 Jun 14. The ship was repositioned so that crane could lower the forward CPS pod to the bottom on the starboard side of the SM, adjacent to the windlass on the forward casing. Once again the ROV was essential in positioning the pod. The ship's position was then adjusted to position the diving bell for work on the forward CPS attachment points. Two dive serials were required to clean the attachment site and connect the CPS pod. The ROV provided invaluable assistance in guiding the divers between the pod and worksite during these serials. The ship moved back adjacent to conning tower, enabling the third dive serial to guide the DSTO ROV, which had been substantially modified overnight, fitted to the insertion pole, into the conning tower and thence into the control room. The VIP Sea Day was successfully completed during the day enabling nine invited visitors to view operations onboard the DSV and view some of the results obtained.

26. Tuesday, 17 Jun 14. This was a day of continuous ROV operation utilising the three ROV pilot working in shifts to complete seven hours surveying in challenging conditions.

Figure 17 Tuesday's shots of the day; Captain Stoker's desk light and the Control Room Log

Images have been recorded from the Control Room through the wardroom, to the fore-ends and back taking in many equipments, artifacts and curiosities providing an unprecedented insight into early submarine construction and operation. Curiously only fragments of the spokes of the steering wheel, fore and after planes control wheels can be discerned, presumably these have corroded away; providing a conundrum for our corrosion team. Among the many images, most memorable were the wooden wardroom furniture, the fluted light shade over the Captain's desk and the port decanter that sits intact on his desk.

Whilst this survey was occurring the ship was moved to the after CPS attachment point, sites cleaned and cables attached during two diving serials.

Figure 18 After CP connection to port hydroplane. Midships CP connection to periscope pedestal

27. Wednesday, 18 Jun 14. The ship was repositioned to the conning tower position, whilst ROV surveying of the amidships tube space continued in good visibility. The amidships CPS pod was attached during the first dive. During the second dive the ROV was extracted and preparations made for the crane insertion of the combined drop camera and Aris high definition sonar rig. This was successfully accomplished without using divers by the crane and an ROV to position the camera. The drop camera was extracted after conducting three sweeps of the control room with the assistance of the ROV to rotate the camera.

Figure 19 Hatch closure (Top Hat) in place, DSP removed. Anode connection cable visible

During the third dive serial the secure hatch was fitted and the DSP removed. An ROV survey of the site was then undertaken to ensure all expedition equipment was clear of the SM and the temporary navigation buoy was then laid. This marked the completion of afloat operations and several team members began the trip back to their homes.

28. Thursday, 19 Jun 14. During the day the AE2CF team cleaned and stowed equipment ready for re-export. A mast fitted with a yellow flashing light and radar reflector was fitted to the navigation buoy. A violent thunderstorm overnight forced the DSV to quit the moorings and seek shelter in Karabiga.

The completion of the afloat activity was reported to the Ministry of Culture and Tourism (Attachment 8) and arrangements made for a complete set of the original data gathered to be passed via the Australian Embassy, Ankara.

Figure 20 Temporary Navigation Buoy in position

29. Friday, 20 Jun 14. The remaining team began the process of returning to Australia. The ship completed the recovery of the moorings and steamed back to Tuzla for demobilization. This was completed on schedule the next day. The position of the navigational buoy was reported to the Department of Navy Hydrography and Oceanography (Attachment 11 refers).

Conclusions

30. Objectives. All major objectives for the MAA were achieved, though not without overcoming a number of significant obstacles and setbacks. This success is a tribute to the technical capability, innovation and flexibility of the DSTO, SeaBotix and DEEP teams. Divers were a critical component for most activities and the tempo of 3 dives in a 12 hour working day, each dive providing 20 minutes work at 73m regulated progress. In addition to providing a unique capability to undertake the internal survey, ROVs allowed work to continue between dives and to maximize the effectiveness of each dive serial.

31. Data. A huge amount of data was collected, most of it in real time via umbilicals connecting to the various cameras and instruments in the water. Each record has been initially assessed and indexed. Full analysis will take many hours of painstaking work by knowledgeable researchers; results will be published in the final report. A set of selected interim images is attached at Annex F.

32. Navigation Buoy. Due to the late decision to fit a 3m buoy in lieu of a smaller buoy and production delays arising from the manufacture of the first buoy of this size in Turkey, the final buoy was not available in time for the MAA. The Directorate of Coastal Safety approved the fitting of a temporary, smaller buoy until the final buoy became available. Arrangements have been made to install the final buoy as soon as it is available which is anticipated will be no later than the end of August 2014. The final fitting will be reported the Navy Hydrograph and Oceanography Department.

33. Scientific Aspects. The scientific objectives for the Project, to undertake an external and internal examination of AE2 using specially developed and adapted instrumentation, high definition sonar and cameras were met. In doing so the DSTO team demonstrated great ingenuity to overcome a number of practical obstacles. A huge amount of data has been collected and a methodology set out for the detailed examination that will now follow. As a final product it is hoped to be able to populate a computer-generated model with the real images enabling us to visualize the interior of AE2. Further details are at Annex C.

34. Maritime Archaeological Aspects. The state of preservation of fittings and furniture is quite extraordinary; the internal examination has opened a time capsule. With the exception of the forward torpedo space, where decaying material severely restricted visibility, good quality images have been collected to enable the internal equipments to be identified and a start begun to better understand the operation of the vessel. The principle of minimum interference was followed throughout and we leave the wreck in a better state for the future, with a functioning cathodic protection system, secure hatch and navigational buoy in place. Further details are at Annex D.

35. Conservation Aspects. The readings taken over the course of the MAA indicate that the CPS is functioning correctly and as expected. It should be noted that this work represents the largest in-situ conservation project ever attempted on an historic iron shipwreck. As a result of this work the AE2 is now being actively preserved while remaining in-situ at the bottom of the Sea of Marmara. Not only will this cathodic protection system stop corrosion of AE2 it will actively remove chloride ions and so stabilise the vessel and preserve it for future generations. Further details are given at Annex E.

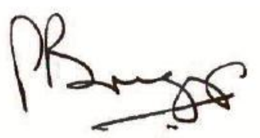
36. Security Aspects. Publication of the images and other information arising from the MAA has a potential downside, being; the attraction of trophy hunters who may attempt to enter the submarine to recover artefacts. While installation of the navigational buoy has reduced the risk of accidental damage it could facilitate undesired activity by indicating the wreck's location. The secure hatch closure provides some protection and the navigation buoy is located at an (albeit limited) distance from the wreck. Some additional protection will be provided by continuing to treat the coordinates of the wreck itself as confidential. However, security would be greatly boosted by activation of the 'no go' zone around the wreck which has been requested in earlier meetings with the Turkish Ministry of Transport, Maritime affairs and Communications and supervision of that zone by the appropriate authorities, including the Coastguard.

Next Steps

37. Selected images will be provided for print and visual media to promote the story of AE2 and Sultanhisar in Australia and Turkey. These will also be incorporated into the Australian educational products such as the Study Guides, IBook and the AE2 graphic novel.

38. The expert members within the AE2CF’s team will undertake further evaluation of the results in order to prepare the Final Report and to deliver papers at the Closing Conference to be held in Istanbul on 20 April 2015.

39. Discussions are underway with the Australian National Maritime Museum regarding the future management and detailed analysis of the data collected during the MAA – truly a joint success for Turkey and Australia.



P Briggs AO CSC
Rear Admiral RAN Rtd
Chairman AE2 Commemorative Foundation
10 July 2014

<u>Annexes</u>

A. MAA Team List
B. MAA Diary and Photo Log
C. Interim Scientific Report.
D. Maritime Archaeology Interim Report.
E. MAA Interim Conservation Report
F. Selected Images.

Attachments

1. AE2CF 14LET4301T 16May14 Ministry of Foreign Affairs
2. AE2CF 14LET4307T 16May14 Navy Hydrography and Oceanography
3. AE2CF 14LET4306T 16Mayis14 Ministry of Defence
4. AE2CF 14LET4305T 16May14 Ministry of Transport
5. AE2CF 14LET4304T 16May14 Ministry of the Interior
6. AE2CF 14LET4303T 16May14 Governor of Canakkale
7. AE2CF 14LET4302T 16May14 Gen Director of Cinema
8. AE2CF 14LET4327T To Ministry of Culture dated 20Jun14-1 Work Completed
9. AE2CF LET4300T 09May14 Coastguard
10. AE2CF LET4325 Acting DG Coastal Safety14Jun14
11. AE2CF LET4328T 25Jun14 Navy Hydrography & Oceanography

Sessiz Anzac Projesi
Authorized Personnel

First Name	Family Name	Parent Organisation	Role
Peter	BRIGGS	AE2CF	Chairman
Adrian	DOLAN	AE2CF	Media Management
Bayden	FINDLAY	Sensible Films	Videography
John	GILBERT	DSTO	Technical
Peter	GRAHAM	DSTO	ROV Operations
Kenneth	GREIG	AE2CF	Project Management
Ian	MACLEOD	WAM	Director Conservation
John	MOORE	Sensible Films	Film Production
Roger	NEILL	DSTO	Director Science
Jesse	RODOCKER	SeaBotix Inc	ROV Ops
Martin	ROWAN	DSTO	Technical
Timothy	SMITH	Heritage Victoria	Director Archaeology
Roger	TURNER	AE2CF	Project Management
Terence	ROACH	AE2CF	Director Operations
David	WHILLAS	SeaBotix Australia	ROV Ops
Nigel	ERSKINE	ANMM	Conservation Management
Frank	SHAPTER	ANMM	Liaison
Alex	DOWELL	SeaBotix Inc	ROV Ops
Harun	OZDAS	13639071064	Maritime Archaeology
Nilhan	KIZILDAG	52699167892	Maritime Archaeology
Murat	ICEL	AE2CF	Project Management
Oguz	KAYNAK	Sensible Films	Audio Recording
Alp	KARABACAK	RTN	RTN Liaison
Zülküf	KARAKUŞ	Çanakkale Museum	Maritime Archaeology

Annex B
Maritime Archaeological Assessment Operations Diary and Photo Log

Image Ref	Day	Date	Activity	Remarks
	(b)	©	(d)	(e)
	-10	Mon 19May	Airfreight equipment from USA and Australia arrives Turkey	• Customs clearance process commences. All gear to be re-exported on completion of MAA.
	-7	Mon 26May	Pre mobilisation meeting	• AE2CF Project Manager (Turkey) met with Supplier to review arrangements. • View divers, vessels and equipment certifications.
	-2	Thu 29May	Planning Group arrive Tuzla, Terry Roach, Ken Greig, Roger Turner,	• Establish domestic arrangements
	-1	Fri 30May	Pre mobilisation meeting and inspection of Diving Support Vessel (DSV), passenger transfer boat and any other vessels nominated by the Supplier. Peter Briggs arrives Tuzla	• Meet DEEP team, identify outstanding issues • Check off equipment boxes • Seek and make purchases • Inspect DSP • Inspect replica – oversee modifications • Plan refinements
	1	Sat 31May	Mobilisation of DSV day 1. AE2CF DSTO Team arrive Turkey, travel to Tuzla. Weather: Showers, heavy pm with thunder. 21C.	• Inspect DSV • Commence kit preparation • Establish Shore HQ, comm's, net access

	2	Sun 01Jun	Mobilisation of DSV day 2. Weather: Showers, heavy pm with thunder. 21C	• DSV preparations (dive bell, generators, containers, workshop, ops room, • DSTO prepare gear on board DSV • Hunt down additional gear
	3	Mon 2 Jun	Mobilisation of DSV day 3. Embarkation of AE2CF team and equipment	• DSTO prepare gear on board DSV • Plan refinements • Address outstanding issues:, nav buoy, hatch preservation.
	4	Tue 3 Jun	Mobilisation of DSV day 4, embarkation of AE2CF team and equipment	• DSTO prepare gear on board DSV • Plan refinements • Dive permit issues – resolved • Replica barge issues resolved
	5	Wed 4 Jun	MRTE Phase 3 Day 1 Weather: Heavy showers, with thunder pm. 22C. ABC TV news telephone i/v Peter Briggs. Weather: Showers. 21C	• Diver brief • Replica deployed • Drop camera demo and training • Pole camera demo and training • Cross beam demo and training • Top Hat demo and training • ROV trials and bottom search
	6	Thu 5 Jun	MRTE Phase 3 Day 2 SeaBotix team arrive Tuzla. Weather: Showers pm with thunder. 22C	• Pole camera trials (dry) • Auto pole camera trials (dry) • ROV Trials • Install DSP
	7	Fri 6 Jun	MRTE Phase 3 Day 3	• Drop camera trials (wet)

				• ROV flight trials (wet) • Recover DSP to DSV
				• Recover replica to barge
				• Advanced Party Tuzla-Sarkoy (Peter Briggs, Roger Turner, Umit) to Sarkoy
	8	Sat 7 Jun	DSV overnight passage to Karibiga	• Fuel, water ship, transit to Karibiga for inspection by Harbour Master and issuing of final sailing approval. • am DSV held off Karibiga awaiting a berth • pm Completed formalities sailing approval issued. • DSV remained in Karibiga o/n, prepare moorings for laying
Day	**Date**	**Task**	**Actions**	**Photo Record**
MAA Day 1	Sun 8 Jun	Locate wreck	• 0600 Marked position of AE2 with FCB and hand held GPS.	
			• 0730 commenced laying 4 x mooring buoys. • 1025 4th buoy laid. • 1212 ship moored using 4 x soft lines to the buoys • 1230 adjusted position using GPS coordinates to position diving bell alongside conning tower at. Sunny. Sea State: calm, wind calm	

		Initial ROV Survey	• 1404 ROV entered water • 1410 located AE2 • Low current on bottom, excellent visibility, conning tower clear of lines/nets, • External fly-by survey complete.	D1 ROV1 Approach, survey.mov D1 B1 GP000241 First Approach.mp4 D1 B1 GP010241 Survey.mp4 D1 B1 GP020241 Bell clump.mp4 D1 B1 GP030241 Bell&survey.mp4 D1 B1 GP040241 Parked fin.mp4 Duplicated: ROV1 &2 Viewable (mp4 converted)
		DSP Installation Attempt 1	• Diving Support Platform lowered over fin and located with ROV guidance and nudging. • Divers inserted for final adjustment. Although within 50cm of final position the crane could not plumb an acceptable point. Attempt aborted at 1800.	D1 ROV2_1 DSP Attempt 1 D2 ROV2_2 DSP Attempt 1 D2 B2 GP000245 D2 B2 GP010245 D2 B2 GP020245 D2 B2 GP030245 D2 B2 GP040245 D2 B2 GP050245
MAA Day 2	Mon 9 Jun	Detailed survey	Wind Fce 3-5, Sea State 2-4, Sunny, good vis. Too windy for crane ops DSP installation deferred • am ROV detailed survey on three levels • identify anode connection sites • pm medevac exercise complete	D2 ROV 1 External Survey 1, Dive 1 D2 ROV 2 External Survey 2, Dive 2 D2 GP000246 Upper level survey D2 GP010246 Mid-level survey D2 GP020246 Lower level survey
		Hatch clean	• Inserted dirt catcher (The DEEP Sausage) • Clean debris away from hatch area	D2 ROV 3 Hatch Clean.mov

			• Take debris sample (proved to be all marine growth, no concretion). • Corrosion meter reading not practical (no bare metal) • Take photo-record of cleaned hatch area (ROV images are quite sufficient without taking stills)	D2 GP030246 hatch clean.mp4
MAA Day 3	Tue1 0 Jun	Installation of DSP	• Locate plumb 22cm aft of fwd periscope • Load DSP lower into position • ROVs to visually guide the DSP positioning and tug the DSP into alignment	D3 ROV1 Crane plumb D3 ROV2 DSP Installation
			Weather Sea state 0 calm, light airs, bright sunshine. • Visual inspection of upper conning tower hatch using diver helmet cam - satisfactory inspection. • Obtained three Corrosion Meter readings in vicinity of upper conning tower hatch – 0.633 and 0.630 satisfactory data. • Concretion sample obtained from same location as above. • Fluid sample obtained from under dome of upper conning tower hatch. • Continued cleaning area around upper conning tower hatch in particular hinges.	D3 Dive Cam CP Readings Hatch and fin D3 Dive CAM Concretion 1
		Drop Camera insertion attempt 1	Weather unchanged. • Task 1 Attempted to insert Drop Camera into upper conning tower hatch. Frustrated by aperture being slightly smaller than expected i.e. less than 100mm. Despite valiant efforts of the diver the camera could not enter aperture	D3 Diver Hatch Cut1 D3 Dive Cam CP Readings Hatch and Fin D3 Dive Cam Attempt 1 Dive 1

			• An obstruction (probably strength web) on the underside of the upper lid also obstructed the entry. This handle was not observed or identified during the previous expedition, nor is it shown on the drawings available to us. Unsuccessful serial took the entire dive time. • After consultation with Tim Smith and Nigel Erskine about the conservation issues, it was agreed with the DEEP Contractor, Ali Uzunoglu that the following actions would be taken: • Cut the hatch securing stirrups holding the hatch open using a hydraulic disc cutter. The presence of oil under the dome of the upper hatch made the DEEP divers wary of using a flame lance. • Stirrups partially cut at end of dive serial. • Some images obtained from under hatch	D3 Drop Camera Insertion Attempt 1 Dive1 D3 Drop Camera Insertion Attempt 1 Dive2 3 Diver Hatch Cut1
MAA Day 4	Wed 11 June	Prepare hatch	Weather good. Seas calm, light airs from the south west, visibility 20km+. Underwater visibility 20m+ no current. • Seabotix Slave ROV check run satisfactory. New Seabotix operator Alex briefed. • Dive 1 successfully cut the remaining three stirrup bars on the upper conning tower hatch using hydraulic disc cutter. • Hatch moved by hand to increase opening by some 3 cm. Upper bearings of stirrups remnants swung freely. Augurs well for hatch opening with jack during next serial. • Prepare for next serial when diver will insert drop camera.	D4 Divers Cam Hatch Stirrup Cut 2

			• Drop Camera successfully inserted. Equipment functioning well and satisfactory technical images recorded inside the control room; however visibility in the tower was poor due to the debris thrown into the tower by the hatch work. With images obtained being of limited value. The observations inside the tower were curtailed and the drop camera was lowered into the control room. • The water quality data was recorded by the instrument pod on the end of the drop camera string during the descent. The data will be recovered when the camera is recovered. • Images were then recorded inside the control room. Visibility was better (up to 1m) and some sediment has settled; some additional debris evident on ladder steps during serial. Best images from upper half of CR where there is less silt on vertical surfaces and better reflectivity. • Lower half had poorer images attributed to more silt on painted surfaces obscuring reflectivity. • Drop camera left in CR. • Seabotix opinion is that low power thrusters in ROV should not cause a problem with silt stir-up.	D4 GOPRO251 to 253 D4 Diver Preps D4 GOPRO254 Drop camera in, bunts and shining D4 GP010254 to GP020254 Drop camera ops, shining. D4 GP040254 Drop camera ops and bunts. D4 Drop Cam 1 CR Upper Level.mov D4 Drop Cam 2 CR Lower and upper.mov D4 Drop Cam Vent mtr.mov D4 Divers of Drop Cam Ops 1 D4 Divers of Drop Cam Ops 2
			Weather unchanged. Thunderstorms passing on either shore.	

MAA Day 5	Thu 12 Jun	Drop camera removal	Weather excellent. Sea calm light airs. visibility above water 20k+, in water 20m+ • Visibility inside CR had continued to improve, however camera lost power when diver rotated the protective spring. • Dive 1 Drop camera recovered. Faults being pursued. • All tools recovered from conning tower hatch site. • Water quality sensor recovered. Data up- loaded. Proved satisfactory.	D5 Drop Cam 3 Final Prior to Extraction D5 Divers of Drop Cam 3 Removal
		CPS Pod 2 Positioning	• CPS Pod 2 laid in position abreast fin port side. SeaBotix ROV proved essential to directing the operation and used to slip the crane shackle. • Crane was unable to plumb the stern CPS Position 3. • The experience shows that calm weather is essential when manoeuvring heavy weights in close proximity to the submarine. • The defect on the drop camera has a fault causing power failure to the upper lighting module. Disconnecting the light renders the the remainder of the camera configuration serviceable for pole cam.	D5 ROV Anode Pod 2 Deploy
		Hatch Opening	• Dive 2 - inserted jack and elevated hatch to approx. 60 degrees reaching the limit of travel for the jack. 12/15mm line attached to stirrup [which was swinging freely] and attempted to open hatch further using manpower. • Bunts very evident in hatch opening, disappeared	D5 ROV Hatch Jack Ops

			when diver approached. Divers are circumspect when near the hatch: it is apparent that they are wary of Bunts.	
		Hatch Opening	Weather unchanged. • Dive Serial 3. Task 1 Hatch opened with chain block and additional tension from 15mm fibre rope on stirrup. • Hatch opened to 85 degrees then settled back. Diver reports hatch now moves by hand. Secured in open position by 15mm line at about 75 degrees open. Operation recorded on diver cam and ROV. There is a massive build-up of silt, shell and concretion behind hatch to a depth of about 25 - 30 centimetres, • Presently manipulating fibre line on jack to clear the hatch opening ready for first Serial tomorrow to insert polecam.	D5 ROV Hatch and Chain Block D5 ROV Hatch Opening D5 Divers Hatch Opening 1 D5 Divers Hatch Opening 2
MAA Day 6	Fri June 13	Prepare Pole Camera	Weather excellent. Seas calm. Light airs. Visibility above water 25km, underwater 15m Current stronger than before. • Ship's position successfully adjusted to lay Aft Pod and confirmed by ROV. • Aft Pod successfully placed in position adjacent to port after hydroplane by crane as directed by ROV. • Ship moved back to its original position. • Dive 1 Hatch secured back in open position - 80 degrees; no further movement possible, silt and shell deposits behind hatch appears to prevent further	D6 ROV Anode Pod aft install

			movement. • Jack removed, tools including sausage removed. • Cross beam supports moved into position ready for insertion of cross beam in next serial. • Dive 2 Divers prepared DSP for pole cam. Two divers involved. Fine adjustments precluded final insertion of pole cam however crane position was marked ready for first serial tomorrow. • ROV camera assisted direction of cross beam, supplementing diver cam.	D6 Divers jack removal D6 Divers Cross beam install D6 ROV Pole Cam attempt 1 D6 ROV Pole coupling D6 ROV Pole lowering
		Meeting with Istanbul Naval Museum	• Peter Briggs, Frank Shapter, DR Nigel Erskine and Umit Kucukoglu met Captain Ilyas Gultas the recently joined Commander of the Museum. • The meeting was cordial the Commander was very interested in the project and Conference. • He was pleased that the wreck was to be left in situ and that the hatch would probably not be removed.	
		Meeting with Sea Safety Directorate	• Peter Briggs and Umit Kucukoglu met with Captain Olcay Özgürce the acting DG. • Sea safety was happy to take ownership of the buoys approved for their long term maintenance, ‘don’t worry about them, we will look after them’.	
		Meeting with Ministry of Culture & Tourism Ankara.	• Dr Harun Ozdas met with officials from the MoCT in Ankara to update them on the project and discuss clearance of images and media release. • The Ministry officials were happy for the release to proceed.	

MAA Day 7	Sat 14 June	ROV Insertion	• Dive Serial 1 Task 1 ROV Pole deployed to DSP with ROV fitted and secured by cable ties. • Diver manoeuvred ROV pole into position and cut cable ties. The ROV was a tight fit and required much manipulation to fit through the upper conning tower hatch. • Visibility in the tower is poor due to disturbed silt, however a telegraph could be discerned. Diver time on task finished with the ROV at the lower conning tower hatch opening with sonar projecting through into Control Room. • Visibility is rapidly improving and many details now very evident, flag locker with plimsolls, engine room telegraph and rod gearing very clear; possible porthole glass on deck. I think we have the 'wow' images.	D7 ROV Pole Lowering D7 ROV Pole Insert 1 D7 ROV Pole Insert 2 D7 ROV Conning Tower D7 ROV Rear Camera D7 Diver ROV Insertion D7 Diver ROV insertion MPG
			• More details in the tower now becoming apparent as the silt settles; high lights include compass repeater, steering wheel and possibly the 'light pipe' from the magnetic compass has fallen down.	D7 ROV Conning Tower 2
			• Diver Serial 2 Task 1 Divers attempted to insert the ROV pole into the Control Room, however the orientation of the ROV was not aligned to the optimum for ease of entry, and it may be catching on the lower lid securing dogs or hatch operating mechanism, noting that the concretion has reduced the clearance of the SeaBotix ROV so that the expected 10mm clearance is significantly reduced.	D7 ROV Bottom Hatch D7 Divers ROV Bottom Hatch

			• Intend using Diver Serial 3 to retract the polecam slightly and to eased the tether tension so that the ROV can rotate using its thrusters. • Due to pain on a diver who has completed surface decompression, RCC treatment procedure was applied and the third dive of the day rescheduled for tomorrow. • Moving the ship to a position to lay the last CPS pod is not an option as the ROV is not available to recover the ROV shackle pins.	
MAA Day 8	Sun 15 June	Remove ROV	• Dive Serial 1 Task 1 Divers manipulated pole and tether was tensioned, maximum power from ROV thrusters, however ROV did not move. It is stuck in the lower conning tower hatch.	D8 ROV Hatch Stuck CV D8 ROV Hatch Stuck HD
		Deploy Midships CP Cables to DSP	Weather moderated, winds have dropped to 15 - 20 knots direction unchanged, SS2, visibility unchanged. • Dive Serial 2 Task 1 diver used an improvised boat hook fitted with camera and light to dislodge ROV from lower conning tower hatch. ROV now free in conning tower conducting a detailed survey of tower. Half of bridge steering wheel identified in tower. • Revised plan for DSTO ROV insertion developed. Intend next dived serial to recover pole and ROV from conning tower and to progress preparation of central CPS attachment site, deploying CPS cables to DSP.	D8 ROV Boathook removal D8 ROV Conning Tower Survey D8 ROV Tether and ROV Retrieval D8 ROV Top Wheel in Conning Tower

MAA Day 9	Mon 16 June	Lift in Fwd Pod	Weather poor. Sea State 3-4 with a swell height to 1 m , wind 15-20 knots from the NNW by N. Visibility 15 k underwater 7 m current stronger @ about 1.5 knots. • Task 1 Ship moved to position to lay forward CPS, uncertain results from GPS meant that the dive bell position was too far from forward CPS cable attachment points. [Speculate that crane boom location may affect GPS locations]. • CPS laid on starboard side of submarine, wave motion made recovery of keep pin and shackle pin difficult for ROV, however skilled operator was successful. • Task 2 Adjusting ship's position to ensure dive bell is in better location for work on forward CPS.	D9 ROV Fwd Pod 1 Lowering D9 ROV Fwd Pod 2 Uncoupling (Minute 09.51) D9 ROV Fwd Pod 3 Static VIP Party A visit DSV am VIP Party B visit DSV pm
			Weather has improved; wind has moderated to Force 2 - 10 knots decreasing. Sea State 2-3. Swell still 1m decreasing. Visibility above water 20k, below water unchanged, current still strong wave motion still evident affecting ROV. • Dive Serial 1 Task 1 ROV guided diver to forward CPS Attachment site. Diver cleaned site with 'barnacle buster' quite quickly. ROV moved to Anode block to guide diver. Diver attempted to deploy cable however ROV tether became foul on Anode block and delayed provision of guidance to diver reach work site. Diver work time expired with cable not deployed. ROV tether cleared.	D9 Divers Fwd Pod Install 1

			Weather continues to moderate. Bright sunshine. breeze now 10 knots decreasing, Vis unchanged from last report. • Ship has moved and is now better positioned with bell between CPS Pod and work site. • DSTO LBV systems tested and correct. Final adjustment to buoyancy being made now.	
		Connect Fwd Pod	Weather continues to moderate. • Dive Serial 2 Task 1 Cables connected to forward CPS connecting point by diver successfully. • Task 2 CP readings taken .654 and .656. Serial complete. • We will move ship back adjacent to conning tower now. DSTO ROV is in all respects, ready for sea	D9 Divers Fwd Pod Install 2
		DSTO ROV Insertion	• Dive Serial 3 Task 1 Diver guided DSTO ROV mated to modified pole into mounting cup on DSP cross beam and lowered the assembly into the Conning Tower and into the Control Room. • All systems on ROV are working correctly and a preliminary exploration of the Control Room was undertaken as far forward as the Aux Switch Board. Identification of AE2 systems has commenced. • Some difficulty has been experienced with tether management within the Control Room. • ROV has been recovered to trumpet mount on pole at control room hatch and will be shut down for the night. Data backup has commenced.	D9 ROV Control Room Survey Stbd Aft D9 AE2 Internal 100 Gopro GPO20130.mp4 Stunning shots, eg Elliot Brother Log at minute 18.22.

MAA Day 10	Tue 17 June	LBV Control Room Survey	Weather very good. seas calm slight swell from the NNW. Visibility 12 k, underwater 5m on the bottom 15 m at 50m , current stronger 2kn. • Ship moved to aft position with aid of ROV. • DSTO ROV systems checked correct, ops normal, continued systematic survey of Control Room, excellent images being recorded, identification of features progressing well. • Dive Serial 1 - 1 CPS cables deployed to port after hydroplane, thickness checked and found suitable for cable clamps. Barnacle Buster deployed ready for next Dive Serial	D10 ROV LBV Control Rear D10 ROV LBV Control Forward D10 ROV LBV Control Forward 2 D10 ROV LBV Control Forward 3 D10 ROV LBV Port to home D10 ROV LBV Stbd Side Officers
		Connect After Anode Pod	• Dive Serial 2 Task 1 CPS sites cleaned. 1 cable connected. Second cable connection proved difficult and will require another dive serial to complete as a new CPS site has to be prepared and the connection made there.	
			• Dive Serial 3 Task 1 Successfully connected second CPS cable clamp to the after hydroplane. • CP readings from aft position - 0.677 and 0.666 • Ship moved back to the conning tower position ready for the CPS cable connections in the first Dive Serial tomorrow.	D10 Divers Rear Anode Pod D10 Divers Rear Anode Pod 2 D10 Divers Rear Anode Pod 3
MAA DAY 11	18 June 2014	LBV Midships Tubes Survey	Weather very good. Sea Calm, slight swell from the SSW. Light airs. Visibility above water 20k below water 10m, • ROV internal survey of midship tubes area in progress. Clear visibility. • Task 2 ROV checked position of bell clump weight. Excellent position above DSP. ROV	D11 ROV LBV Stbd Rear D11 ROV LBV Rear 2

		Prepare and connect midships anode	recovered. • Dive Serial 1 Task 1 Cleaned both CPS Sites on forward and after periscope standards with Barnacle Buster. • CP readings taken 0.680 and 0.676. • Connected both CPS cables.	
		Recover ROV	Weather unchanged. • Dive Serial 2 ROV successfully recovered from submarine. • Go Pro camera recovered from ROV. It has excellent images. • Began preparation of DSP for recovery and insertion of Drop Cam and Aris sonar in next dived serial	D11 ROV LBV Removal D9 AE2 Internal 100 Gopro GPO20130.mp4 Etc. Stunning stuff
		Insert Drop Camera and Aris	Weather. Wind veered to the NNW and increased to Force 2. Sea State 2. Visibility unchanged. • Task 1 Drop Camera with Aris sonar inserted and 3 rotations obtained, all assisted by the ROV. Drop Camera recovered.	D11 Drop Aris insert D11 Drop Aris insert 2 D11 Drop Aris Insert 3 D11 ROV Drop Aris Insert D11 ROV Drop Aris Insert 2 Aris sonar images in D11 AE2 Aris
		Fit Top Hat Recover DSP Final Survey	• Dive Serial 3 Top Hat successfully fitted of Top Hat successfully completed. • Task 2 Recovery of DSP successful. Portion of a trawl fouled a leg of the DSP and came up with it. • Task 3 ROV Survey of submarine completed as observed by Dr Harun Ozdas. Ship clear of expedition equipment. Corrosion products evident on	D11 Divers Camera x 3 D11 ROV DSP Removal D11 ROV2 Final Flyover

		Lay Temporary Nav Buoy	CPS Anode Pod first laid on 13 June [5 days ago]. • Task 4 Ship shifted position to lay temporary navigation buoy. • Task 5 Laid temporary buoy in position details provided separately. • Task 6 Ship returned to conning tower position	D11 ROV2 Buoy Inspection D11 ROV2 Buoy Inspection HD

Highlight Log

First approach	D1 ROV1 Approach	14.07
Climb the fin	D1 ROV1 Approach	14.10
Hatch opening	D1 ROV1 Approach	14.19
Forward periscope pedestal and fish	D1 ROV1 Approach	14.20
After planes	D2 GP020246 Lower Survey	25.01
After torpedo tube	D2 GP020246 Lower Survey	25.55
Diving bell ops	D5 ROV Hatch Opening	2.45
DSP Installation	D3 ROV 2 DSP Install	9.48
DSP Foot dropping into silt	D3 ROV 2 DSP Install	9.50
Bunts	D4 GOPRO254 Drop Camera in, Bunts and Shining	11.02
Drop Cam going in	D4 GOPRO254 Drop Camera in, Bunts and Shining	16.00

Lights – the shining	D4 GOPRO254 Drop Camera in, Bunts and Shining	16.27
Camera rotation	D4 Divers of Drop Cam Ops1	19.36
Ladder	D4 Drop Cam 1 CR lower and upper level	5.07
Stbd Ballast Pump Suction and Discharge Gauges	D4 Drop Cam 1 CR lower and upper level	5.52, 7.40
Sweep	D5 Drop Cam 3 Prior to removal	7.40
Drop Cam removal	D5 Divers of Drop Cam 3	
Bunts	D5 Divers hatch opening	5.08
Hatch opening	D5 ROV Hatch Jack Ops	00.00
Jack and Hatch	D5 ROV Hatch opening	31.28
Open Hatch	D5 ROV Hatch opening	31.59
Open hatch	D6 Divers Jack Removal	15.40
X-beam installation	D6 Divers Cross Beam Install	07.06
Bell descent onto DSP	D7 Diver ROV insertion	05.02
Crane signals to insert ROV pole	D7 Diver ROV insertion	06.54, 9.10, 9.43
ROV entering upper opening	D7 Diver ROV insertion	14.26, 20.0,
Conning Tower Survey	D8 ROV Conning Tower Survey	Many options close ups of inside of tower
Control Room	D9 ROV Control Room Survey Stbd Aft	Log, 18.22, Aux Switchboard

Day 10 and Day 11 files include a wide variety of stunning images from inside and outside the wreck. Will require much work to analyse and catalogue.		

INTERIM SCIENTIFIC REPORT

Dr Roger Neill, DSTO

INTRODUCTION

1. The scientific program that was developed to support this project aimed to significantly enhance the knowledge of the AE2 submarine, while minimizing the impact upon the vessel. Where it was impossible to avoid disturbing the vessel in the course of scientific investigations, every effort was made to record or measure what was done, so that the likely long-term impact of the activity can be assessed.

2. The general objectives of the science program were to:

a) Collect essential information to enable assessments to be made of the state of the vessel from a corrosion protection perspective;

b) Make an assessment of the environment inside the submarine, to see whether it is reflective of the outside environment or of a 'micro-environment';

c) Gather data which can be used to make assessments of the change in the physical state of the submarine since it was last studied in detail in 2007;

d) Collect detailed archaeological information from inside the boat, enhancing the knowledge of the state of preservation of the vessel plus building upon the knowledge of how submarines were operated in the early twentieth century; and

e) To develop methodologies and representative technologies that may be applicable for use in other relevant research programs.

3. This is a preliminary report, so in several instances detailed analyses of results is yet to take place. The intention here is to give the reader an appreciation of the planned outcomes of the scientific program.

PLANNED SCIENTIFIC METHODOLOGY

Baseline Measurements.

4. The overall strategy developed for this program was one of 'progressive intrusion' into the AE2. Thus, in the first instance baseline measurements would be made of the environment before the site was disturbed in any measurable way. These measurements comprised:

a) Visual surveys of the outside of the wreck using a Remotely Operated Vehicle (ROV).

i. Data gathered would allow an assessment to be made of the general physical condition of the vessel's exterior.
ii. The survey would also allow assessments to be made of the relative state of burial of the boat, compared to its status in 2007.
iii. In addition, some differences had been noted between the flora and fauna of the site as observed in 1998, 2007 and a preliminary ROV survey undertaken in October 2013.
iv. This more detailed survey would support further analysis of these differences.

b) Assessment of the physical properties of the environment.
   i. A YSI EXO1 water quality sonde was used to measure the properties of the environment immediately adjoining the submarine.
   ii. This instrument measures: conductivity, temperature and depth (yielding salinity as an incidental measure); dissolved oxygen; pH; and oxidation reduction potential.
   iii. The device was strapped to a remotely operated vehicle and delivered from the sea surface to a position in close proximity to the submarine, thus a full-height profile was recorded for the full water column.

c) Low-impact Insertion of sensors inside the submarine.
   i. A system was developed to enable the sonde to be inserted into the submarine through the partially open upper hatch, along with a high definition camera and two lighting arrays.
   ii. This was known as the 'Drop Camera' system.

5. The design enabled divers to insert the system into the submarine, lower it to various depths inside the boat and rotate the camera. The design brief was for all of this to be achieved without the need to disturb the upper hatch. As this would minimize disturbance to the environment inside the boat, it represented another baseline measurement. Because the submarine was believed to be a relatively 'closed' environment, there was some possibility the properties of the water inside the boat may be quite different from those of its surroundings.

Measurements Involving Minimal Disturbance to the Submarine

6. Having undertaken the baseline study of AE2, the next step was to take a set of measurements that did require some disturbance to the boat.

7. A set of representative sites were selected to take corrosion potential measurements. Corrosion potential readings give a measure of how well protected the vessel is from degradation due to corrosion. This required cleaning concretion from the sites and application of a measurement probe to the cleaned surface. These readings comprised the final set of baseline measurements, to be used in the long term in monitoring the effectiveness of the cathodic protection system (planned for installation as part of this mission).

8. The upper hatch of the submarine was scheduled to be opened to enable insertion of a more complex sensor suite than could be incorporated into the drop camera. This system added an ARIS 3000 scanning sonar, plus a more sophisticated insertion and rotation system, to enable the instrumentation to be more precisely controlled. This system was dubbed the ‘Pole Camera’.

9. The aim was to use the sonar data to support the development of a digital ‘wireframe’ model of the conning tower and control room and to drape video imagery over that model. This would provide a precise model of these spaces *as built*. DSTO previously developed a virtual equivalent of this, based upon the general arrangement drawings of the submarine. It is of great interest to compare the two models. Apart from the fact the hatch would have been opened, this was still designed to be a relatively minimal disturbance evolution. The system carried no propulsion system and its cross sectional area was relatively small in comparison with the area of the submarine’s access hatches, hence it would be expected to cause minimal disturbance, both during the insertion process and while being deployed inside the boat.

Measurements Involving Insertion of an ROV

10. The proposed final step in the survey process was to use a ROV to survey the space beyond the vicinity of the lower hatch. Because the ROVs use a propulsion system, they will inevitably cause some disturbance of the environment. Specifically, it was expected that the wash from the vehicle’s thrusters would cause mixing of the water within the submarine. Careful ballasting of the vehicle was planned to ensure it was as close as possible to neutrally buoyant, hence minimizing the need to use thrusters to maintain station in the vertical plane.

11. The ROV which was planned for use in this exercise was a specially-configured SeaBotix VLBV, configured to fit through the two hatches. This vehicle was fitted with a high definition camera system and an ARIS 3000 sonar. The plan was to undertake the survey by undertaking a progressive advance into the interior of the boat. The planned sequence of advance was to first survey the spaces in the boat that represented the least risk to the ROV, and then move to spaces that were believed to contain a higher concentration of fouling hazards. Thus the planned sequence of the survey was to cover the control room; then forward to the wardroom; next, presuming the hatchway is open, the forward torpedo room would be entered; the vehicle would then return to the starting point at the conning tower hatch before moving aft, surveying the midships torpedo room; and then the midships petty officers’ mess and workshop would be investigated. This would bring the ROV to the aft bulkhead. A number of crew member’s diaries state that this hatch leading to the engine room was dogged shut. Thus it was of particular interest to investigate whether the aft half of the boat could be accessed.

12. The main objectives for this part of the operation were to locate and identify as much of the ‘fabric’ of the boat as possible. This included installed machinery and fixtures, any equipment (instruments, tools etc) that may be

scattered throughout the boat, plus personal effects of crew members. It was hoped that the survey, combined with the results from the pole camera survey, would enable the science team to:

a) learn more about how a submarine was operated in the early twentieth century;
b) Provide an insight into what life was like for the crew of AE2, specifically during the final week of operations; and
c) Provide better understanding of the nature of the sinking of the boat.
d) Of particular interest to the team was to identify items or systems for which archival searches provided little or no information. Obvious items of interest were the wireless telegraphy set and the gyro compass.

Other Planned Measurements

13. In order to gain a preliminary indication of the effectiveness of the cathodic protection system, post installation, it was proposed to take a further set of corrosion potential readings immediately prior to departure from the site. This would enable the corrosion team to check performance of the system against predictions.

14. Lastly, if time permitted, it was proposed to record a final water property profile from inside the submarine. By making comparisons with the baseline data, this would give an indication of the impact of operations upon the internal environment.

RESULTS

15. This interim report describes the status of the various scientific activities at the time of writing. Work is ongoing and will be for some time - hence this report doesn't attempt to present data in final form, nor does it draw final conclusions.

16. In the course of the expedition, a number of physical challenges and technical issues had to be addressed and overcome, as is described below. The Sea of Marmara is not a controlled laboratory and inevitably, in the process of meeting these challenges, modifications and compromises had to be made with regards to the scientific program. The indications from preliminary analyses, nevertheless, are that the majority of the scientific objectives of the expedition can be deemed to have been met.

Baseline Measurements

17. The visual survey undertaken by the ROV indicated that AE2 is substantially unchanged relative to the 2007 survey, although in some places holes in the casing that were evident in the earlier survey had become considerably larger. In one or two places substantial areas of concretion appeared to have either been knocked off the boat, or corrosion processes had caused exfoliation of the corrosion layer. One example was a patch of

bare metal at the stern. Undoubtedly the corrosion team will be commenting upon these sites.

18. The ROV carrying the YSI sonde undertook two return excursions through the full height of the water column. As can be seen below, the dissolved oxygen profiles show good repeatability and the halocline, extending between approximately twenty and thirty metres depth, is very evident. The very significant reduction in measured dissolved oxygen levels as the instrument approached the submarine is of particular significance for the submarine in terms of its long-term wellbeing. Other measurements delivered by the instrument showed similar relative repeatability and were consistent with reasonable expectation for this environment.

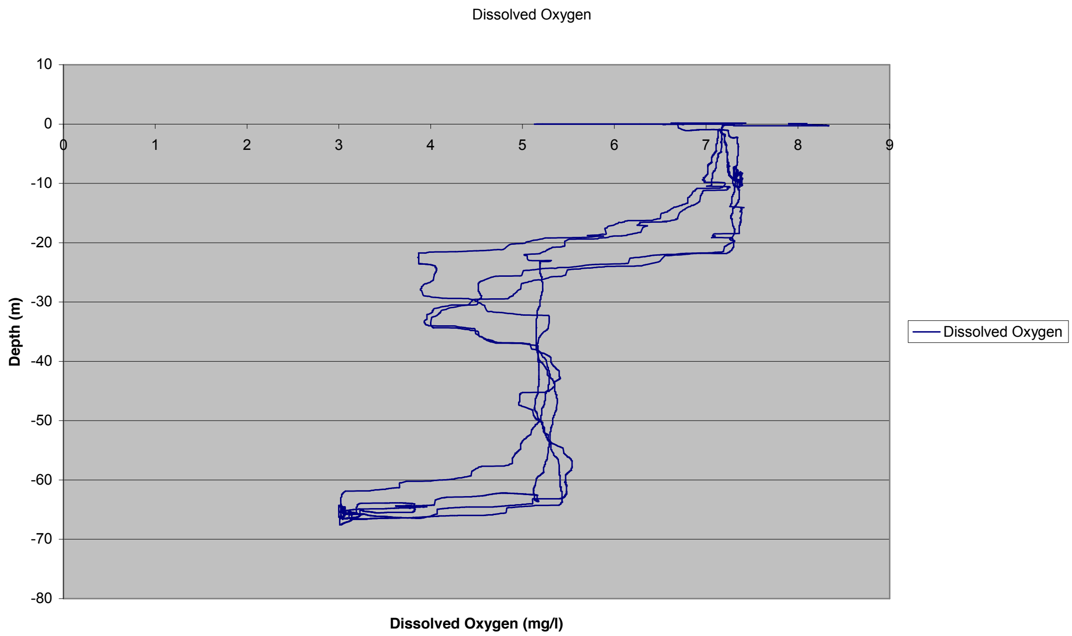


Figure 1 Dissolved Oxygen Profile Obtained by YSI Sonde

19. Insertion of the Drop Camera proved to be more difficult than was initially anticipated. The 2007 drop camera, which had a diameter of 8.5 centimetres, was inserted into the submarine with no difficulties whatsoever. Divers at the time stated there was approximately 3 centimetres clearance for that camera, so the decision was made to build the 2014 drop camera system around a maximum diameter of 10 centimetres. What was not known was that, just inside the hatch, there is a strengthening web in the casting which would significantly impinge upon the hatch opening. Hence when an attempt was made to insert the system, while the sonde and the first lighting module could be inserted into the opening, the camera simply would not fit. The only alternative was to develop a procedure for the divers to follow which would enable the hatch to be opened slightly. The plan, which proved to be achievable, was to force the opening by the smallest amount needed to permit insertion of the camera, thus causing relatively minimal disturbance to the environment.

20. On the second attempt the system was successfully installed into the boat, with the sonde being lowered to the level of the battery tank. The lighting array proved very effective in providing uniform, soft light for the interior, hence excellent video imagery was able to be recorded. On this occasion the diver exhausted his time on the bottom so the system was left inside the submarine overnight.

21. On the next morning the plan was to take advantage of improved visibility inside the submarine (because material disturbed during the insertion process had settled out of the water) and undertake a further set of video sweeps with the drop camera. Unfortunately, shortly after commencing the sweep, a leak in one of the lighting modules caused the system to protect itself by powering down, so the evolution was aborted and the system was recovered.

22. The YSI instrument had been collecting data overnight, resulting in a very large data file being stored on board the instrument. The software supplied with the instrument, which must be used to convert the data from proprietary format to a form which can be exported to standard analysis packages, has to date proven unable to cope with a data file of this size. The Australian agent for YSI is currently seeking a solution to the problem.

<u>Measurements Involving Minimal Disturbance to the Submarine</u>

23. The initial external survey was used to confirm that the initially-suggested sites for attaching the anode arrays were potentially viable. The next step was to clean concretion from these candidate sites and ensure valid corrosion potential measurements could be taken. This was done and the results at each site proved to be very consistent. These results are discussed in Annex E. As a result of this process being undertaken the sites were confirmed as the favoured locations for attachment of the anode pods.

24. After successful opening of the upper hatch, the plan was to insert the Pole Camera system. During the course of the ‘set to work’ of the system after it had been reconfigured from Drop Camera to Pole Camera configuration, it proved impossible to get the ARIS sonar to communicate with the rest of the system. Diagnostic procedures revealed that the interconnect cable between sonar and the Ethernet connector inside the camera module had been wired in a way which was incompatible with the sonar. This required rewiring and repotting the cable connector, which would delay the operation by at least 36 hours. Hence it was decided to hold this operation over until the end of the survey.

25. In the event, time pressures prevented the Pole Camera operation from being undertaken in its planned form, but a considerably ‘cut down’ form of experiment was undertaken on the last operational day of the survey. In this form, rather than using the rigid pole arrangement, the steel spring that was a part of the drop camera system was used to support the camera/sonar/lighting rig, as shown below. This system was able to be inserted into the submarine using the ship’s crane to support it and the ROV to guide it. The ROV proved

capable of rotating the system by using the vehicle's grabber to attach to the upper end of the spring. Three heights within the submarine control room were surveyed. While no analyses of these data have been undertaken as yet, it is believed the data set is of sufficient quality to assess whether this form of sonar data could be used to support development of a digital 'wireframe' of a space such as the submarine control room, should the opportunity arise in future.

Figure 2 Modified Pole Camera with Aris Sonar Unit

Measurements Involving Insertion of an ROV

26. The 'miniaturised' version of the VLBV vehicle was set to work and proved to be in all respects seaworthy. The vehicle was then mated to the insertion pole and the insertion operation initiated. The diver was able to pass the vehicle through the upper conning tower hatch, albeit with some difficulty. The vehicle was then lowered to the level of the lower hatch, whereupon it got thoroughly jammed. As the diver's evolution was complete there was no choice but to leave the vehicle in place until the next day.

27. On the following morning the vehicle remained jammed and no amount of shunting with the vehicle's own propulsion system would move it. An attempt was made to jerk the vehicle free by pulling on the tether from the surface, but once again the vehicle wouldn't release from the hatch opening. A camera was therefore attached to a long boat hook and a diver sent down to attempt to free the vehicle using the imagery from the camera to guide him via communications from the surface. This operation was successful, but again the diver ran out of time and had to leave for the surface, with the vehicle free-floating but still inside the conning tower. This proved to be rather

fortuitous as the ROV undertook a detailed survey of the space, which provided the team with a wealth of information. The high definition camera system on the VLBV worked very well and provided some of the best imagery of the mission.

28. At this point it was decided that there was no prospect of successfully installing the VLBV into the submarine's control room. The alternative was to reconfigure the smaller DSTO LBV vehicle, arranging for it to be installed 'nose-first' and then allowed to reorient to its normal horizontal attitude once it had been inserted into the boat. In the course of the next 24 hours the vehicle was physically reconfigured, had a high definition camera installed, re-trimmed to be neutrally buoyant at 70 metres depth, interfaced to the insertion pole and tested. The modified vehicle is shown in Figure 3 below:

Figure 3 Modified LBV ROV

The DSTO vehicle was successfully installed into the submarine and it was operated for three consecutive days inside the boat. The image below is one of the first views the vehicle revealed – the starboard side ballast pump and controller. During the time the vehicle was inside the boat the control room, Officers' Quarters, forward torpedo room and some of the midships space were surveyed. Unfortunately the threat of bad weather then caused operations to be curtailed.

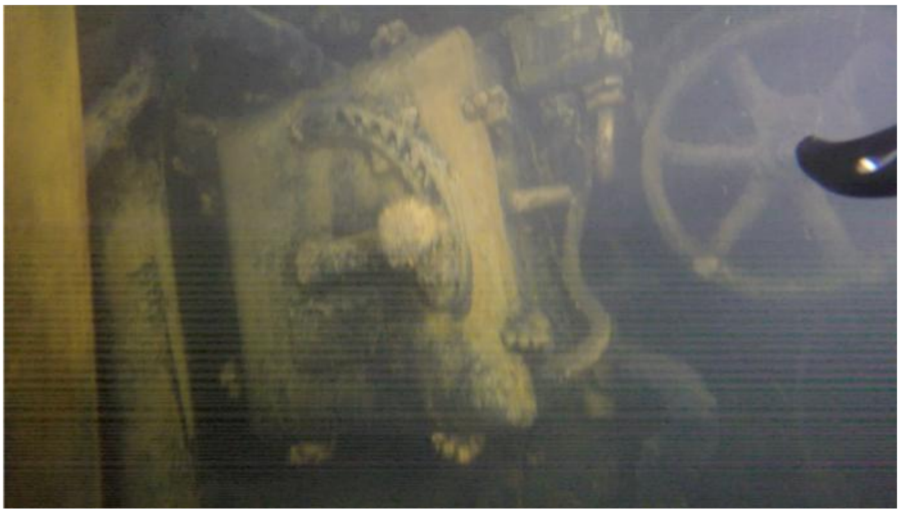


Figure 4 The First Images - Starboard Ballast Pump Controller

29. While the DSTO ROV was being reconfigured a vigorous debate was used to weigh the pros and cons of leaving the sonar on board the vehicle. While it would have been of great value in assisting the pilots to navigate the vehicle, it represented a very significant fouling hazard. In the end it was decided (by Neill) to remove the sonar. While the vehicle didn't get irreversibly fouled, perhaps justifying the decision, the pilots found it very challenging to navigate without a sonar. A vehicle carrying a sonar, such as the ARIS unit, would be much easier to navigate.

30. The process of post-processing the imagery gathered by the DSTO ROV has just begun. Already it is apparent there is much to learn from the data. To cite just one example, the wheels of the two hydroplane controls and the main helm have corroded away to stubs. This contrasts to virtually every other control wheel inside the boat. It would appear these three wheels were aluminum. Was this to make them lighter for the crew members to turn? This has not yet been debated or considered by the team. What is apparent though is that, while they lasted, these wheels played the role of sacrificial anodes.

Other Planned Measurements

31. As planned, corrosion potential readings were taken prior to departure from the site. These are discussed in Annex E. Due to time constraints it was not possible to repeat the measurements using the sonde.

DISCUSSION AND RECOMMENDATIONS

32. This section gives a description of 'next steps' for the science program. It gives a description of what is proposed by way of ongoing analyses of data, and it includes suggestions regarding some possible activities that may be undertaken if other people or groups have a will to undertake the activities. One issue which will have to be discussed in detail by the AE2CF team relates to who does what in the post-processing domain. Relative to the situation in 2007, DSTO can devote very limited staff resource to ongoing activities related to AE2. Obviously over many years individual staff members have given freely of their own time, and this is likely to continue where possible, but it should not be relied upon.

External Survey

33. The first step in analysing the results of the external survey is to create a damage map. DSTO undertook such a process when it analysed the damage sustained by HMAS Sydney for the Cole Commission of Inquiry 2014[1]. With this process, every damage site is mapped and measured and an assessment made of the cause of the damage. In the case of AE2 the causes

1 Buckland, M., Cannon, S.M., de Yong, L., Gamble, G.I., Jeremy, J.C., Lyon, T., McCarthy, P., Morris, B., Neill, R.A., Skeen, M.B., Suendermann, B., and Turner, T. (2009) *HMAS Sydney II Commission of Inquiry: Report on Technical Aspects of the Sinking of HMAS* Sydney *and HSK* Kormoran. DSTO General Document, DSTO-GD-0559.

will generally be either corrosion or damage sustained due to fishing activity. The 2014 external survey of AE2 is one of several that have been undertaken since her discovery in 1998. It would be worth considering creating a timeline map of the exterior of the boat – illustrating how the incidence, distribution and severity of damage resulting from fishing activity and corrosion-related processes have progressed in time.

34. Cathodic and physical protection systems have now been put in place, so subsequent surveys will be able to make assessments of the comparative rate of change in the vessel following installation of these systems. It has been commented above that there appears to have been some change in the flora of the site in the intervening years from 1998 and the present. Detailed comparison of the imagery gathered in the various surveys could confirm or discount this assertion.

Internal Survey

35. The internal survey of AE2 gathered a very extensive set of image files, extending to many gigabytes. It is therefore imperative an efficient scheme be adopted for logging the results of analyses. Obviously when each video file is reviewed, the filename and time code will be important relocator indexes. The following describes a proposed set of additional data fields to be recorded as part of the analytical process.

36. In 2012 DSTO undertook an internal survey of the HMVS Cerberus wreck at Black Rock, Victoria [2]. A methodology was developed for analysing and logging the video imagery recorded in that survey. As this proved quite effective it is suggested a similar approach be adopted in analysing and logging the very extensive dataset recorded for AE2.

37. In the Cerberus survey, the ship was divided into four zones across the ship and 26 along its length and a designator was defined for each deck. As objects or features of interest were identified, the location was defined relative to the resulting three-dimensional grid. Added to this location code were a number of descriptors and all were recorded in an Excel spreadsheet.

38. In the case of AE2 it is suggested three zones be used to define the across-boat location of objects of interest - Starboard, Midships, Port; the frame number should define the along-boat position; and a height designator should indicate where the ROV was in the water column - in the LOWER third of the control room or conning tower, the CENTRAL section, height-wise, or in the HIGHEST third (Above about five feet in the control room or six feet in the conning tower). As the ROV could pivot about a vertical axis it is necessary to record which way it was pointing relative to the ship's head; in addition, the internal camera on the ROV could be rotated up and down, so its orientation should also be recorded. Obviously the feature of interest should be described

2 Neill, R.A., Gilbert, J., Graham, P. Mart, P., Grandison, C., Rowan, M. and Winter, N. (2013) *Survey of HMVS Cerberus, December 2012*. DSTO-CR-2013-0092.

and, if a still image is captured from the video stream, then an image filename should be recorded.

39. Thus a designator would be assigned to each object of interest along the lines of:

a. ROV Data File; Timecode in file (minutes: seconds); Vehicle (VLBV or DSTO); Camera (GoPro, HiDef or StDef); Deck Level (Conning Tower or Main Deck); Approximate Frame Number of AE2; Across-ship Position (P,M,S); Height in boat or conning tower (L,C,H); approximate orientation of the vehicle/camera (e.g. Green 45, Up); Name of image capture file if one is created; Description of object.

b. A specific example, based upon the above image of the Ballast Pump controller, to be entered datafield-by-datafield into an Excel Spreadsheet, would be:

    100GOPRO; 06:38; DSTO; GoPro; Main Deck; 58; S; C; Green 60, Horizontal; FirstView.png; First view of the ballast pump controller and Kingston valve wheel.

40. As planned, these data should enable a comprehensive inventory to be recorded of the properties and distribution of both ship's infrastructure and non-secured items. From this it is anticipated a great deal will be learnt regarding the operational status of the boat immediately before she was scuttled and of the manner in which submarines of this class were operated.

Composite Video and ARIS Sonar Data

41. The constraints imposed by time lost due to technical issues caused the dataset recorded from this component of the expedition to be relatively incomplete. There should be sufficient data available, however, to prove the validity of the concept: i.e. using the sonar data to generate a digital wireframe model of the boat, upon which video imagery can be draped. While it is beyond the scope of the current project to return to the submarine and complete this part of the scientific program, if the concept can be shown to be valid then there may be other candidate wrecks to which it could be applied under separate sponsorship (i.e. not as part of the Silent ANZAC Project). For example the J-Class submarine at Sandringham Yacht Club may be a worthwhile wreck to study.

Corrosion Potential Measurements

42. While comparison of corrosion potential measurements taken pre- and post- installation of the anodes indicate the cathodic protection system is working, it is imperative a set of check measurements be taken after a reasonable settling period. The proposed 2015 check survey should include visual inspection of all anode pods and connection points plus recording of a set of corrosion potential measurements taken at each of the connection

points. This will confirm performance of the system as a whole and of each of the individual anode pods.

<u>Measurement of Physical Properties of the Water Inside the Submarine</u>

43. An unfortunate result of the schedule slippage during the 2014 expedition was that the final set of water property measurements couldn't be taken. These were important measurements, because they would have given a good indication of the short-term impact survey activities may have had upon the internal environment. That was unfortunate but unavoidable. Possibly of greater importance is for measurements to be taken to give an insight into the medium-to-long term effects of the intervention. On several occasions during the course of the 2014 expedition the versatility of ROVs was demonstrated. It is possible a rig could be designed to enable an ROV to insert the sonde through the slot in the 'top hat' that has been installed onto AE2 at the conclusion of the expedition and thence lower it to the level of the battery tank cover. To date no formal consideration has been given to this idea, but it is a recommendation that a material and financial feasibility assessment be made in the short term, to see whether such a measurement could be included in the planned 2015 check survey.

GENERAL CONCLUSIONS

44. In the author's experience every sea trial presents its own set of challenges and throws up unique obstacles to be overcome. The 2014 MAA expedition was no exception. In almost every respect the problems that arose could be successfully addressed. Consequently the science program resulted in the gathering of a very impressive data set. As analyses are ongoing, it is not yet possible to make specific claims regarding what has been achieved, but preliminary indications are that the vast majority of the expedition's scientific objectives will ultimately be met.

Maritime Archaeology Interim Report

Tim Smith

Heritage Significance

1. The site has been identified to be of national heritage significance to Australia, and similarly an important site in the focus of Turkish interests in their ultimate defence against the Allied invasion of the Dardanelles Peninsula during the early stages of World War One.

2. As such, both governments have taken an increasing interest in the safeguarding of the site, with the Turkish Government specially declaring the *AE2* submarine an item of archaeological heritage protected under their national heritage legislation in 2006.

3. *AE2* is one of 57 completed E-type British submarines that served as the backbone of the British submarine force during the Great War.

4. *AE2* played a critical role in the Dardanelles offensive by making the first successful penetration of the Dardanelles Strait during the opening hours of the ground offensive (25 April 1915). Although subsequently caught on the surface by Turkish gunboats, damaged by *Sultanhisar* and forced to scuttle (30th April 1915), the *AE2* led the first Australian forces into battle, opened up the ensuing Allied submarine campaign and interrupted the flow of supplies and troops to the Çanakkale War.

5. *AE2's* successful wireless message to the British Fleet considering evacuation on the day after the awful landing at Anzac Cove (Anzac Koyu / Ari Burnu), may have had a seminal role in the decision to keep the troops ashore, leading to the prolonged eight-month campaign.

6. The wreck survives as one of the few E-class submarines located underwater internationally and one of the most intact and undisturbed. The discovery of the British submarine *E14* in The Dardanelles Strait (Turk Bogazlari) by Selcuk Kolay and Savas Karakas in 2011 adds another comparative site for future analysis and comparison to the interpretation and management of *AE2*, with both submarines being closely linked in the historical story.

7. *AE2's* archaeological potential is therefore identified as significant, with potential to generate new insights into the design, construction and operation of this class of submarine.

Principal Collaborators

8. The AE2CF has used the professional Maritime Archaeological services of Mr Timothy Smith throughout its archaeological programs at the

AE2 site. Mr Smith was also present during two previous trips in 1997 (prior to the site being located), and in 1998, following Selcuk Kolay's discovery of AE2. Mr Smith has 25 years' experience in the field of Maritime Archaeology and is currently the Executive Director of Heritage Victoria, within the Victorian State Government's Department of Transport, Planning and Local Infrastructure, Australia. During the 2014 MAA, the AE2CF also obtained the services of Dr Harun Ozdas, a professional Turkish Maritime Archaeologist employed as Assistant Professor within the Dokuz Eylul University in Izmir, Turkey and also Director of its Institute of Marine Sciences and Technology.

Introduction

9. The 2014 Maritime Archaeological Assessment (MAA) sought to build on the previous archaeological findings in order to provide an update on site condition, changes to the physical appearance (e.g. from fishing impacts to the site), and to examine new aspects of the AE2 that hadn't previously been interrogated.

10. The previous inspections included an initial site significance and condition survey following the 1998 discovery of the site (Smith, Tim., 1998); the major assessment work conducted in 2007 (Smith, Tim, et al, 2007); and intervening multi-beam surveys of the wreck site and its environmental setting (Kolay, Selcuk, 2010, 2103).

11. The 2007 Maritime Archaeological Assessment had a number of specific focuses:

a) To complete an external condition survey, including visual recording (diver and ROV); battle damage survey; base environmental, water quality and sediment analysis; corrosion potential survey (at fixed locations of hull), and

b) To initiate a limited survey of the submarine's interior, through deployment of a fixed 'drop camera', to ascertain presentation and condition of the interior spaces.

12. All of these studies aimed to compile additional scientific data to help inform an understanding of the integrity and intactness of the archaeological site, the site's significance values (historical, archaeological and research), condition and form of associated fixtures and fittings and presence of relics collections.

13. This data was used to refine the AE2 Commemoration Foundation Ltd's (AE2CF) understanding of the historic and archaeological significance of the site, and to inform current and future management approaches to protect and preserve AE2.

14. The results tabled at the Istanbul stakeholder Workshop in 2008 and subsequent Assessment Phase Report [1] directly informed the joint decision to preserve and protect AE2 in situ in its 1915 battle context. The survey data also identified the need to have a better understanding of the complexity of the interior spaces of the submarine and led to the archaeological methodology established to guide the 2014 Maritime Archaeological Assessment (Smith, 2013).

2007 Maritime Archaeological Assessment outcomes

15. The highly successful 2007 operations provided a superior understanding of the state of AE2, particularly the integrity of the steel hull plates and intactness of the site.

16. The external surveys demonstrated that the AE2 was and remained at risk of damage (and therefore impacts on its significance) through inadvertent contact with fishing trawling activity (particularly through hook-ups at the fragile bow region).

17. Additional damage to the bow and forward casing was observed in 2007 which has altered the external appearance of AE2 in this area. It was determined that a surface marker buoy should be established on site to better warn local fishing trawler operators of AE2's presence. This activity was completed during the 2014 operations and will have a positive effect in maintaining the integrity of this unique archaeological site.

18. Although the camera inspection of the Conning Tower and Control Room space beneath it was limited and restricted by lighting available at the time, it provided a critical understanding of the likely state of the interior (i.e; free from significant sediment ingress, limited water movement, limited marine growth and corrosion product build-up on internal surfaces and observed fittings).

19. A key outcome of the 2007 survey was the confirmation that the lower Control Room hatch was left open by the crew enabling access to the main hull. The survey highlighted that a more challenging inspection of the interior spaces of the AE2 was indeed possible.

20. This had the potential to allow a much fuller understanding of the form and condition of the submarine to be made and to ask additional research questions relative to the design and construction of an E-boat prior to the First World War; to learn about the fitting out of a British submarine during conflict operations and to potentially identify a range of archaeological artefacts within the hull that might relate to the crew, operations of the boat

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[1] Operation Silent Anzac Report to the Australian Government on the Assessment Phase HMAS AE2 dated 10 June 2008.

and the sinking event on 30 April 1915.

Aim of 2014 Maritime Archaeological Assessment

21. Armed with the 2007 information on the state of the observed elements of the site, the 2014 expedition was designed to explore the largely unknown internal state of the submarine in detail.

22. To this end, the Science Team developed a range of equipment that would enable high quality archaeological and scientific data to be extracted. All of these tools (drop camera, fixed instrumentation packages, moving remote operated vehicles and 3D sonar mapping packages), were designed to incur least impact to the fabric of the AE2 during their deployment.

At all times, the data sought was offset against the amount of interference with the hull and fabric.

Impacts to Conning Tower Upper Hatch

23. The AE2CF undertook the Maritime Archaeological Assessment with a least impact approach in mind.

24. A key potential archaeological impact involved the Conning Tower upper hatch. To enable the fuller documentation of the interior spaces of AE2, the hatch had to be opened. A lot of discussion went into the likelihood that the hatch, or more importantly the hinges, could be made to work. Limited historical records relative to the form and construction of the upper hatch meant that this discussion was somewhat speculative.

25. A range of interventions were therefore planned, starting with the least impact insertion of an initial refined drop camera and instrumentation package through the partially opened hatch. Pending the successful insertion of that system, the next intervention proposed was a manual attempt to open the hatch using divers working at depth.

26. If this failed to enable the hatch mechanism to be freed, attempts would be made through the application of localised manual force via a hand-operated jack.

27. Failure of these approaches would require a more substantive impact whereby the hatch would need to be separated from its hinges and locking mechanism by direct cutting (grinder or oxy acetylene torch).

28. This level of intervention would cause greater impact to the hatch and surrounds and would result in an artefact requiring recovery to surface,

conservation treatment and later professional curation and display. This approach was identified as the least desired in terms of interference to the otherwise intact archaeological site.

29. However, from an archaeological perspective it was argued that the level of disturbance was warranted in terms of the greater insights overall the project team would gain from a sophisticated mapping of the interior spaces. The application for archaeological VISA approvals to the Turkish Ministry of Culture and Tourism, General Directorate of Cultural Heritage and Museums (Smith, 2013) therefore included an application to cut and remove the hatch if required.

30. The resulting Archaeology Approval issued (94949537-163.99 72221, February 2014), included provision for this activity with certain conditions regarding the conservation facility to be used (Archaeology Museum, Canakkale) and long-term display venue (Naval Museum, Istanbul).

Opening the Upper hatch – Results

31. In order to provide a working area for the divers to manipulate the hatch, loose shell and sediment had to be cleared away. This was partly in order to define the rim of the hatch at the deck casing level, to access the hinge mechanism and to limit the amount of loose material accidently knocked into the pristine interior of AE2.

32. The DEEP Offshore team fabricated a fabric collar that was placed around the slightly open hatch during clearing works that successfully limited shell and sediment movement into the submarine.

33. The cleaning up operation identified that the accumulated natural deposit on the flat horizontal deck surface was in the order of 10-15 centimetres in thickness. A sample of Oyster shells was recovered for species identification, silt samples having previously been obtained in 2007. The silt material proved a constant issue, being of very fine sediment size and staying suspended in the water column long after contact.

34. One of the archaeological tasks was to obtain a good cross-sectional sample of the marine concretion layer formed against the original Phosphor Bronze Conning Tower structure. A series of corrosion potential measurements were also obtained at the hatch and immediately forward of it on the upper deck during the cleaning works. These were used as base measurements prior to opening of the hatch and later fitting of the cathodic protection system.

35. Unfortunately, the depth of shell deposit, the very hard nature of the concretion products (estimated at 2.5 centimetres in section) and the limited

diver working time, meant that a representative sample could not be obtained.

36. Prior to attempts to open the Upper Hatch, divers were provided with a specially constructed syringe to try and recover an oil sample from under the domed hatch. Oil had been observed collected under the hatch in 2007 with a sample being identified as a mixture of diesel fuel and lubricating oil. Unfortunately a sample could not be extracted despite several attempts.

37. Later opening of the hatch revealed that a substantial accumulation of oil had formed under the hatch and across the underside of the Upper Deck. This oil occasionally made it to the surface 74 metres above the submarine and could be observed as tell-tale spotting on the surface. Later internal survey findings (below) identified at least once source of the slowly leaking fuel oil being the Number 1 Fuel Oil tank below the Forward Torpedo Room.

38. Despite attempts to initially insert the drop camera and water quality instrument package into the interior of AE2 without having to interfere with the Upper Hatch, this proved impossible. The camera system had a very fine tolerance and with the build-up of shell and concretion deposits and previously unsighted metal rib under the hatch (cast for structural strength), the drop camera could not be inserted.

39. Divers had to resort to manually cutting the stirrups used to secure the hatch with a pneumatic disc saw. Once cut, the Phosphor Bronze hinge mechanism moved quite readily. This indicated that the bronze hinge mechanism of the hatch itself could probably be freed up, once the concretion layer had been broken.

40. Again, the limited level of interference to the hatch handle mechanism was agreed to be outweighed by being able to access the interior spaces and obtained scientific data on the internal spaces. Several dives were required to complete this work and a level of sediment was unavoidably introduced into the interior.

41. The drop camera serial was successfully completed and a range of features observed inside the Conning Tower and through into the main Control Room space (see below).

42. With the initial drop camera serial completed, attempts were made to open the Upper Hatch to a near 90 degree position. This was critical to enable insertion of a remote operated vehicle (ROV) that would be used to explore and map the interior confines beyond the Conning Tower and Control Room spaces below the main hatch.

43. Working on the principle of least possible disturbance to the

submarine and marine growth and concretions, divers resumed the manual attempts to open the upper hatch. After several dives using a hand operated jack, the hatch was opened to about the 80 degree angle in the vertical access. This was a significant achievement at 74 metres depth and showed great skill on behalf of the Turkish commercial divers (DEEP Offshore).

44. Complete access into the confines of AE2 was now assured and there was no residual complication of having a hatch to remove, recover to the surface and treat in the field, saving additional expedition time. Archaeologically, minimal impact had been caused to the archaeological site.

Aims of ROV insertion into AE2

45. The principle aim of extended internal documentation of the *AE2* hull was to gather more visual and scientific data. The principal objective was to gain detail on the internal makeup of a British E-class submarine for comparison to limited surviving historic plans, photographs and written records.

46. The inspection had the dual aim of examining the state and condition on the internal hull surface area and associated fittings, fixtures and major plant (e.g. engines). The visual inspection of corrosion activity and physical condition, including the build-up of concretion products, coupled with internal water quality data, will be key to identifying the current state of the vessel overall.

47. This information, compared with data obtained on the external hull, will allow a far more rigorous and scientific assessment of the *AE2's* condition, future survival patterns and will guide long term management options.

48. Only an ROV has the capability of moving the distance through the confined hull of the submarine with sufficient power and illumination. The ROV introduces few risks to the archaeological site if carefully operated.

49. The major impacts to be mitigated are contact with fixtures and fittings, fouling of the tether, potential loss of the ROV internally and excessive destabilisation of internal water layers and sediment deposits.

With the upper Conning Tower hatch now open, the expedition moved into the next major phases – insertion of the ROV to undertake comprehensive mapping of the interior.

50. The custom-designed ROV by Seabotix ran into complications however as the tolerance for insertion through the hatch coaming (opening) was very slight. Thicker build-up of concretion products on these surfaces and unforseen obstructions (metal lugs), caused difficulty in inserting the ROV into the upper hatch, and then an inability to move it through the lower

conning tower hatch.

51. Whilst the recovery operations were underway, the ROV did obtain some 80% coverage of the interior surfaces of the Conning Tower.

52. With the recovery of the ROV, the DSTO Team successfully modified and inserted a smaller SeaBotix ROV into the interior and began a successful navigation of the interior (see also Annex C, Science Report). This ROV had some limitations in terms of lighting, thruster control and lack of a high definition camera. It also could not carry the ARIS Sonar that was hoped to generate a 3D image of the interior spaces.

53. The ROV survey however proved extremely successful, generating images of the interior features of AE2 and its working spaces previously only interpreted through two-dimensional historic construction plans and a 3D interactive model built from the plans (DSTO).

54. The internal ROV survey was conducted over 3 days, with 3 ROV pilots working in shifts to achieve the maximum coverage in the limited time available and in the following pattern:

- Immediate Control Room area in vicinity of internal Conning Tower ladders
- Auxiliary Electrical board (Starboard side) and Hydroplane stations within Control Room
- Main Electrical Board (Port side)
- Officers' Quarters (forward of Control Room
- Forward Torpedo Room (through forward bulkhead)
- Amidships Torpedo Tubes

55. Details of key features observed through these spaces are recorded in Annex B and will be subject to more intensive study and identification once the many hours of footage are interrogated.

56. The following comments are summary in nature only. All major spaces expected to be locatable from the historic plans could be identified. The two electrical switchboard provided a wealth of detail to add to the historic plans.

<u>Control Room</u>

57. Throughout the Control Room and forward areas, the overall impression was of the complexity of the interior spaces and the abundance of pipes, valves, motors, gearing and other machinery.

Of great interest was the clarity of the water in the main Control Room and the very limited concretion and marine growth build up on all surfaces. The plethora of observed dials and gauges were in remarkable condition. The glass covers were intact in every observed instance and the needles and units of measure also readily observable.

58. In many cases, the name of the manufacturer was clearly visible, for example, on the boat's Log, Elliot & Son, London.

59. Key machinery items were searched for, located and documented. These included both periscopes that were observed to have retracted into the floor wells, suggesting that they were intact. This would equate with historic accounts of the sinking which make no mention of the periscopes being raised in the frantic actions at time of loss.

60. On the deck beside the forward periscope was the compass repeater that played such a critical role in AE2's passage through the Narrows and the minefields on its journey into the Sea of Marmora.

61. Whilst most items were related to the operations or fit out of the boat, a timber picture frame hanging above the forward periscope perhaps once held a daily record, eg the contents of trimming tanks or perhaps the printed operational orders or some other rules, giving a glimpse into the lives of the crew.

62. Remarkable throughout the boat was the strong evidence of the original gloss white enamel paint that once adorned all interior surfaces. This was particularly evident within the Conning Tower but also in the main pressure hull areas.

63. One of the key research questions was an assessment of the sediment levels inside AE2. The ROV examinations indicated that the main Control Room up to the Officers' Quarters was rather devoid of sediment on the floor spaces. This enabled the ROV to be flown around with comparative ease and ongoing forward visibility.

64. The depth of sediment was perhaps in the order of 5 centimetres. This changed dramatically however as the ROV progressed forward into the Officers Quarters and especially the Forward Torpedo Room.

65. One of the puzzling observations was the absence of the two large hydroplane wheels where the helmsmen controlled the diving and surfacing of AE2. The pedestals for both wheels and associated depth gauges were readily located. The loss of the wheels will require more analysis as both steering helms from the Conning Tower (steering wheels), were found intact.

66. This puzzle was compounded when the main steering helm near the periscopes was also observed to be missing. Speculation on the metal used in their construction might be an answer if they have sacrificially corroded in comparison to the boat (perhaps of Aluminium construction). In this case, the remains of the wheels may have fallen off onto the floor and not been observed.

67. An alternative theory is that the crew deliberately removed these wheels whilst they escaped the boat, perhaps to compromise any Turkish attempts to enter the flooding AE2 submarine to affect a capture.

68. A metal box was observed under the Hydroplane Stations which might equate with the location of the scuttling (demolition) charge that was known to have been carried in that location (AE2 crew diaries).

69. Perhaps of greatest surprise was the state of conservation of the Officers' Quarters. The timber cabinetry, known from the plans, was found absolutely intact. Such was the condition of the organic materials that all handles and knobs were intact and all cupboards, drawers and shelving could be readily interpreted. It is believed to have been built from Teak or Mahogany, the state of preservation provided a unique opportunity to interpret this personal space within AE2.

70. Remarkably, the officers' writing desk, most likely used by Captain Stoker to write his Log and for plotting the course of AE2, was intact. A timber drawer beneath it was partially open and revealed a tube of toothpaste or perhaps Brill Creme still intact.

71. Between the two bays (port and starboard) of timber cupboards was found the upturned officers timber wardroom table. Two beautifully turned solid legs pointed vertically from the floor and the other two removed legs were found stowed neatly together. It is unclear if the table was deliberately turned upside down when not in use to limit restriction of the passage way in this part of the boat, or if this reflects the state of chaos in the boat when crash diving to escape the attack of the Turkish torpedo boat *Sultanhissar*.

72. Even more remarkable was the presence of a small (approximately 10 centimetre) glass or crystal flask sitting upright on the writing table. Its glistening surfaces were clear and the fluted shoulder detail could be readily observed. It is unknown what this flask once contained and whether it was standard naval issue or a personal item introduced into AE2 by one of the officers.

73. Remarkable above the writing desk was the intact ceiling light fitting. A glass tulip style light fitting, its elongated shape and scalloped edge seemed

incongruous on a fighting warship. Again, it is highly likely that this was an individual item brought into the boat to bring a ‘touch of home’. Also on the writing desk amongst built up sediment was another globular vessel that may have been an ink well.

74. All other ship light fittings were of the standard naval glass dome and webbed cover type. All observed were intact except one that had a smashed glass case.

75. Inspection of the sleeping fixtures revealed a different construction fit out to the original plans. The officers were originally supplied with three timber drawers expected to be pulled out into the passageway to serve as sleeping berths. The AE2 instead appeared to have fold down metal cots suspended from chains with intricate brass brackets for setting inclination.

76. Also on the floor immediately aft of the Officers’ Quarters was a large timber drawer that appeared to have been thrown out of place onto the floor area. This again is probable evidence of the sinking events where the crew described AE2 “trying to stand on her nose”, and all loose items tumbling through the boat including spanners and tools from the engine room. These historical accounts are all the more remarkable when one considers the survival of the glass flask on the officers’ table. It is possible that it sits within a circular recess cut into the desk surface providing some stability.

77. Remarkable also in the Officers Wardroom was the clear evidence of substantial quantities of decomposed organic materials. The build-up of this material was readily visible and severely constrained the forward movement of the ROV. Combined with confined spaces travelling forward, dark, and increasing sediment build up on the floor area; visibility was largely lost with any use of the ROV thrusters.

78. It appears that this localised build-up of organic material reflects the bedding materials of the officers’ quarters, perhaps the decomposed mattresses, uniforms and other organic materials such as the velvet curtains once used to create some personal space from the 29 crew.

Forward Torpedo Room

79. Access was made into the Forward Torpedo Room although it was very challenging due to the risk of ROV tether hook-up, the narrowness of the boat going forward and elevated build-up of organic materials that became easily suspended in the water column. Only limited examination could be made of this space.

80. It was uncertain whether the torpedo tube was actually sighted, although it appeared to be seen in one pass forward on the starboard side.

An operating handwheel (possibly the bow cap operating handwheel), was visible on the starboard side matching historic drawings of this compartment. Interestingly though, it appeared partially buried suggesting that the Forward Torpedo Room was perhaps one third – half buried in silt at the floor level.

81. It was clear that sediment and organic materials had accumulated in a much thicker state here and it is difficult to account for such a level from the general passage of silt through the boat over 99 years, even with its slight bow down attitude. It is likely that the bow section has openings to the external environment and that sediment is ingressing into the archaeological site from outside.

82. The bulkhead surface was examined and appeared to be rectangular in section, although it was difficult to extract much meaningful data in this space.

Clearly evident in this confined space was the presence of fuel oil. Landing the ROV on the accumulated floor deposits readily released bubbles of oil that coated the ROV camera lenses and rose upward. It is clear that the oil is leaking from below the floor area and likely from the Number One Fuel Oil tank situated in the bilges in this location.

83. It is not known how much capacity this tank still retains and whether this is an ongoing localised leak, or evidence of a future more substantial collapse of fuel bunkers within the AE2 hull. The presence of fuel leaking from the submarine to the surface should be monitored into the future.

Amidships Torpedo Room

84. This complex area of AE2 could only be imaged in the final days of the survey operation and a complete inspection could not be made. One of the interesting research questions guiding the 2014 expedition was whether the bulkhead door to the engine room was shut, matching historic crew accounts.

85. Unfortunately the rear area of this compartment could not be viewed and ROV passage through it was undertaken at high risk. The survey did confirm that both replacement torpedoes for the midships tubes were missing, again confirming historic accounts that all torpedoes were expended from these tubes. Interestingly, it was confirmed that the crew had taken down the slings for the spare torpedoes, showing evidence of trying to approve crew amenity and movements within the boat.

Conning Tower

86. The Conning Tower (between the upper and lower hatch) received the

most detailed inspection. The original white gloss enamel painted surfaces were very evident and largely intact. Of key interest in this key working space with AE2 was the engine room telegraph repeater, with face clearly readable, piping and electrical equipment, the Conning Tower helm (steering wheel), and the stowed bridge helm (steering wheel) stowed against the starboard side. Interestingly, the wheel was observed to be collapsed into two pieces, explaining how they brought the wheel into the boat from outside prior to diving.

87. The horizontal ribs of the tower were very pronounced and an unknown detail, a timber flag locker, was built into the ribs on the starboard side. The timberwork here was in exceptional condition and it was clear that the shelves still had stowed organic items that have been identified as signal flags. It is tempting to think that the oversized White Ensign that Captain Stoker hoisted when surfaced within the Sea of Marmara, is also contained in this shelving. Tell-tale copper alloy corrosion products suggest the presence of cleats to attach the flags to halyards for hoisting.

88. Also of key interest were the pairs of soft shoes observed stacked in this shelving, identified as Plimsolls used when walking on the deck casing. These items provided a remarkable connection to the crew of AE2 and the human element of the archaeological study.

89. An equally important observation was the state of the viewing ports that provide a visual link to the outside of AE2. All ports had their brass scuttles (covers) in the open, drop down position. This detail exactly matched crew accounts that record the First Officer Lt. Haggard, looking through the ports as AE2 came back to the surface on 30 April 1915. It was in this position that he observed the *Sultanhissar* getting ready to perhaps ram AE2 on the surface, and urging that the crew abandon-ship.

90. Another unique feature was a coil of electrical wire and possible stand that has been identified as a possible jury-rigged portable radio antennae (discussed elsewhere). This might be evidence of the historic transmission of a radio signal to the Allied Command that AE2 had successfully breached the Narrows and was “running amok’ inside the Sea of Marmara.

Summary of research findings

91. As previously noted, the 2014 Archaeological project had the following key aims;

a) To record the physical condition of the internal hull and components to aid long-term site conservation;
b) To map the appearance and spatial layout of the internal spaces compared to historic records;

c) To confirm the existence and location of archaeological relics (‘objects’);
d) Document evidence of the crew’s life and actions during the fatal loss of the submarine, as part of the research investigations into *AE2* and its loss.

92. The 2014 Maritime Archaeological Assessment has provided a wealth of information on these aspects. The archaeological surveys confirmed the main structural features of the submarine, key equipment, fixtures and fittings.

93. Importantly, the survey confirmed the wonderful state of preservation of the interior spaces that has enabled a unique insight into the design, construction and use of this important British submarine type.

94. The survey also confirmed the presence, though limited, of personal effects related to the crew and their life on board. It was apparent that the heavier build-up of sediment levels in the bow perhaps hide the bulk of the artefact scatters. Crew accounts clearly document the accumulation of small articles into the bow area as AE2 crashed dived before its final scuttling. The absence of artefact scatters within the Control Room perhaps supports the more likely accumulation of relics in the forward spaces, now buried by accumulated sediment.

95. The documentation of personal effects, particularly in the Conning Tower, provided an insight into life on board an E-Class submarine and a direct link to AE2’s crew.

96. The confirmation that the majority of the submarine is devoid of sediment, flooded and largely sterile in terms of water movement, will assist the management of the wreck site into the future.

97. The survey has confirmed the potential for ongoing archaeological interrogation of the AE2 to build on the knowledge gained on this special class of vessel. The future opportunity for controlled archaeological recovery of specific relics for research and display has also been highlighted.

Management of AE2’s archaeological relics collection

98. The AE2CF accepts that *AE2* is regarded by Turkey as an asset belonging to Turkish military history. Article 25, *Preservation of Cultural and Natural Resources Law*, states that, "In regions where weapons or other artefacts related to Turkish military history are located, further exploration and the examination and evaluation of historical characteristics of these weapons and/or artefacts shall be conducted by the General Staff of the Republic of Turkey”.

99. Artefacts contained within the *AE2* archaeological hull, and the submarine as an object itself, are classified as archaeological remains and artefacts defined as of militarily historic and cultural assets belonging to the Republic of Turkey ("cultural assets"). These may be subject to the Regulations for Military Museums, specifically the 7th, 15th and 16th provisions. Specific approvals for any interference to these elements must be obtained from relevant Turkish Government authorities.

Conservation Assessment of the AE2: June 2014

Dr Ian D MacLeod, FTSE, FIIC, FRACI, FRSC, FSA Scot
Executive Director, Fremantle Museums and Collections, Western Australian Museum

Condition Assessment of the Hatch

From a combination of the divers' description and the work carried out in the serials it was apparent that the conning tower hatch was heavily concreted with a combination of directly deposited calcium carbonate, $CaCO_3$, with a very dense load of secondary concretion. The secondary material consisted of a relatively loose conglomeration of marine debris, siliceous materials and entrained debris. Rather than finding a 1-2 mm thick layer of inorganic $CaCO_3$, typical for shallow water wrecks, the divers found a massive bonded layer approximately 25-35 mm thick which was closely adherent to the original bronze metal. This rock hard layer has been formed by the reaction of the super-saturated hypersaline water, approximately 42‰, with generally low currents at 73 metres. Hydroxide ions generated from the cathodic protection of the bronze hatch by the electrically connected iron components on the AE2 cause the calcium in seawater to precipitate out according to the following reaction scheme. In the corrosion reaction iron is oxidized at some remote point on the submarine,

$$2\ Fe \rightarrow 2\ Fe^{2+} + 4\ e^-$$

and it gives up electrons which are consumed by the dissolved oxygen which is reduced at the bronze hatch to provide a more alkaline microenvironment,

$$O_2 + 2\ H_2O + 4\ e^- \rightarrow 4\ OH^-$$

Even in hyper-saline waters such as at the bottom of the Sea of Marmara, calcium is soluble as the bicarbonate species but the subtle change in pH caused by the cathodic reduction of dissolved oxygen at the bronze-sea water interface is enough to bring about precipitation of inorganic $CaCO_3$,

$$Ca^{2+} + HCO_3^- + OH^- \rightarrow CaCO_3 \downarrow + H_2O$$

This thick layer of primary concretion is a unique signature of the AE2 due to the natural galvanic coupling of the steel submarine with the bronze hatch for it is only due to the ratios of the size of the hatch to the rest of the submarine that there has been sufficient throwing power of the reaction to bring about this much thickness of the primary concretion layer.

Underneath this dense layer of $CaCO_3$ there will be zero dissolved oxygen and the anaerobic bacteria in seawater will have produced sulphide ions which will have resulted in a chalcocite or copper (I) sulphide (Cu_2S) protective layer on top of the bronze which will have preserved all the original wear and manufacturing marks. The massive amount of secondary concretion on the hatch amounted to a thickness of approximately 30 cm that presented the divers with a challenge of how to get the conning tower hatch to move backwards. This problem was overcome with a combination of mechanical action from deconcreting tools, localised precision pressure from a hydraulic jack inserted into the nominal 10 cm opening of the hatch (see Figure 1) and the application of a chain block to pull the lid opening to a near vertical position.

Figure 1: The partially opened de-concreted hatch cover

Since the hatch cover had been cathodically protected for 99 years it was possible to prize the lid open to a point where it allowed complete access for the ROV to penetrate into the interior of the submarine and obtain images of the layout of the vessel and its contents. The concretion sample obtained will be examined when it arrives in Australia but as it came from the secondary layer it will not provide any depositional profiles of changes in the microenvironment of the submarine which the primary layer would have done. The attempts to recover samples of the oil trapped under the lid with a syringe failed, however oil collected on the ROV when it went forward into the interior of the submarine were sampled and have been packaged up with the corrosion inspection gear to be subsequently analysed. Provisional analysis by viscosity and the volatiles organic compounds coming from the oily residue indicate that it is diesel fuel that had been leaking from the forward tanks.

The retention of the hatch in situ was a major achievement of the program as the original integrity of this iconic area of the submarine had been protected.

Cathodic Protection System

The difference in reactivity of various elements was first discovered in the 18th century by Volta with the development of the voltaic pile, a sandwich-like structure of alternating layers of copper and zinc sheet. This was the western world's first battery. The use of sacrificial reactions of a more reactive metal to provide cathodic (negative) current to stop the removal of electrons i.e. corrosion, from a more noble metal has been the subject of electrochemical experiments since the time of Sir Humphrey Davy in the 18th century. Sir Humphrey examined the corrosion reactions of copper sheathing on Royal Navy wooden ships that had been fastened with iron bolts, which lead to a much better understanding of the interaction of metals in the marine environment. The difference in reactivity of zinc and iron is the driving force of the cathodic protection system that was installed on AE2. Assuming that the microenvironment of the boat is similar to that measured in the first expedition, the difference in voltage of the submarine and the anode is of the order 400 millivolts. This is a sufficient driving force to stop corrosion and to remove acidity at the metal-concretion interface. This reaction also removes chloride ions from the submarine whilst it is on the seabed. Because of the large size of the submarine it was necessary to provide enough anode capacity to keep the vessel protected for a design period of between 5-10 years. The other consideration of the design life was the high cost of mounting sea-borne operations.

Figure 2. Steel support structure for a 17 anode pod.

Figure 3: The three anode pods assembled on the deck of the dive support vessel.

Three clumps of anodes were constructed, the details of which are shown in the attached drawing that formed the basis of the tender let by the AE2CF for their construction. The anodes can be seen in Figures 2 and 3. It should be noted that this work represents the largest in-situ conservation project ever attempted on an historic iron shipwreck. Previous work by the author of this Annexe has resulted in successful in-situ treatment of guns, anchors and a marine steam engine through use of anodes to remove the chloride ions and to eliminate the high acidity microenvironment underneath the concretion. It is this environment that promotes corrosion of iron in the presence of chloride ions.

In order to achieve a good spread of protection through the length of the boat one pod was attached aft near the rear hydroplane, one amidships at the conning tower and one up forward on the windlass. Each of the locations was selected on the basis that there was significant residual metal present in that part of the wreck to enable the safe and long-lasting attachment of the cables from the anode pods onto the submarine. A summary description of the anode structures is given below:

- The 2.6m square sided base was filled with approximately 4.8 tonnes of concrete to provide stability and prevent them from sinking into the silt which will ensure that the anodes remain clear since they corrode more rapidly in flowing seawater. However if the silt layer increases as a result of external oceanographic events then the zinc anodes will continue to corrode and provide protection to AE2
- The total weight of the zinc anodes is approximately 1.8 tonnes which together with the concrete and steel supporting structure gives an aggregate weight of around 7 tonnes to each pod. Each anode has a central iron core to which insulated current carrying cables are attached.
- The cable connecting arrangement was a specially designed three screw clamp arrangement modelled on those used in the cathodic protection of gas and oil production facilities.

- Each anode was 150 x 7.5 x 7.5 cm in size which gave an individual surface area of 4,613 cm^2 and with 17 anodes on each pod the total reactive surface area of each clump was 7.84 m^2.

Table 1: Corrosion potential (E_{corr}) measurements on the AE2 as a function of time (hours)

Date	Time	Location	E_{corr} vs. Ag/AgCl	Time hours	log time
10/06/14	12:45	Adjacent to CT upper hatch, naturally cathodically protected	-0.630	0.1	-1.000
10/06/14	12:45	Adjacent to CT upper hatch, naturally cathodically protected	-0.633	0.1	-1.000
12/06/14	12:00	Midships site, periscope standards, anode pod laid			
13/06/14	10:00	Aft site on port, aft of the hydroplane, after 96 hours	-0.677	96	1.982
13/06/14	10:00	Aft site on port, aft of the hydroplane, after 96 hours	-0.666	96	1.982
16/06/14	10:30	Fwd. site, windlass shaft, 4 hours after anodes attached	-0.654	4	0.602
16/06/14	14:30	Fwd. site, windlass shaft, 4 hours after anodes attached	-0.656	4	0.602
18/06/14	9:15	Anodes attached midships after 141 hours	-0.680	141	2.149
18/06/14	9:15	Anodes attached midships after 141 hours	-0.676	141	2.149

Prior to attaching the anode cables with clamps to the submarine, the surfaces were mechanically cleaned to remove small areas of concretion from the metal surface to get ohmic connections. It should be noted that for each location the elapsed time is measured from the time at which the pods were attached and the time when the E_{corr} measurements were taken. Plotting the E_{corr} data against linear hours and the square root of time, the latter would be indicated for a diffusion controlled process, produced general scatter distributions. The initial assessment of the data considered each of the three locations as separate sets but it became apparent that there was a common pattern when all the data was plotted as a function of the logarithm of the reaction time of the anodes i.e. the real functional variable was the amount of time each pod had been connected to the submarine – see Figure 4. When the corrosion potential data (E_{corr}) is plotted as a function of the logarithm of the elapsed time since application of the anodes it can be seen that there is a linear trend towards more negative E_{corr} values with the log of time – see Figure 5. Since all the data points follow the same trend this indicates that there are common mechanisms involved in pulling down the E_{corr} values.

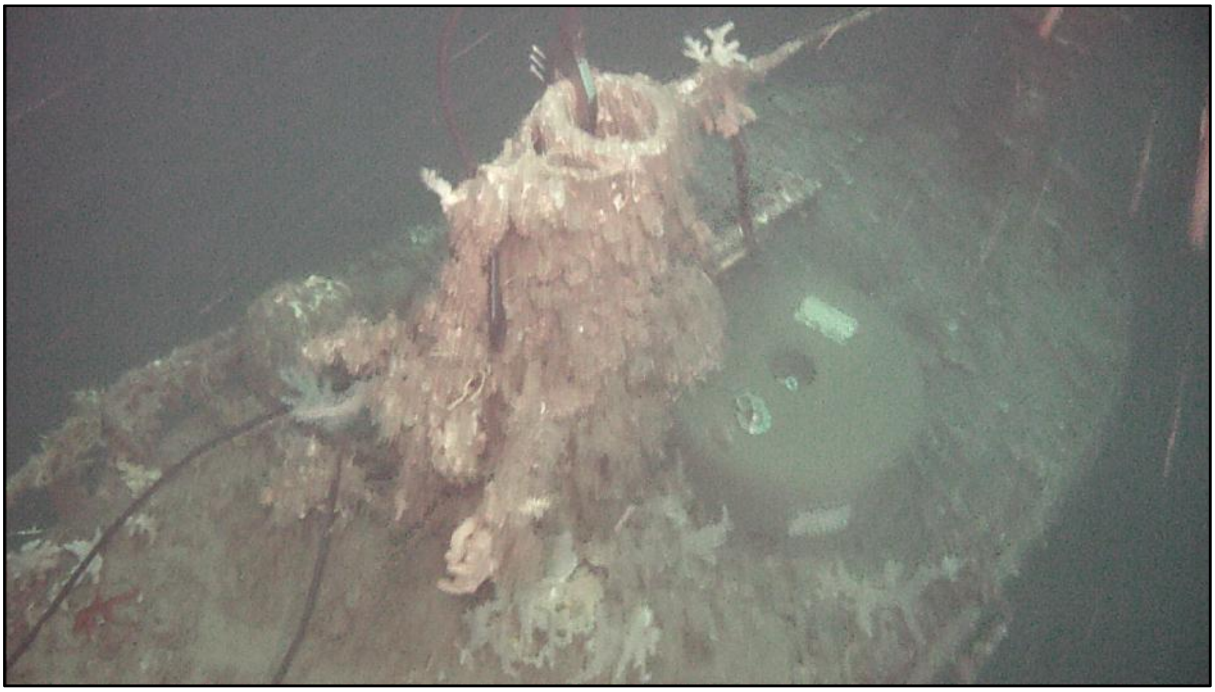


Figure 4: Clamp and cable arrangements for central anode pod connection to the conning tower.

The drop in voltage demonstrates that the attachment methods have worked and that the cathodic protection system is functioning as it was designed to. The initial measurement of the area adjacent to the conning tower hatch cover provides the baseline for demonstrating that the anodes are working as this section of the vessel has been naturally cathodically protected by the reactive iron to which it was originally attached, so any voltage decrease proves that cathodic current is flowing into the shipwreck. The logarithmic fall of the E_{corr} with time is consistent with the establishment of the cathodic protection system as the anodes become activated as they respond, through the attached cables, to the difference in the voltage of the corroded submarine and the zinc blocks. The regression analysis of the line of best fit of the E_{corr} data with the log of the attachment time had an R^2 of 0.9648 (a R^2 of 1.0 is a perfect fit to the straight line) with an associated equation,

$$E_{corr} = -0.646\ (0.002) - 0.014\ (0.001) \log t$$

The errors in the intercept of 2 mV and of 1 mV in the slope are shown in parentheses, which amount to an error of approximately 9% in the value of the slope and 0.3% in the intercept value. Since all the measurements fall along the same line this indicates that the submarine is acting as an interconnected electrical unit. If this is the case then the disposition of anodes along the length of the vessel will ensure that there is an even current distribution across the vessel and that all of the hull will be protected through the application of the three anode pods to AE2. Inspection of the data in Table 1 shows that the greatest voltage drop between the natural cathodic protected E_{corr} of the conning tower was 50 mV after 141 hours or close to 8 days. This voltage drop is the equivalent of a 42% drop in the corrosion rate of the submarine!

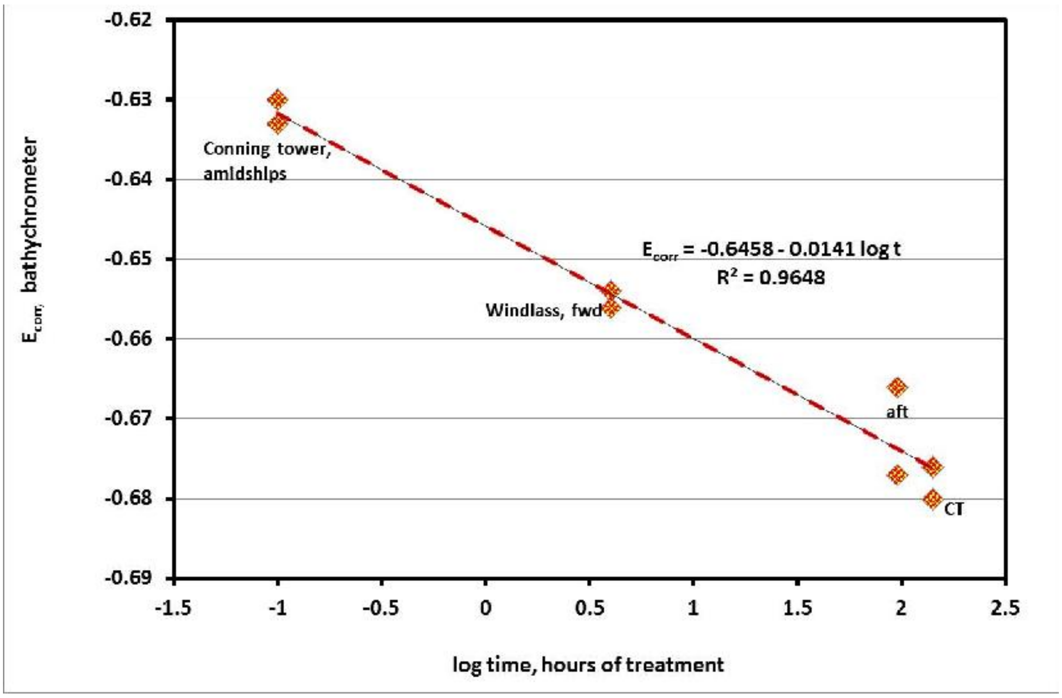


Figure 5: Plot of the E_{corr} values vs. log time (hours) after application of anodes

One of the most significant features is the measurement of the conning tower before and after 8 days following the anode pod at that location. The fall in the E_{corr} values is proof that the system is working. Because the corrosion current has a logarithmic relationship with the voltage, a fall of 50 mV is a very significant fall when the massive surface area of the submarine is taken into account. There is also a logarithmic relationship with current and voltage that has been empirically and experimentally observed that for corroded concreted marine iron. The equivalent voltage drop of approximately 330 mV is needed to bring about a ten-fold decrease in the rate of corrosion. An image of the corroding anodes after 2 days at the central pod, attached at the conning tower, is seen in Figure 6.

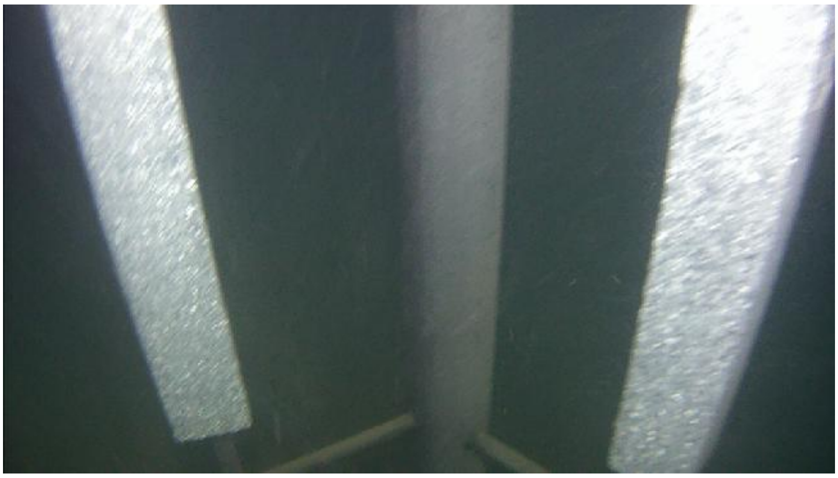


Figure 6: Corroding zinc anodes on the amidships pod two days after connection.

Assessment of the Cathodic Protection System

In order to gain an understanding of the way in which sacrificial anodes work it is important to be able to calculate out the surface area ratios of the object being protected and the anodes that are providing that protection. In the case of AE2 it is assumed that the submarine to be the equivalent of a cylinder with an approximate surface area of 660 m^2. This calculation is based on the known length of the submarine and its average depth or thickness. Since the combined surface area of the three pods of anodes is 23.5 m^2 the surface area of submarine is approximately 30 times the area of the anodes. This ratio of anode (zinc) to cathode (submarine) helps to provide a sufficient driving force to help the anodes corrode and to be able to see a definite change within a few days of application of the pods to the wreck. This ratio was developed by John McCoy of McCoy and Associates to comply with industry standards and to avoid damage to the submarine which could occur if the ratio was significantly smaller. When there are too many anodes compared with the surface area of the object you can get over-protection which could cause damage to the surface concretion, which would obviate the tenant of minimal interference with the archaeological integrity of the site.

The drops in the E_{corr} values all conform to a logarithm of the time plot which shows that a common mechanism is controlling the voltage. Since all the data points align on the same time axis this indicates that all anode pods have been successfully connected to the submarine. These results are a vindication of the years of planning and careful execution of the operation. As a result of this work the AE2 is now being actively conserved while remaining in-situ at the bottom of the Sea of Marmara. Not only will this cathodic protection system stop corrosion of AE2 it will actively remove chloride ions and so stabilise the vessel and preserve it for future generations.

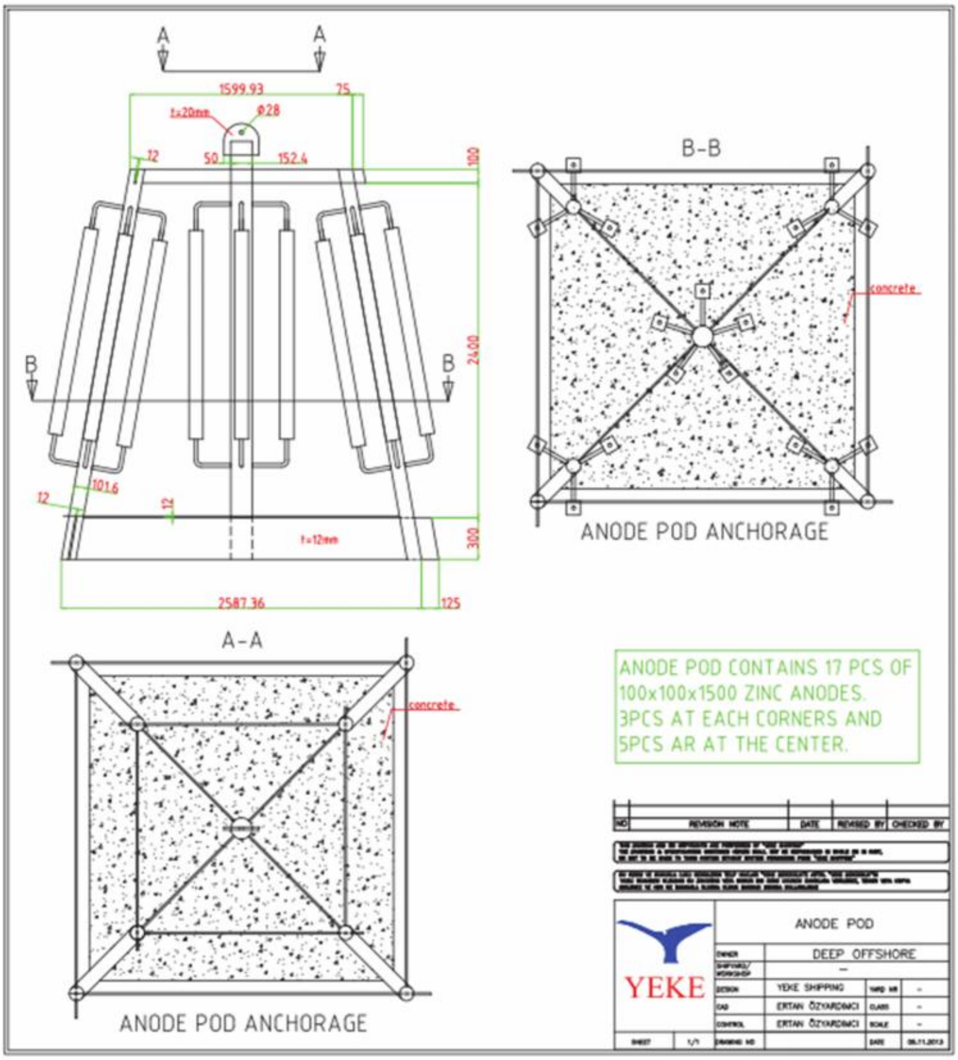
Chemical Environment in the Water Column and Inside AE2

The on-board instrumentation collected data on the salinity, temperature and dissolved oxygen levels in the water column from the surface down to the 73 metre depth of the wrecked submarine. Owing to operational delays this data has not yet been received but verbal reports from DSTO's Roger Neill have indicated that there is very clear evidence of the dramatic change in water quality as one passes through the halocline, in terms of changes in the physical oceanography of the seawater. This change had been provisionally reported in the first expedition to the site. As previously noted there was a very dramatic drop in the level of dissolved oxygen as the seabed was approached. The low levels of dissolved oxygen will have helped to protect the AE2 from the worst of the ravages of corrosion over the past 99 years.

It should be noted that this is an interim report made based on the summary 'quick look' data. When the drop camera with its instrumentation module was left inside the vessel for 24 hours it continued to record the water quality measurements. This resulted in collection of a large amount of data. A full report will be given once that data has been fully analysed. This data should provide information on the actual water quality inside the submarine and so help resolve the archaeological riddles associated with the apparent presence of a halocline inside the wreck.

Attachment:

1. Design of Anode Pods



Selected Images from AE2 Marine Archaeological Assessment

Initial Approach

Figure 1 After casing and approach to rear of fin

Figure 2 Fin bridge and Fin from Forward

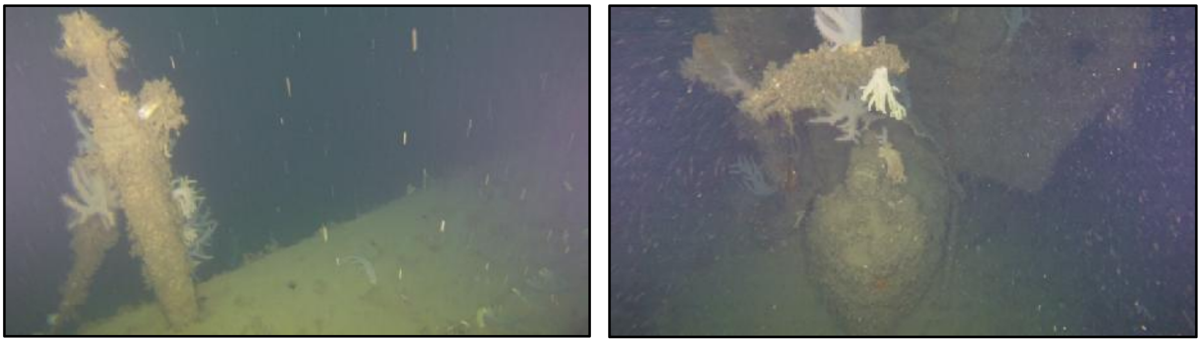


Figure 3 WT Antenna Stump and Forward Torpedo Tube

Figure 4 Forward Periscope pedestal and Conning Tower Hatch

Drop Camera Insertion

Figure 5 Drop camera, Bunts the Conger and Drop Camera Illumination

ROV Images from inside Conning Tower

Figure 6 Conning Tower Light and Scuttles, Flag Locker

Figure 7 Conning Tower Wheel and Flag Locker Deck Shoes

Figure 8 Conning Tower Engine Telegraph and Portable Antenna Cable

Control Room Drop Camera First Pass

Figure 9 Drop Camera Images: Log and Depth Gauge, Operating Valves

Control Room ROV

Figure 10 Descent into Control Room; first ROV shots from inside

Figure 11 Ballast Pump Starter, operating handwheels and gauges plus detail

Figure 12 Auxiliary switchboard; ladder and gyro compass repeat

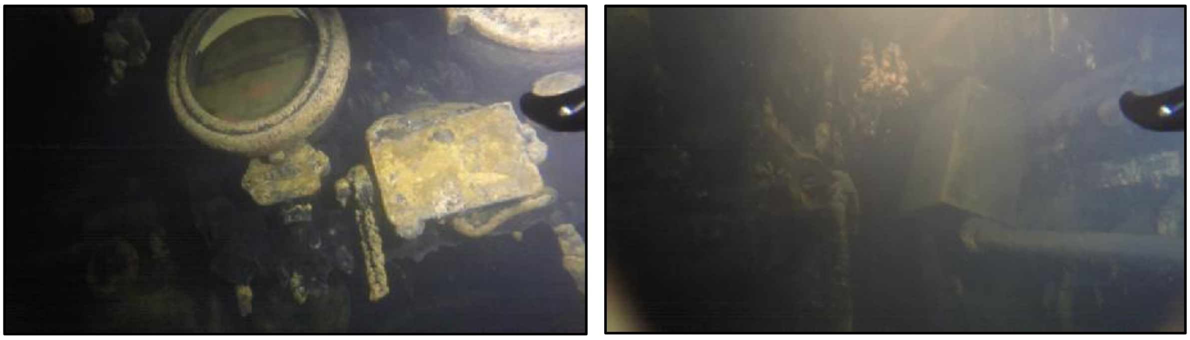


Figure 13 Log (Elliot Brothers); Aux panel and scuttling charge box

Figure 14 Wardroom table (upside down); Captain's Desk Light

Final Flyover Survey

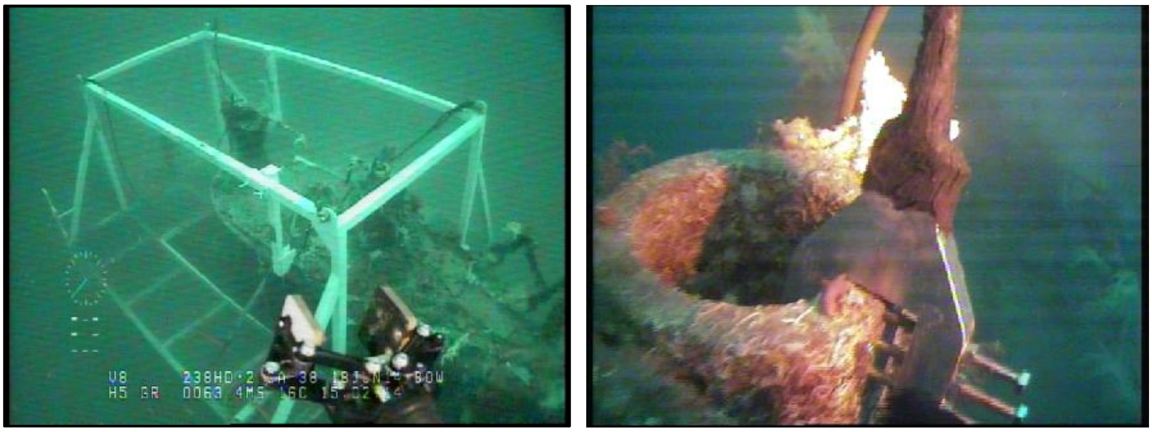


Figure 15 DSP Prior to Removal; Midships (Periscope Pedestal) CPS connection

Figure 16 Forward (Windlass) and After (Port Hydroplane) CPS Connections

Figure 17 After anode pod after 48 hours of depletion; Hatch closure device (Top Hat) in place

Figure 18 Bunts relocated to the after casing; final view of after casing on departure

Above water infrastructure

Figure 19 DSV Deck Layout and DSP Diver Briefing

Figure 20 MRTE Phase 3 Replica and DSP Launch

Figure 21 ROV (vLBV) Preparation; ROV (LBV) Briefing

Figure 22 Diving Bell Preparation; DSC loading temporary buoy

Figure 23 CPS Anode Pods; CPS Cable Connecting Clamp

Figure 24 DSV In position; Laying the moorings

Figure 25 Temporary Buoy in position: Shore HQ film shoot

16 Mayıs 2014 AE2CF REF: 14LET4301T

Sn. Sebnem NCESU
Yurtdışı Tanıtım ve Kültürel lişkiler Genel Müdürü (TKGM)
Dış şleri Bakanlığı

<u>Sessiz Anzac Projesi – Faaliyete Başlama hbarı</u>

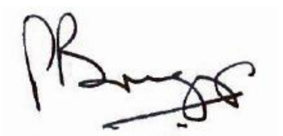
1. Dış şleri Bakanlığı tarafından verilen 2014/46373548-KUGY/4541837 sayı ve 21 Nisan 2014 tarihli onay çerçevesinde Marmara Denizinin altında yatan HMAS AE2 batığında yapılacak çalışmaların 7 Haziran 2014 tarihinde başlamasının planlandığını duyurmak isterim

2. N40 32.66. E27 16.14 batık koordinatında demirli olacak olan Dalış Destek taşıtımız M/V Kaptan-I Derya -2 (IMO:95037756) gemisine personel nakli için küçük hız tekneleri kullanarak, operasyonlarımıza 7 Haziran 2014 tarihinde Şarköy'den başlama niyetimizi buradan teyit etmek isterim. Çalışmalar 20 Haziran Cuma gününe kadar sürecektir.

3. Seyir şamandırası ile ilgili işlemler konusunda Deniz Güvenlik Müdürlüğü ile mutabık kalınarak yürütülecektir.

4. Türkiye'nin bir parçası ve Avustralya'nın ortak denizcilik mirasının korunması ve muhafazası ortak çabalarımızda devam eden desteğiniz için size teşekkür etmeyi bir borç bilirim.

Saygılarımla,



P. Briggs AO CSC
Emekli Tuğgeneral,
Başkan

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16 Mayıs 2014 AE2CF REF: 14LET4307T

Navigation, Hydrography and Oceanography Department

Sessiz Anzac Projesi – Faaliyete Başlama hbarı

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Başkan

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Registered Office: 51 Arkaringa Crescent, Black Rock, Vic 3913 Australia

16 Mayıs 2014 AE2CF REF: 14LET4306T

Ministry of Defence

Sessiz Anzac Projesi – Faaliyete Başlama hbarı

1. Dış şleri Bakanlığı tarafından verilen 2014/46373548-KUGY/4541837 sayı ve 21 Nisan 2014 tarihli onay çerçevesinde Marmara Denizinin altında yatan HMAS AE2 batığında yapılacak çalışmaların 7 Haziran 2014 tarihinde başlamasının planlandığını duyurmak isterim

2. N40 32.66. E27 16.14 batık koordinatında demirli olacak olan Dalış Destek taşıtımız M/V Kaptan-I Derya -2 (IMO:95037756) gemisine personel nakli için küçük hız tekneleri kullanarak, operasyonlarımıza 7 Haziran 2014 tarihinde Şarköy'den başlama niyetimizi buradan teyit etmek isterim. Çalışmalar 20 Haziran Cuma gününe kadar sürecektir.

3. Seyir şamandırası ile ilgili işlemler konusunda Deniz Güvenlik Müdürlüğü ile mutabık kalınarak yürütülecektir.

4. Türkiye'nin bir parçası ve Avustralya'nın ortak denizcilik mirasının korunması ve muhafazası ortak çabalarımızda devam eden desteğiniz için size teşekkür etmeyi bir borç bilirim.

Saygılarımla,

P. Briggs AO CSC
Emekli Tuğgeneral,
Başkan

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16 Mayıs 2014 AE2CF REF: 14LET4305T

Chief of Staff
Ministry of Transport, Maritime and Communications

<u>Sessiz Anzac Projesi – Faaliyete Başlama hbarı</u>

1. Dış şleri Bakanlığı tarafından verilen 2014/46373548-KUGY/4541837 sayı ve 21 Nisan 2014 tarihli onay çerçevesinde Marmara Denizinin altında yatan HMAS AE2 batığında yapılacak çalışmaların 7 Haziran 2014 tarihinde başlamasının planlandığını duyurmak isterim

2. N40 32.66. E27 16.14 batık koordinatında demirli olacak olan Dalış Destek taşıtımız M/V Kaptan-I Derya -2 (IMO:95037756) gemisine personel nakli için küçük hız tekneleri kullanarak, operasyonlarımıza 7 Haziran 2014 tarihinde Şarköy'den başlama niyetimizi buradan teyit etmek isterim. Çalışmalar 20 Haziran Cuma gününe kadar sürecektir.

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4. Türkiye'nin bir parçası ve Avustralya'nın ortak denizcilik mirasının korunması ve muhafazası ortak çabalarımızda devam eden desteğiniz için size teşekkür etmeyi bir borç bilirim.

Saygılarımla,

P. Briggs AO CSC
Emekli Tuğgeneral,
Başkan

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AE2: The Silent ANZAC
AE2 Commemorative Foundation

16 Mayıs 2014 AE2CF REF: 14LET4304T

Coastal Safety Command
Ministry of Interior

<u>Sessiz Anzac Projesi – Faaliyete Başlama hbarı</u>

1. Dış şleri Bakanlığı tarafından verilen 2014/46373548-KUGY/4541837 sayı ve 21 Nisan 2014 tarihli onay çerçevesinde Marmara Denizinin altında yatan HMAS AE2 batığında yapılacak çalışmaların 7 Haziran 2014 tarihinde başlamasının planlandığını duyurmak isterim

2. N40 32.66. E27 16.14 batık koordinatında demirli olacak olan Dalış Destek taşıtımız M/V Kaptan-I Derya -2 (IMO:95037756) gemisine personel nakli için küçük hız tekneleri kullanarak, operasyonlarımıza 7 Haziran 2014 tarihinde Şarköy'den başlama niyetimizi buradan teyit etmek isterim. Çalışmalar 20 Haziran Cuma gününe kadar sürecektir.

3. Seyir şamandırası ile ilgili işlemler konusunda Deniz Güvenlik Müdürlüğü ile mutabık kalınarak yürütülecektir.

4. Türkiye'nin bir parçası ve Avustralya'nın ortak denizcilik mirasının korunması ve muhafazası ortak çabalarımızda devam eden desteğiniz için size teşekkür etmeyi bir borç bilirim.

Saygılarımla,

P. Briggs AO CSC
Emekli Tuğgeneral,
Başkan

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16 Mayıs 2014 AE2CF REF: 14LET4303T

City Directorate of Culture and Tourism
Governorship of Canakkale

<u>Sessiz Anzac Projesi – Faaliyete Başlama hbarı</u>

1. Dış şleri Bakanlığı tarafından verilen 2014/46373548-KUGY/4541837 sayı ve 21 Nisan 2014 tarihli onay çerçevesinde Marmara Denizinin altında yatan HMAS AE2 batığında yapılacak çalışmaların 7 Haziran 2014 tarihinde başlamasının planlandığını duyurmak isterim

2. N40 32.66. E27 16.14 batık koordinatında demirli olacak olan Dalış Destek taşıtımız M/V Kaptan-I Derya -2 (IMO:95037756) gemisine personel nakli için küçük hız tekneleri kullanarak, operasyonlarımıza 7 Haziran 2014 tarihinde Şarköy'den başlama niyetimizi buradan teyit etmek isterim. Çalışmalar 20 Haziran Cuma gününe kadar sürecektir.

3. Seyir şamandırası ile ilgili işlemler konusunda Deniz Güvenlik Müdürlüğü ile mutabık kalınarak yürütülecektir.

4. Türkiye'nin bir parçası ve Avustralya'nın ortak denizcilik mirasının korunması ve muhafazası ortak çabalarımızda devam eden desteğiniz için size teşekkür etmeyi bir borç bilirim.

Saygılarımla,

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Emekli Tuğgeneral,
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AE2: The Silent ANZAC
AE2 Commemorative Foundation

16 Mayıs 2014 AE2CF REF: 14LET4302T

General Directorate of Cinema

<u>Sessiz Anzac Projesi – Faaliyete Başlama hbarı</u>

1. Dış şleri Bakanlığı tarafından verilen 2014/46373548-KUGY/4541837 sayı ve 21 Nisan 2014 tarihli onay çerçevesinde Marmara Denizinin altında yatan HMAS AE2 batığında yapılacak çalışmaların 7 Haziran 2014 tarihinde başlamasının planlandığını duyurmak isterim

2. N40 32.66. E27 16.14 batık koordinatında demirli olacak olan Dalış Destek taşıtımız M/V Kaptan-I Derya -2 (IMO:95037756) gemisine personel nakli için küçük hız tekneleri kullanarak, operasyonlarımıza 7 Haziran 2014 tarihinde Şarköy'den başlama niyetimizi buradan teyit etmek isterim. Çalışmalar 20 Haziran Cuma gününe kadar sürecektir.

3. Seyir şamandırası ile ilgili işlemler konusunda Deniz Güvenlik Müdürlüğü ile mutabık kalınarak yürütülecektir.

4. Türkiye'nin bir parçası ve Avustralya'nın ortak denizcilik mirasının korunması ve muhafazası ortak çabalarımızda devam eden desteğiniz için size teşekkür etmeyi bir borç bilirim.

Saygılarımla,

P. Briggs AO CSC
Emekli Tuğgeneral,
Başkan

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20 Haziran 2014 AE2CF REF: 14LET4327T

Sn Abdullah KOCAPINAR
Kültürel Varlıklar ve Müzeler Genel Müdürlüğü
Kültür & Turizm Bakanlığı

<u>Sessiz Anzac Projesi – Çalışmaların Tamamlanması</u>

1. Kültür ve Turizm Bakanlığının 94949537-163.99 72221 sayı, 11 Nisan 2014 tarihli yazısı ile verilen onay uyarınca, Marmara Denizinin tabanında yatan HMAS AE2 batığında yapılan çalışmaların başarılı bir şekilde tamamlandığını bilgilerinize sunarım.

2. MAA araştırması sırasında çekilmiş olan tüm görüntülerden oluşan 8 adet sabit sürücü ile faaliyetlere dair özet bilgi ile ilgili çeşitli etkinliklere dair bir liste de ekte ilginize sunulmuştur.

3. MAA araştırması sonuçlarına dair Bilimsel Rapor hazırlanmakta olup, 2 hafta içerisinde sunulacaktır.

4. Türkiye'nin bir parçası ve Avustralya'nın ortak denizcilik tarihinin koruma ve muhafazası konusunda ortak çabalarımıza devam eden desteğinizi için size teşekkür etmek isterim.
.

Saygılarımla,

P. Briggs AO CSC
RADM RAN Rtd,
Başkan

Ekler:

1. WD Unsurları 2 TB Seyyar Depolama Sürücüsü 1'den 8'e kadar numaralanmıştır. .
2. Günlük

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Dağıtım:

Sn Şebnem INCESU, Kültürel Diplomasi Genel Müdürü
Yurtdışı Tanıtım ve Kültürel lişkiler Genel Müdürlüğü
Dış şleri Bakanlığı

9 Mayıs 2014 AE2CF REF: 14LET4300T

Albay Mehmet KARABACAK,
Türk Sahil Güvenlik Komutanı
Marmara Denizi ve Türk Boğazları Bölgesi

<u>Sessiz Anzac Projesi – Yüzey Çalışmaları için Onay</u>

1. Avustralya'dan saygılarımızı sunarız. 16 Ocak 2014 tarihinde gerçekleştirmiş olduğumuz toplantyı takiben, Marmara Denizinde yatan HMAS AE2 batığında yapılacak olan çalışmalar için gerekli izinler alınmış olduğunu bilginize sunarım. zinlere dair belgelerin kopyaları ekte iletilmiştir.

2. N40 32.66. E27 16.14 batık koordinatında demirli olacak olan Dalış Destek taşıtımız M/V Kaptan-I Derya -2 (IMO:95037756) gemisine personel nakli için küçük hız tekneleri kullanarak operasyonlarımıza 7 Haziran 2014 tarihinde Şarköy'den başlama niyetimizi buradan teyit etmek isterim. Çalışmalar 20 Haziran Cuma gününe kadar sürecektir.

3. Marmara sahil güvenlik karakol komutanlıklarına gerekli talimatları iletmenizi rica ederim.

4. Türkiye'nin bir parçası ve Avustralya'nın ortak denizcilik mirasının korunması ve muhafazası ortak çabalarımızda devam eden desteğiniz için size teşekkür etmeyi bir borç bilirim.

Saygılarımla,

PBriggs

P. Briggs AO CSC
RADM RAN Rtd,
Başkan

Dağıtım:

Sn. Suat AKA,
Müsteşar Vekili,
Ulaştırma, Denizcilik ve letişim Bakanlığı

Sn. Şebnem INCESU
Kültürel Diplomasi Genel Müdürü,

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Dış şleri Bakanlığı

Ekler:

1. Dış şleri Bakanlığı Üçüncü Şahıs Notu 2014/46373548-KUGY/4259662, tarih 10 Şubat 2014.
2. Kültür ve Turizm Bakanlığı mektup referans: 94949537-163.99 72221, tarih 11 Nisan 2014.
3. Dış şleri Bakanlığı Üçüncü Şahıs Notu 2014/46373548-KUGY/4541837 tarih 21 Mayıs 2104.
4. Deniz Güvenlik mektup 19931511-207.2/23767 tarih 6 Mayıs 2104

18 Şubat 2014 AE2CF REF: 14LET4325T

Albay Olcay Özgürce,
Genel Müdür Vekili
Kıyı Emniyeti

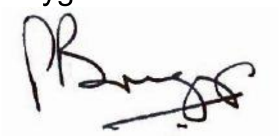
<u>Sessiz Anzak Projesi – Şamandıra Mülkiyeti</u>

1. Sessiz Anzak Proje uygulaması sırasında yerleştirilecek geçici ve kalıcı seyir şamandıralarının mülkiyeti ve bakımı hakkında 13 Haziran 2014 tarihinde düzenlenen toplantı için teşekkür ederim. Projeye olan kişisel ilginizi ve kısa surede düzenlenen toplantı için zaman ayırmanızı takdirle karşıladığımı ifade etmek isterim.

2. Şamandıralara sahip çıkma ve gelecekteki bakımlarını üstlenme kararınız bizleri çok memnun etmiş, şamandıralara dair devamlı bir Avustralya yükümlülüğü konusunda endişelerimi ortadan kaldırmıştır.

3. Ortak çabalarımıza devam eden desteğiniz için yeniden teşekkür etmek isterim.

Saygılarımla



P. Briggs AO CSC
Emekli Tümamiral
Avustralya Kraliyet Donanması
Başkan, AE2CF

Dağıtım:

1. Sn. Suat Hayri AKA, Ulaştırma, Denizcilik ve Haberleşme Bakanlığı Müsteşar Yardımcısı

2. Sn. Şebnem INCESU, Dış şleri Bakanlığı Yurtdışı Tanıtım ve Kültürel şler Genel Müdürü

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25 June 2014 AE2CF REF: 14LET4328T

Hakan Albay DIKKATINE
Deniz Kuvvetleri Komutanligi
Seyir Hidrografi ve Oşinografi Dairesi

<u>Sessiz Anzac pojesi – Seyir Şamandırası Yerleştirilmesi</u>

1. 14LET4326 sayı, 20 Haziran 2014 tarihli çeviri mektubumdaki bir hatayı düzeltmek isterim.

2. Geçici şamandıranın doğru pozisyonu [redacted] olacaktır.

3. Denizaltının kumanda kulesi merkezi [redacted] koordinatında olup, pruva [redacted] noktasında yatmaktadır.

4. Meydana gelebilmiş olan karışıklıktan dolayı özür diler Türkiye'nin bir parçası ve Avustralya'nın ortak denizcilik tarihinin koruma ve muhafazası konusunda ortak çabalarımıza devam eden desteğinizi için size teşekkür etmek isterim.

Saygılarımla,

P. Briggs AO CSC
RADM RAN Rtd,
Başkan

Ekler:

1. Geçici Şamandıra Fotoğrafları

Dağıtım:

1. Deniz Güvenliği Daire Başkanlığı Vekil Müdürü.

2. Ulaştırma, Denizcilik ve Iletişim Bakanlığı