

# **Motorised Submersible Canoe (MSC) 'Sleeping Beauty' Project**

**Report on background and maritime archaeological survey for a Motorised  
Submersible Canoe (MSC) or 'Sleeping Beauty' lost 1945, HMAS *Stirling*,  
Careening Bay, Cockburn Sound**



**Report—Department of Maritime Archaeology—No. 261  
Western Australian Museum**

**Ross Anderson  
April 2010**

## **Contents**

Acknowledgements

Background

Statement of Significance

Materials and predicted potential for site preservation

Collaboration

Survey results

Conclusion

Recommendations

## **Appendix A**

Statistics and specifications for the MSC 'Sleeping Beauty'

## **Appendix B**

Siebe Gorman & Co. Mark II Amphibian rebreather apparatus and diving suit

## **Acknowledgements**

This report is dedicated to the memory of Jack Sue who sadly passed away just before the survey for the MSC was undertaken. It is also dedicated to all of the brave men who joined the Services Reconnaissance Department (SRD) and trained in MSCs.

Mr Jack Sue DCM, ex Leading Aircraftman, RAAF, Z Special Unit

Mr Barry Sue, researcher

Capt Tom Hall, Operation Rimau researcher

Capt Wayne Gardiner RFD, Curator, Army Museum of Western Australia

Mr Gordon Hamilton, ex SRD

Des Williams, Historical Diving Society-Southeast Asia Pacific

Cmdr Brett Dowsing RAN, Commanding Officer, Fleet Base West, RAN

Lt Cmdr Grant White, Port Manager, Fleet Base West, RAN

Lt Cmdr Paul Sedgeman, Commanding Officer, Clearance Diving Team 4, RAN

Lt Katey Mouritz, RAN

Mr Gary Booth, RAN

Mr Mike Jones, MSC researcher

Mr Chris Ransted, National Archives, UK

Mr Gary Redmond, Secretary, Z Special Unit International

Commander Shane Moore, CSM RAN, Curator RAN Heritage Collection

Capt Duncan Perryman CSM, Senior Naval Historical Officer, Seapower Centre

Mr Peter Dick, ex-clearance diver

## Background

Between February and April 1944 following the spectacular success of Operation Jaywick, the British-Australia Services Reconnaissance Department (SRD) were training for another attack on Japanese shipping in Singapore Harbour codenamed Operation Rimau. The training for Operation Rimau was undertaken at Station XIII - Careening Bay, Garden Island, Western Australia. Operation Rimau was carried out in October/ November 1944, though with disastrous results when the mission was compromised and all the crew either killed, or captured and executed by the Japanese. Although Operation Rimau was unsuccessful, crews continued to train on Motorised Submersible Canoes, and Welman and Welfreighter mini-submarines at Garden Island until the end of the war.

The key to the stealth attack strategy for Operation Rimau was to use Motorised Submersible Canoes (MSC), also affectionately known as 'Sleeping Beauties', powered by batteries and an electric 1.5hp starter motor. The Sleeping Beauties' single operators wore rubber wetsuits and oxygen rebreathing gear, and were exposed to the ocean and elements.

The Allied Inter-Services Research Bureau began work on the MSC in 1942. The craft was designed by Major H.Q.A. Reeves and originally named the Underwater Glider (UWG), to become affectionately known as the 'Sleeping Beauty' (SB) and later officially designated by the Admiralty as the Motorised Submersible Canoe (MSC) (Davis 1955: 317; Rees 2008 247-252). The project design was for a single operator craft that could carry a larger explosive charge to attach to ships' hulls below the waterline, than could be carried in a two person Folbot (collapsible paddled canoe) and be able to penetrate all known enemy harbour defences. The craft could also be used for short-range reconnaissance and to reconnoitre the sea bottom down to a maximum depth of 50 feet (Rees 2008: 250, 258). Trials took place in late 1942 in Scotland, and crews trained on MSCs in Scotland, England, Ceylon and Australia (<http://www.welfreighter.info/SB.html>).

In early 1944 trials of MSCs were undertaken at Station XIII Careening Bay, Garden Island, Australia, which had facilities for MSCs including a testing tank, degaussing coil and workshop (Rees 2008: 263). Ten Mark IIa MSCs were provided and training and tests involved endurance testing, night dives, and practical exercises involving attacks on ships with limpet mines, and on anti-submarine nets (*ibid*).

Following Operation Rimau sometime between February and May 1945, during a night training exercise, an unknown number of MSC trainees were to affix limpet mines to a plate hanging from a ship anchored in Careening Bay/ Cockburn Sound. During the exercise one of the MSCs was reported as circling out of control in 60-70 feet depth in Careening Bay. RAN corvettes in the area were called in, and they were able to track the craft on anti-submarine detection (ASDIC) sonar equipment, however eventually the batteries gave out causing the craft to be lost on the seabed, and it was not found nor ever recovered. The cause of loss was most likely that the operator had passed out using standard oxygen re-breathing diving equipment in excess of 5-7 fathoms (30-42fsw/ 9-13msw), as recommended as the maximum dive limit on oxygen in later US Navy dive tables (J. Sue to M. McCarthy/ WA Museum, 28/3/1979).

In the 1980s a un-named crab fisherman caught an unidentified metal object in his net in Careening Bay. The object was handed in for identification to the RAAF Museum at Bull Creek, who subsequently contacted ex-RAAF Sergeant Jack Sue. Jack Sue immediately identified the object as an aluminium instrument console from an MSC. This find provided the first post-war indication of an approximate location and depth for the missing MSC. At a ceremony on 21 May 2009 ex-Z Special Unit personnel Jack Sue and Gordon Hamilton handed over the console to the Royal Australian Navy, HMAS Stirling. Barry Sue (Jack Sue's son) also advised the fisherman said he recovered another object he believed was a limpet mine, that he later regretted 'taking to the dump' (B. Sue to WA Museum, 21/7/09). This would most likely have been a practice/ dummy limpet mine.

## Z Force and a long-lost canoe

22/May/2009

Comments:



Commander Angela Bond, HMAS Stirling, with Gordon Hamilton and Jack Sue, former 'Z' Force members. Picture: Neil Mulligan [Buy this photo](#)

**Figure 1: Jack Sue and Gordon Hamilton with MSC aluminium console at handover ceremony, HMAS Stirling, 21 May 2009 (Community Newspapers, 22 May 2009, world wide web archive)**

While the approximate location is known by Mr Jack Sue (reportedly to within 100m), diving and tow searches by himself, and Mr Harold Roberts from the WA Underwater Explorers Club in the 1970s failed to locate the craft (J. Sue to M. McCarthy/ WA Museum, 28/3/1979). The Royal Australian Navy has not conducted any searches for the MSC (G. Booth to WA Museum, pers. comm., 7/7/2009) though Navy personnel are aware of the report and there have been anecdotal reports from Navy divers searching for the site during training exercises. There has been a long history of correspondence between Jack and Barry Sue and the WA Museum regarding a proposed search for the MSC.

### Missing operator

Research has been carried out in an attempt to ascertain the identity of the MSC operator and confirm the loss of an MSC in a training accident. As the SRD had personnel from many Allied countries the operator could be from any Commonwealth or Allied country.

Major Tom Hall (Ret.) provided information from his card file of names listed by the Australian War Graves Commission that no Australian lives were lost during training at Garden Island, WA. (T. Hall to WA Museum 5/8/09). No reply has as yet been received from the Department of Veterans' Affairs, Office of Australian War Graves on records held, or other avenues for research into Allied personnel killed in training accidents in Australia. Major Hall also advised that:

During my research – 1958 – 1990, I found only one Soldier who had an accident in SB's – or Underwater Submersible Canoes to give them their correct name. Sergeant HARRY BROWN served in SRD and was listed to take part in Operation RIMAU – he told me that he panicked and COMMANDER DONALD DAVIDSON (who was the 2 I/C of the Operation and was killed in action in November 1944) dived in and saved him from drowning. (T. Hall to WA Museum, pers. comm., 5 August 2009)

An search of the National Archives in the UK provided copies of files relating to Operation Rimau and MSC training at Garden Island but these files do not have any definite information on any death(s) occurring in training.

From the evidence so far discovered it seems apparent, at least, that the operator was not Australian.

Mr Gordon Hamilton, who trained in the third MSC training course in October 1944 and was a member of Z Special Force at Garden Island said that he was not aware of any loss of an MSC or personnel in a training accident. He described one training incident where one of his mates was trying to do a loop but ended up coming out of the water 'like a rocket' and had to abandon the MSC. Eight of them had to search Careening Bay for the missing craft and eventually found it in 6 feet of water near the shore.

Mr Hamilton provided other information about the use, capabilities and training in MSCs at Garden Island including:

- The SRD training depot was north of old Garden Island store, managed by Fred Oliver;
- The MSC training course took 6 weeks;
- They had a hole in the craft to fit a pole and sail but this was 'no good';
- The MSCs were 'hard to paddle' and you had to 'come home with enough juice' in the batteries;
- They did a battery test every week where they would submerge to chin height, blow tanks and surface then submerge again over and over until the batteries ran out. There was variation in the life of the batteries;
- The trainees would try and do loops but 'you couldn't do a complete loop' as it always twisted halfway;
- They didn't use the Dunlop shallow water craft gear but used wetsuits from the submarines that you had to step into the middle of 'like an apron';
- They used submarine escape lungs he thought were called 'Johnson' escape gear (Davis??) rebreathers;
- They were weighted and wore a couple of weights around their waist and a couple of weights around their ankles, worn with a lanyard;
- They used to do regular weighing and buoyancy exercises, involving a 'static dive' exercise where they would put on their gear and weights and (minus the MSC) get into the water close to the jetty and put their arms over their heads

and submerge, the idea being to get 5-6 feet underwater, and achieve neutral buoyancy.

## STATEMENT OF SIGNIFICANCE

### HISTORIC

The MSC is associated with the training and wartime operations of SRD, which was the forerunner of the Special Air Service (SAS) and Special Boat Service (SBS) arms of British and Australian military covert and stealth operations. Due to the catastrophic loss of British naval power in Southeast Asia after the sinking of the HMS *Repulse* and HMS *Prince of Wales*, Singapore—the bastion of British colonial rule and ‘Gibraltar of the East’—effectively became a land base. Upon Singapore’s capture by the Japanese the RN and RAN were forced to adapt their naval strategy to use stealth, as opposed to strength. The MSC is therefore representative of the inventive and technical efforts made by Allied forces to harass enemy shipping in the region, and strike at the then enemy’s heart in heavily defended harbours.

### TECHNICAL

The Underwater Glider (UWG) / Motorised Submersible Canoe (MSC)/ ‘Sleeping Beauty’ was designed by the famous British engineer and inventor Major Hugh Quentin Alleyne Reeves (later Lieutenant Colonel). It is believed that author Ian Fleming (who worked in naval intelligence during World War II) based the character ‘Q’ in the James Bond series of books on Major Reeves (Rees 2008: 249). Major Reeves was one of the most prolific engineering designers at The Frythe at Welwyn, Hertfordshire or research station IX of the Inter Services Research Bureau (Special Operations Executive) (*ibid*). The MSC was essentially a disposable craft and parts were not designed for longevity or re-use, however as a design it was proven to be seaworthy and could operate in paddling, sailing or submersible modes. Reeves obtained a patent over the craft and fully intended to commercialise it following the war for use in pearl diving and salvage operations (*ibid*), however he was killed in an aircraft testing accident in 1955 (Rees 2008: 247). The MSC is also a unique design borne of wartime requirements, with the use of mild steel sheet construction, car batteries and electric starter motor propulsion unit necessitated by wartime shortages (Rees 2008: 249).

### SOCIAL

The MSC is closely associated with the training and operations of the SRD and the tragic failure of Operation Rimau.

Past members of Z Special Unit and the SRD such as Sergeant Jack Sue (Ret.) and their families have a strong interest in the location of the MSC and its lost operator. The loss of Operation Rimau personnel is publicly commemorated at Kings Park, Perth on the Sunday closest to 10 July every year.

At present the name of the MSC operator is unknown however on the basis of present research he appears to be an overseas Allied serviceman, and his family and relatives may be surviving. There is an international community of returned servicemen who also relate to the MSC and similar Allied assault craft, submarines and submersibles. For example it is planned for a memorial to be built at Queen Mary Reservoir in Staines, UK, to commemorate SRD personnel who trained and experimented on MSCs, Welman and Welfreighter mini-submarines, and some of whom died there during training (M. Jones to WA Museum, pers. comm. 22/7/09).

The MSC is closely associated with the RAN and World War II secret training

operations carried out at Station XIII Garden Island naval base, which is currently HMAS *Stirling* Fleet Base West for RAN submarines and Clearance Diving Team 4.

#### ARCHAEOLOGICAL

At present the archaeological site has not been located and cannot be assessed, however is predicted to be in fragmented and deteriorated state. There may be remains of the operator and diving gear on the site. Due to its historic, technical and social significance described above, any remaining evidence of the site will have archaeological significance.

#### SCIENTIFIC

The MSC has scientific interest for its application of materials and underwater technologies. If the site is located, environmental, microbiological and corrosion studies of the site's materials and its site environment can provide information to assist in conservation and management of the site, with findings and ramifications applicable to the study of similar sites worldwide.

#### INTERPRETIVE

Due to its possible location in restricted Commonwealth naval waters the site has little interpretive significance for the public. An original example in the Army Museum Fremantle and replica in the WA Museum, Victoria Quay are on public display that serve to interpret the design, construction and purpose of these craft. The MSC and its operator can also be interpreted and commemorated via display of the recovered console and associated interpretive material at HMAS *Stirling*.

#### RARE

The MSC is a unique example of a stealth assault craft built for special operations in coastal waters behind enemy lines. During the war it's construction, experimental development, training and missions were conducted in secrecy, and following the war they were destroyed in secret. After World War II a number of Sleeping Beauties are said to have either been dumped in the Ships' Graveyard off Rottnest Island (G. Booth to WA Museum, pers. comm., 7/7/2009), or buried in landfill in the Jandakot area (S. May, Manager Maritime History, WA Museum, pers. comm., 6/7/2009) or Byford ammunition dump areas, however the exact location of these craft are either disputed, not known and/ or not recorded. Due to the veil of secrecy there is little information and documentation on the Sleeping Beauties and SRD activities, and the Royal Australian Navy Historical Branch and RAN Seapower Centre have confirmed they have no further details on the craft or their operations in Australia. Any relevant archives were apparently removed after the war and sent to the UK (G. Booth to WA Museum, pers. comm., 7/7/2009).

The Army Museum of Western Australia in Fremantle has an original hull of an MSC obtained from the UK for a display relating to the SRD, though the hull was bought in a stripped state, and interior fittings have been replicated (W. Gardner, Army Museum to WA Museum, pers. comm., 11/6/2009). The Western Australian Museum has a replica of an MSC that is on loan from Jack Sue for display in the naval exhibit, Victoria Quay Maritime Museum.

Operation Rimau required a total of 36 MSCs with 6 required for training and 30 for operational use. MSCs # 22, 23 24, 37, 38, 39 were allocated to Australia for Operation Rimau, before they had come off the production line (M. Jones to WA Museum, pers. comm. 21/7/09). Sixteen MSCs were sent on Operation Rimau and upon the operation being compromised were scuttled in Malaysian waters. # 38 and #39 are recorded as being prepared for training at Raeo Island near Morotai on

9/7/1945 (M. Jones to WA Museum, pers. comm. 21/7/09).

Given the information of 36 craft provided to Australia, allowing for the 16 lost in Operation Rimau, #38 and 39 at Morotai and single MSC lost in Careening Bay, up to 17 MSCs may have been scuttled or buried in Western Australia following the war.

The only original (as fitted out) MSC/ Sleeping Beauty in Australia is the Careening Bay MSC. It is the only RAN submarine/ submersible lost during operations or training in Australian waters. It has the potential to exhibit original details of fit out and equipment relating to these craft, as fitted for wartime and training purposes.

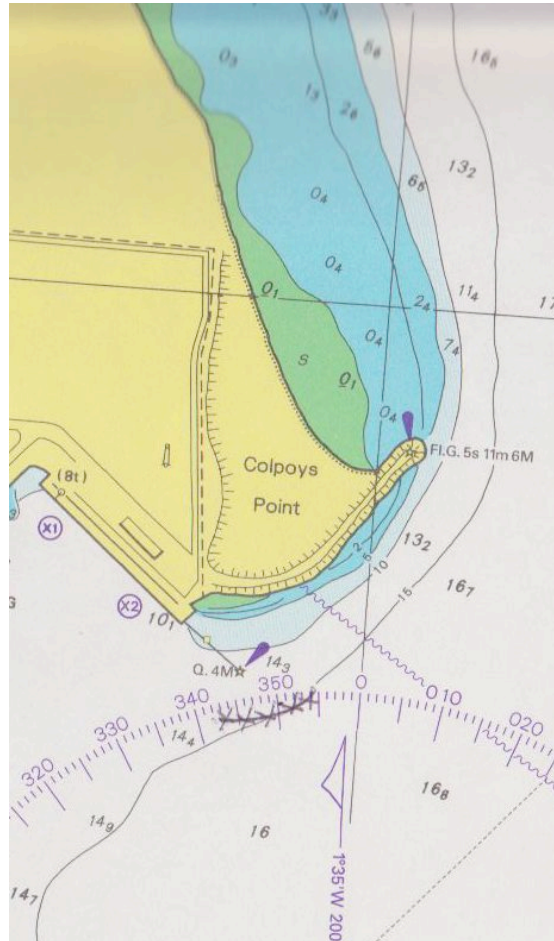
#### REPRESENTATIVE

The MSC is representative of the total of 218 MSCs delivered to the Admiralty (of 244 ordered), though it is also claimed that of 300 hulls ordered 257 were supplied and fitted out (Rees 2008: 250).



## Location

Jack Sue provided an approximate location based on his personal contact with the crab fisherman who recovered the MSC aluminium console. A copy of AUS111 Careening Bay chart was provided to Barry Sue, and Jack was able to mark the approximate position on the chart, off the southeast end of Colpoys Point on the 15 metre contour.



**Figure 2: Approximate location of MSC wreck site in Commonwealth waters, Careening Bay as marked on AUS111 chart by Jack Sue.**

## Materials and predicted potential for site preservation

The MSC hulls were lightly constructed of mild steel sheet welded together with mild steel stiffeners. The high pressure air bottles used for the ballast system are aluminium alloy, and the cowlings, deck hatch covers and rudder are aluminium. Questions remain as to the exact nature of other fittings and materials that include the propeller (copper alloy?), compressed air piping (copper alloy?) and seat (timber? aluminium?).

The condition of the aluminium console cowling recovered in the 1980s is fragile and corroded, and was minus the instruments and gauges (these may still be attached to the craft instrument panel). They are consistent with materials that have been submerged in the marine environment. If there are remnants of the hull then it is likely to be very fragile and corroded. Copper alloy materials and more solid components such as the batteries, craft flooding, suction, ballast and trim tank valves

and nozzles, compressed air cylinders, compressed air piping, starter motor, propeller shaft and propeller are likely to be intact, if undisturbed.

If the site has been protected in deep water (c.15m depth), and is fully or partially buried and undisturbed in Careening Bay there is a chance that the remaining components of the site have been preserved *in situ* to some degree. However known disturbance in the Careening Bay area includes the crab fisherman who discovered the console, anchoring, dredging, placement and recovery of moorings, propeller wash from large vessels, construction of jetties and other navigation and naval infrastructure, and clearance diver training activities.

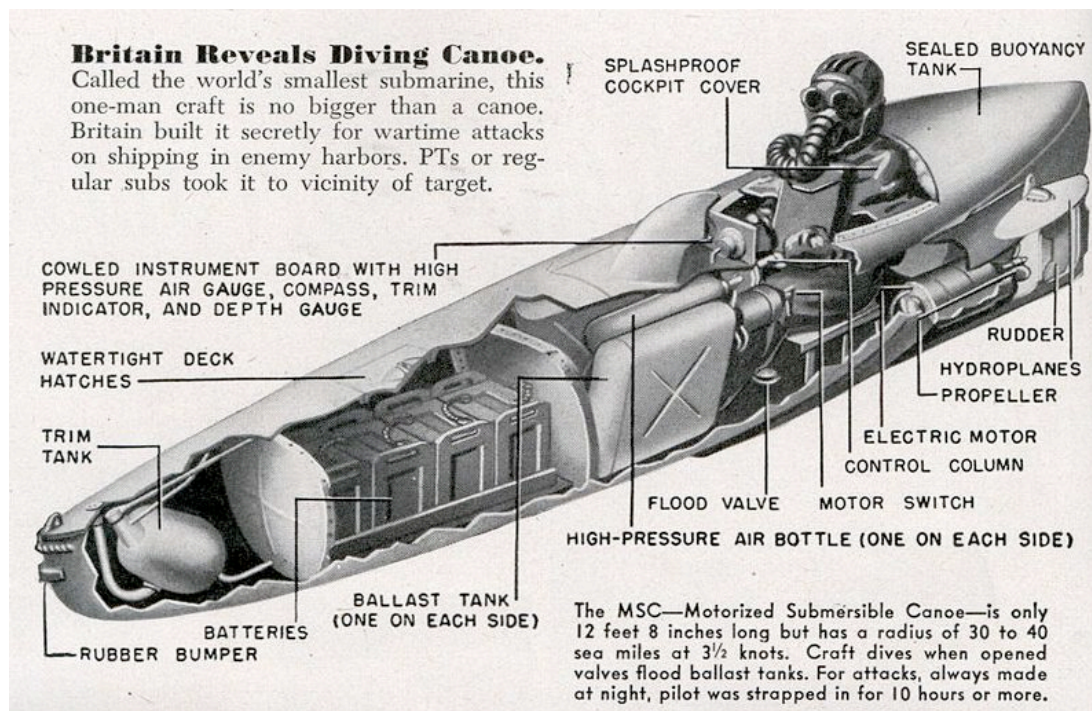
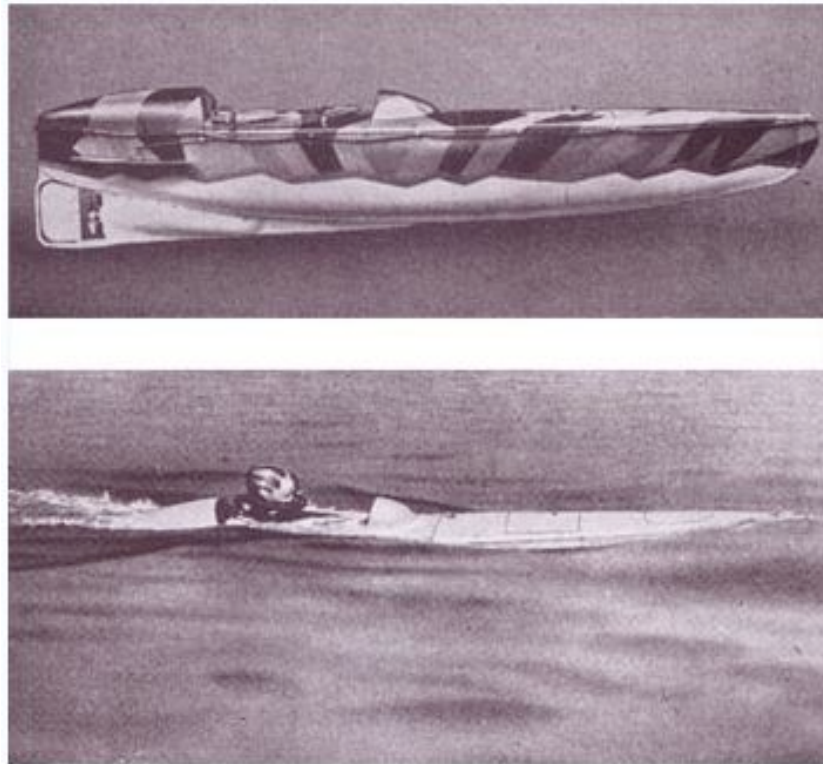


Figure 3: Schematic diagram of MSC (*Popular Science*, March 1947)



**Figure 4: MSC in profile, and showing 'trimmed down' position on the surface (National Archives UK)**

The seafloor in the area of Careening Bay and Cockburn Sound is soft clay (AUS 111 Careening Bay and Approaches) and silt that provides good conditions for site preservation.

Artefacts and materials that are known to have survived from other World War II aircraft and shipwreck sites in temperate waters in Australia include aluminium aircraft fuselages and components, human remains, rubber gas masks and tyres as well as more durable materials such as copper alloy, steel and lead. Mild steel is known to corrode more readily than steel or iron, so little can be expected to remain of the actual hull, or if so, it will be extremely fragile.

Therefore the site is predicted to be in a disintegrated state, with longer-lasting component materials surviving within a discrete area, depending on any disturbance that has affected the site. The controls, instruments and ballast system may have been held in place by their interconnected wiring, Teleflex controls and compressed air piping. The site may be partially buried to its 'waterline', or deeper, with a build up of sediment. The potential for associated human remains and diving equipment that may be located within and/or outside the hull cannot be discounted. The operator's oxygen re-breathing apparatus and diving equipment consists of a rubber bag, steel oxygen bottle, glass and rubber mask, rubber hood, lead weights and rubber hoses while the diver wore a rubber wetsuit.

### **Search strategy**

The search is planned to be conducted using the WA Museum's side scan sonar, magnetometer and fathometer. There is potential for assistance from the RAN Hydrographic Survey to conduct a magnetometer, multi-beam and/ or side scan sonar survey within the search area, and also for the Clearance Diving Team 4 (CDT4) to assist with diving searches.

Using the approximate position provided by Jack and Barry Sue as a search starting point, it is planned to conduct a detailed remote-sensing search which can be undertaken within a day. Anomalies recorded as targets will be recorded for later investigation by divers from CDT4 and the WA Museum. As the MSC was only 3.85m in length it will only register as a small target. There may be associated fish (as with any small 'reef' or substrate for marine growth offering habitat and protection), small tidal scour holes, or a small wreck mound to assist in its identification as a target. Using a non-disturbance circular search method all targets are to be examined visually by divers, photographed and reports of all findings are to be collated.

A staged approach is planned for the search that is outlined as follows:

- 1) RAN and WA Museum meeting to discuss collaborative approach and support, agreement on non-disturbance search strategy, archaeological guidelines (non-disturbance) and ethical considerations.
- 2) Search strategy and timing agreed upon by all parties
- 3) Non-disturbance search conducted – remote sensing and diving
- 4) Report and results

It is proposed that the WA Museum be responsible for archaeological and heritage site management issues, and produce the final report.

Depending on the outcomes of the non-disturbance search following stages will involve:

- 5) Historic Shipwreck Declaration;
- 6) Management assessment (site and environmental data, corrosion survey, integrity, human remains);
- 7) Report and Conservation Management Plan.

### **Site management issues, roles and responsibilities**

The main issues surrounding this site are as follows:

- 1) Long term protection and management

What is the best outcome for the site in terms of its long-term protection? Issues include its location in Commonwealth/ naval waters, materials, integrity, site environment and conservation.

If the MSC wrecksite is located it could be nominated for declaration as an historic shipwreck less than 75 years old (requiring special declaration by the Commonwealth Minister for Environment, Heritage Water and the Arts). The WA Museum is the statutory authority for the management of historic shipwrecks in Western Australia, and existing historic shipwrecks in Commonwealth/ naval waters at Careening Bay include the *Day Dawn* and *Dato*.

*In situ* preservation and non-disturbance of historic shipwrecks is the preferred way to manage historic shipwreck sites. Guidelines for the best practice of managing of historic shipwrecks include the ICOMOS Australia Burra Charter and UNESCO Convention for the Protection of Underwater Cultural Heritage 2001. Any disturbance would require a permit with conditions based on accepted archaeological and heritage site conservation practice.

## 2) Human remains and commemoration of service personnel

As the Careening Bay MSC is reported to have been lost with its operator, the site must be approached with regard for the potential for human remains to be found in association with the site. If the site is found a non-disturbance survey may provide visual evidence for any obvious human remains, or remains of the operator's diving equipment.

Full consultation will be held with the RAN on the issue of human remains as this is a Department of Defence personnel issue.

If excavation and recovery of human remains is recommended by the Department of Defence this should be carried out in accordance with the Commonwealth *Historic Shipwreck Act 1976* and conditions of standard archaeological procedures and controls. This could be managed by the WA Museum with support and assistance of the RAN.

### **Roles and responsibilities**

The following roles and responsibilities are proposed for organisations to be involved in a collaborative partnership with WA Museum and RAN as lead organisations.

WA Museum –archaeological and heritage site management, materials, corrosion and conservation studies, publication of report;

RAN – naval area access permits and clearances, project collaboration, shipping movements, CDT diving support, RAN Hydrographic Service multi-beam sonar survey of search area;

Jack and Barry Sue, Gordon Hamilton – providing position of search area, research assistance and support;

Z Special Force Association – research assistance and support;

Royal Australian Army Museum, Fremantle – research assistance and support.

### **Survey results**

Two magnetometer and sidescan surveys were carried out at HMAS Stirling in November 2009, with the support of the Department of Defence and RAN observers onboard.

The area covered was in the immediate vicinity of Colpoys Point from the shore out to the 20 metre contour.

The first survey resulted in unworkable data, possibly due to electrical interference and choppy seas while the second survey provided better data, but did not locate any features or anomalies worth investigating.

### **Conclusions**

A concerted attempt to relocate the site of a reportedly missing MSC was unsuccessful in finding any targets on the seabed that could be the wreck site. It is possible that, as a small craft made of mild steel, the site has degraded and become buried in silt to make it difficult to observe visually via diver survey or remote sensing. There is still potential for remains of the MSC to survive buried in the seabed.

**Recommendations**

1. Though the search was inconclusive the MSC should be recorded as a potential unlocated underwater cultural heritage site in Department of Defence/ Commonwealth waters;
2. Liaise with Department of Defence personnel regarding conservation of the MSC console at HMAS Stirling;
3. Provide a copy of this report to the Department of Defence, HMAS Stirling, and Fremantle Army Museum.

#### 4. Appendix A

##### Statistics and specifications for the Motorised Submersible Canoe/ Sleeping Beauty

References: Inter-Services Research Bureau, c.1942, *The Sleeping Beauty provisional handbook for training operational teams*, Inter-Services Research Bureau, London and Rees 2008 (264).

Length overall	3850mm
Beam	685mm
Height	787mm
Weight	279kg with all gear, air bottles, oxygen apparatus and cargo but minus operator
Hull	Best quality mild steel semi-silver finish plate. All joins welded and beaten true to moulded offsets and flow lines. Stiffeners, top hat section of mild steel are riveted or spot welded on to the craft. Top deck hatches of craft and instrument panel aft of battery rack, streamlined cowl and rudder are constructed of aluminium. Hull able to withstand pressure to 50ft (15.24m).
Cowlings	aluminium
Air bottles	Two aluminium alloy air bottles charged to 2000lbs/sq.in. interconnected to blow main ballast tanks off an HP valve. Ballast and trim tanks fitted with self blowing Kingston valves.
Oxygen	2 hours max.
Compass	Combined compass and trim indicator. Magnetic compass in binnacle with correction rods and spheres, horizontal trim indicator marks inside compass sphere
Controls	Single stick operating rudder and hydroplanes via teleflex wiring sheathed in brass tubing and levers on control surfaces
Clock	Watertight 8 day aircraft clock, luminised orange
Depth gauge	1x 50ft (15.24m), luminised orange
Air pressure gauge	Watertight HP air gauge connected to bottles by flexible HP rubber tubing, clipped to inside left hull accessible by operator to remove and inspect, luminised orange
Paddle	1
Cockpit cover	Waterproof cockpit cover that can be rolled back and fastened with a zip for flooded up or trimmed down position
Stern locker	The stern cowling forms the stowage locker, access via hinged headrest.
Seat	Spring controlled two-position seat (high-low)
Headguard	Collapsible headguard permanently fitted, two positions (raised and lowered)
Mast	wooden two piece (for stowage) 6ft total length
Lug sail	Area 36sq.ft. parachute silk (Egyptian cotton for training purposes) stowed in stowage locker in stern cowling
Charges	Two types charges: 3.5lb of explosive (neutrally buoyant), 2.5lb of explosive
Batteries	Four 6 volt Exide type 3XCZ-15H lead acid batteries, 89 amp hr/ 15 hr discharge rate. Exide Type K pillar clamps, connected in series to provide 24V for Full Speed and in two paralleled pairs in series to provide 12V for Cruising Speed.
Motor	24 volt (0.5hp), electric compound wound direct drive to 8" three bladed propeller



Electricals	Santon rotary speed switch Type Special R349 (Full and Cruising Speed modes, Full Astern Mode), interconnecting wiring
Full speed	4.4 knots for 12 miles
Cruising speed	3.1 knots for 40 miles
Operational planning range	3 knots for 30 miles

Davis records that due to wartime scarcity of aluminium alloy bottles in the UK, supplies were sourced from Luftwaffe bombers that had crashed, as they carried their oxygen in racks of aluminium alloy bottles of the exact size and thread type used by Siebe Gorman & Co. for their diving equipment. Orders were given that all oxygen bottles should be collected from Luftwaffe aircraft wrecks, and the undamaged ones were tested, re-valved and used in underwater breathing apparatus (Davis, 1955: 306).

It would be of interest to see any markings on the aluminium alloy MSC bottles to see if they were manufactured in the UK or Germany.



## Appendix B

### Siebe Gorman & Co. Mark II Amphibian rebreather apparatus and diving suit

The MSC operator wore the Siebe Gorman and Co. Amphibian Mark II rebreather apparatus and Dunlop diving suit that was designed for shallow-water work and special operations. The suit consisted of a Dunlop rubber wetsuit with built in shoes, and the rebreather apparatus was fitted to the operator with a heavy duty harness. The Siebe Gorman Mark II Amphibian suit replaced the 'Charioteer' human torpedo type goggles and was in use for MSC operations from December 1943. It took a minimum of three months for personnel to become trained and competent in diving dress, rebreather and MSC operational use (Rees 2008: 266).



Fig. 305

*Top Left:* Amphibian Mark I suit for shallow-water work—also used by Army in rivers and canals.  
*Bottom Left:* Suit worn by crew of "Human Torpedo".\*

*Top Right:* Mine recovery suit of non-magnetic material.  
*Bottom Right:* Amphibian Mark II suit for shallow-water work and special operations (submersible canoes).

\* This is an enlarged version of the D.S.E.A., i.e. larger cylinders and CO<sub>2</sub> absorbent chamber, and with a reducing valve on a neck extension of a cylinder, as in the Davis "Proto" apparatus.

**Figure 5: Bottom right diver is shown wearing the Amphibian Mk II suit designed for 'shallow-water work and special operations (submersible canoes)'. Bottom left is the 'Charioteer' human torpedo type dress (Davis 1955: 321)**

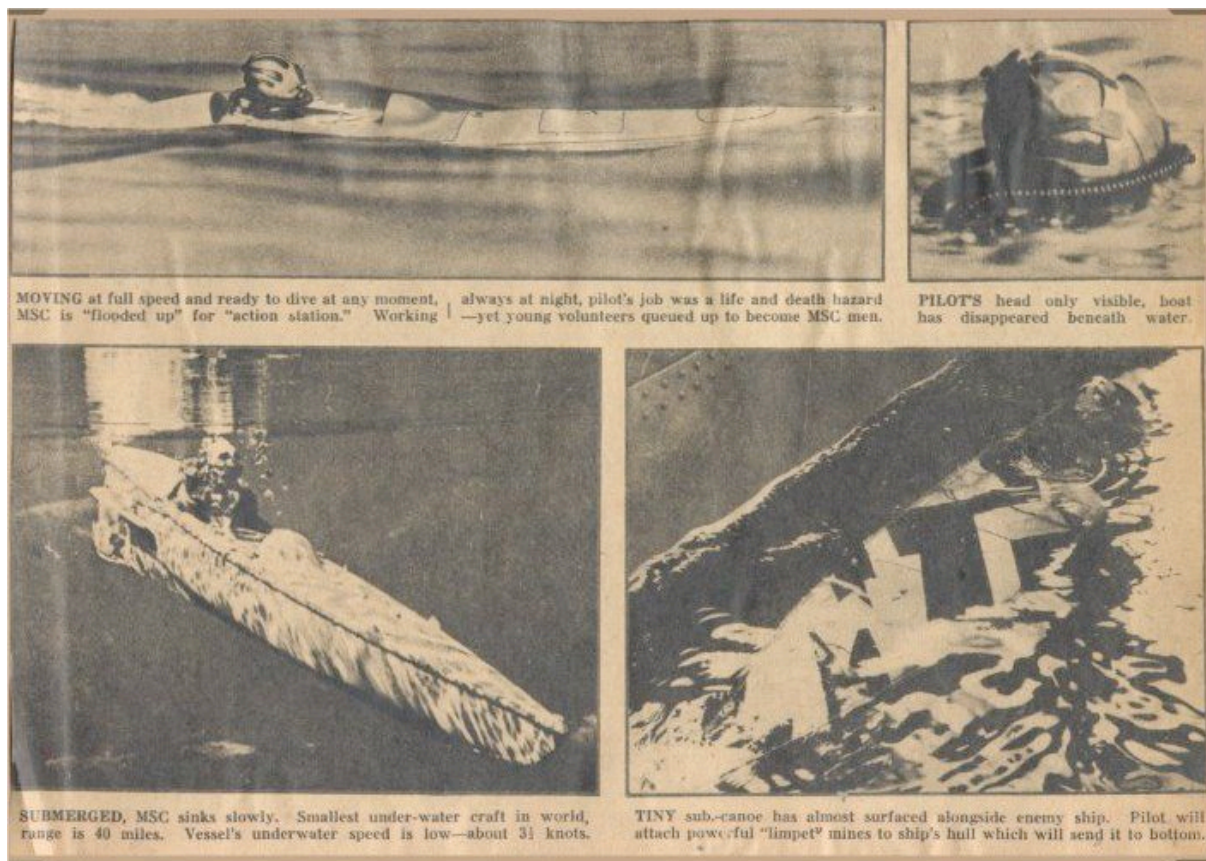


Figure 6: Various photographs of MSC and operator in diving dress.



Figure 7: MSC and operator in Mark II Amphibian diving dress



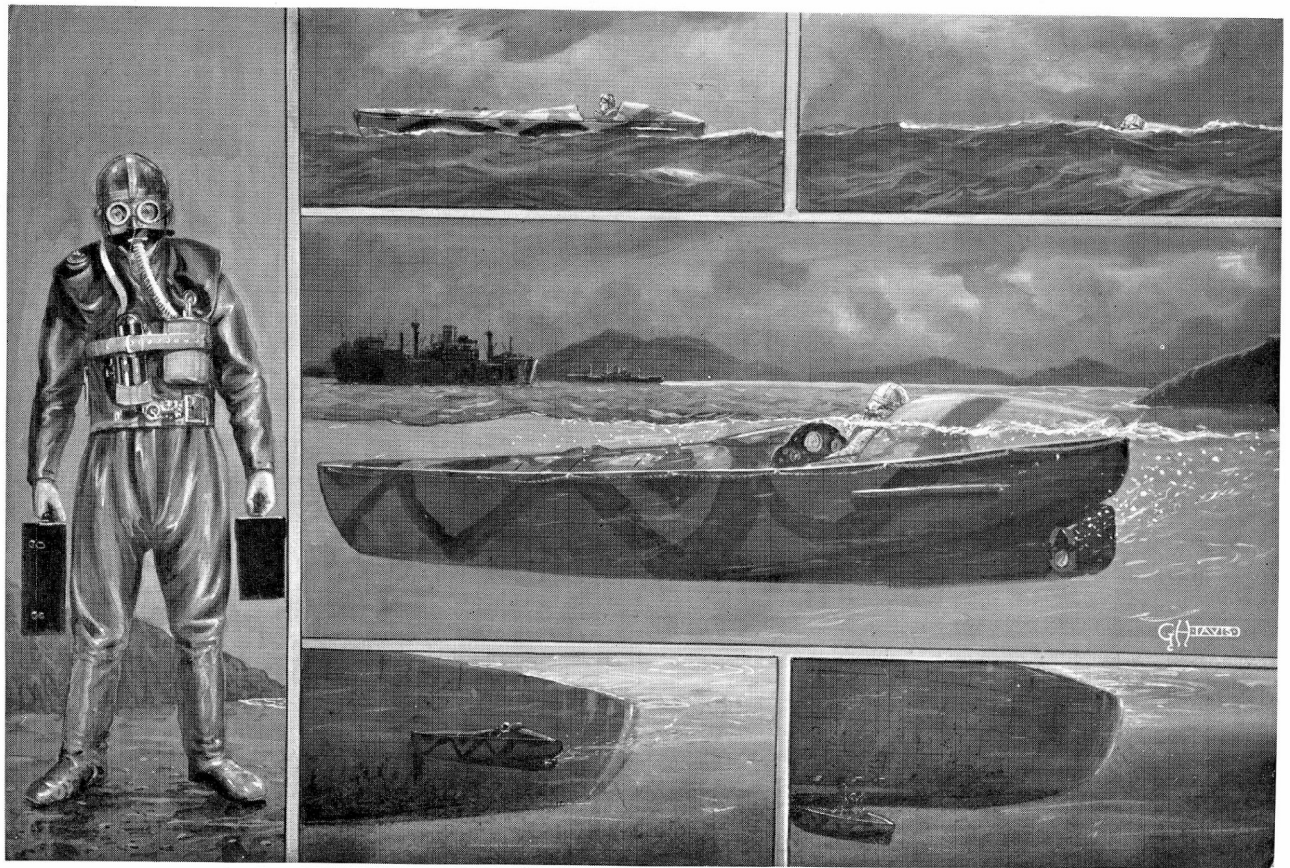


Fig. 302. Siebe, Gorman & Co.'s Amphibian Mark II apparatus as used in submersible canoes

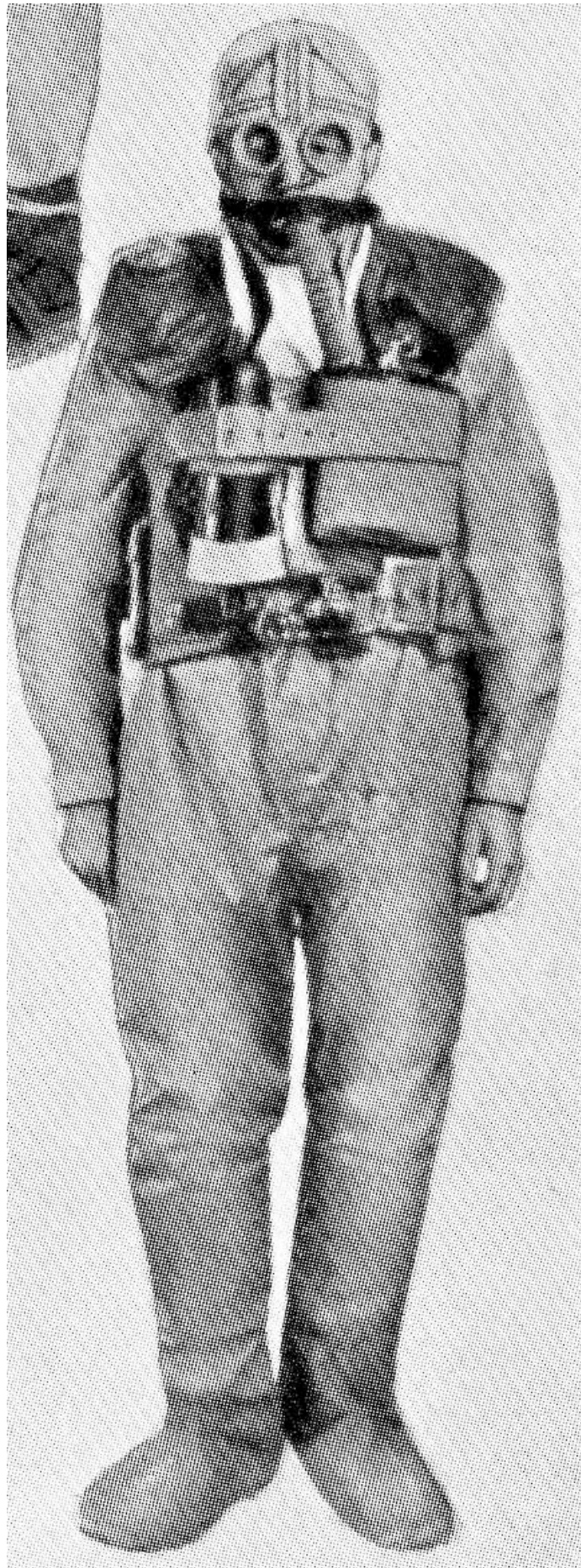
**Figure 8: Siebe Gorman and Co. diagram of MSC and operator in diving dress (Davis 1955: 317)**

Figure 8 shows a diagram of the operator in a Dunlop rubber suit wearing the Amphibian Mark II apparatus and carrying explosive charges. He is fitted with a twin eyepiece mask and hood with spiderbands. The mouthpiece for the single hose rebreather is held on by a strap.



**Figure 9: Detail of layout and components of Siebe Gorman & Co. Mark II Amphibian rebreather (Source unknown)**

Figure 9 shows the oxygen diluent bottle and carbon canister. The bottle was steel, mounted on the front with the scrubber and a modified exhaust valve. The backpack contained the counter-lung. The rebreather automatically added oxygen to the circuit and had a maximum operating depth of 30 feet (9.14m).



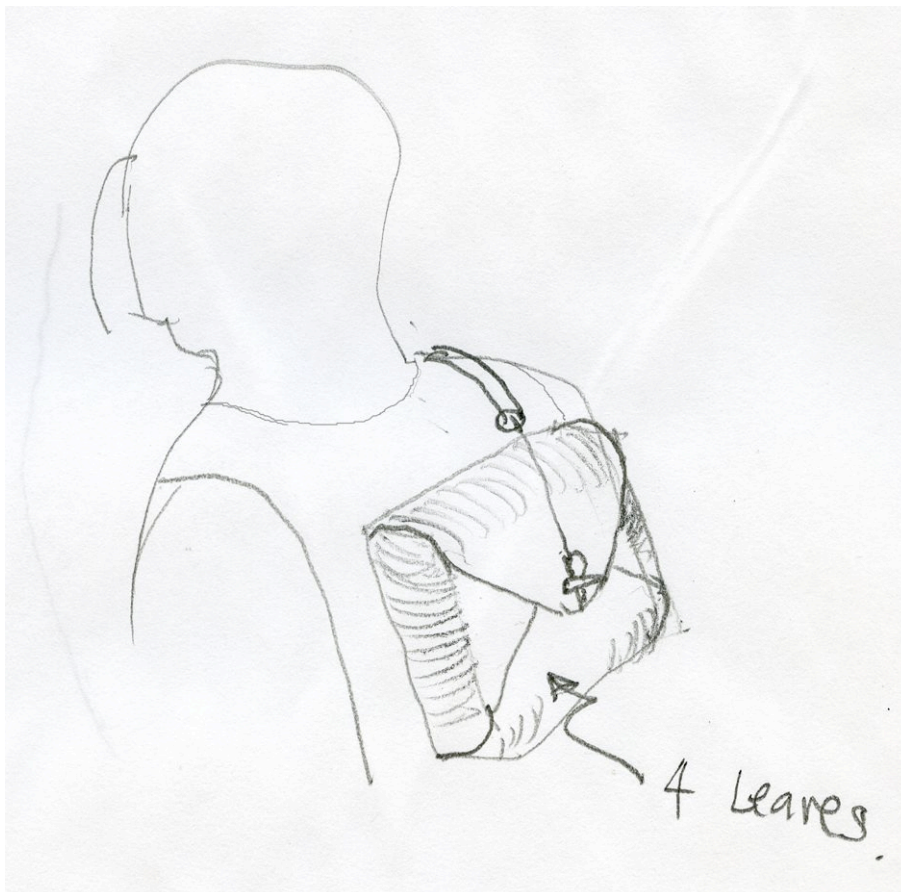
**Figure 10: Detail of operator wearing Amphibian Mk II rebreather and Dunlop suit for shallow-water work and special operations (submersible canoes) (Davis 1955: 321)**



Peter Dick also trained in MSCs and provided the following information about the diving suits and weighting arrangements.

The Dunlop gear came late in the war and Dunlop also built the later post-war CDBA (Clearance Diver Breathing Apparatus). Therefore, it is reasonable to assume that the weighting arrangement remained the same. Both Rob and self have used the CDBA, myself a long time ago. Nonetheless I remember the weights being 16oz lead balls contained in a pouch, say 10x8 inches, placed high on the diver's back. That is, counterlung and cylinders were on the front, the diver's head went through a hole in the rubberised fabric which reached down to the waist at the back. With the nitrox sets, there were two cylinders in the small of the back supported by this harnessing.

My quick crude diagram shows how I remember they were held together - each leaf with a hole at the extremity which went over a vertical post. The leaves were sprung loaded, so they were held in place by a wire split ring through a hole in the pillar.



**Figure 11: Diagram of weighting arrangement for MSC operators (Drawing Peter Dick)**

The ring was connected to a string which went into a tube that, in earlier models went down to the waist and in later ones terminated at shoulder level, in a pull ring. Pull it and the pouch sprung open to drop the weight.

We have no pictures. I went through a number of the books in my library but could not find a trace. However, the Australian Navy will undoubtedly have an operations manual from the 1950s or whatever which should give a line drawing of the arrangement. They may even have a CDBA in a museum. Robe tells me that the Australian Navy called the CDBA the 5561 when it was the basic oxygen arrangement and 5562 when it was the nitrox arrangement.

(P. Dick to WA Museum, pers. comm., 22/7/09)

## References

Davis, Sir R.H., 1955, *Deep diving and submarine operations: a manual for deep sea divers and compressed air workers*, Parts I and II Sixth Edition, London.

Inter-Services Research Bureau, c.1942, *The Sleeping Beauty provisional handbook for training operational teams*, Inter-Services Research Bureau, London. (Copy No. 179, National Archives of Australia, with handwritten notes).

Rees, Q. 2008, *The cockleshell canoes: British military canoes of World War Two*, Amberley Publishing, Gloucestershire.

## Websites

[http://www.knaw.nl/ecpa/sepia/exhibition/pro/pro\\_5\\_4.html](http://www.knaw.nl/ecpa/sepia/exhibition/pro/pro_5_4.html) (accessed 12/7/09)

[http://www.therebreathersite.nl/Zuurstofrebreathers/English/hall-ress\\_and\\_davis\\_escape\\_apparatus.htm](http://www.therebreathersite.nl/Zuurstofrebreathers/English/hall-ress_and_davis_escape_apparatus.htm) (accessed 15/7/09)