

The Challenge of Hydrographic Surveying and Charting the Antarctic

Roderick NAIRN, Australia

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SUMMARY

The Antarctic represents unique challenges for surveying and charting due to its remoteness, severe climatic conditions and political circumstance. Nevertheless the need for accurate and reliable nautical charts has never been greater especially with the increasing number of vessels of all sizes navigating the area for scientific research, in support of national Antarctic programs and, ever increasingly, for “eco-tourism”.

This paper discusses the need for hydrographic surveys and charting in Antarctica, it outlines the challenges faced in coordinating efforts to undertake surveys and produce charts in Antarctic waters (largely undertaken by the International Hydrographic Organization’s Hydrographic Sub-Committee on Antarctica) and finally it provides an insight into the practical challenges of conducting hydrographic surveys in the harsh conditions of the Antarctic.

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1.0 INTRODUCTION

1.1 Accurate, comprehensive and reliable nautical charts are essential for safe and efficient movement of marine traffic. Nautical charts also provide the base level, three dimensional situational awareness framework that supports scientific research and conservation efforts. Hydrography provides the underpinning information to produce these nautical charts, thus is the fundamental enabler of safe navigation and marine scientific research. The detailed bathymetry, bottom texture information and water column data such as sea temperature and salinity, collected during hydrographic surveys provide critical ground truth to support wide area analysis using remote satellite sensors and are essential to the modelling and understanding of oceanic currents and sea temperature trends.

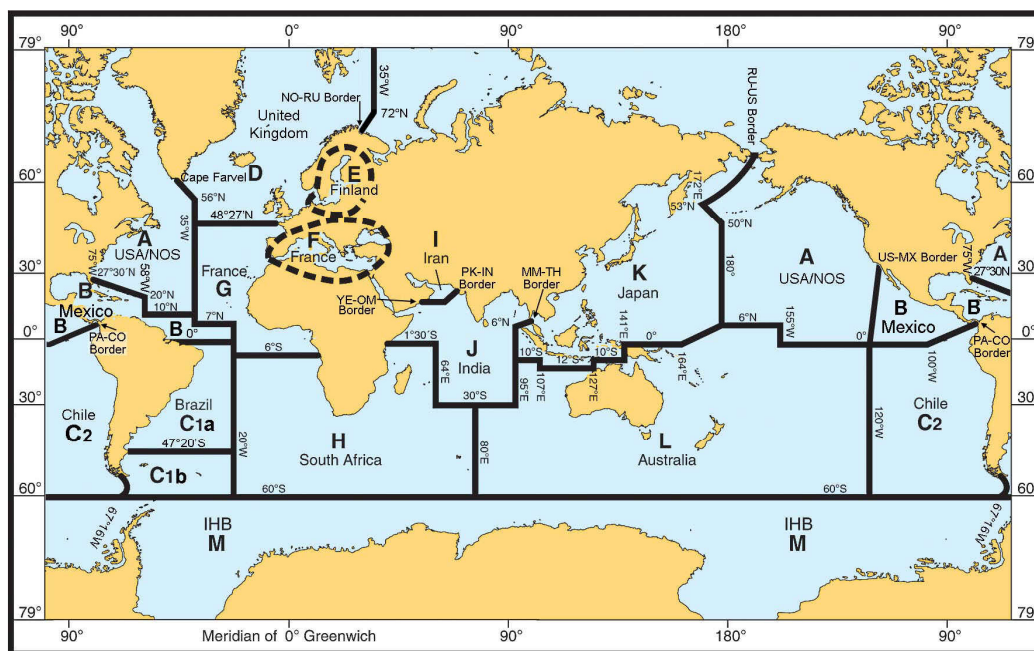
1.2 Hydrographic data assists in the prevention of maritime accidents in two principal ways. Firstly, identification and publishing of hazards to navigation allows ships to safely avoid them. Secondly, by “providing data for electronic navigation (in which ships’ positions from satellite are displayed continuously with chart information) they help to reduce human error in navigation which, at present, is the most common cause of shipwrecks.”¹

1.3 The Antarctic is a unique region, characterised by its remoteness, its hostile extreme climatic conditions and its void status with respect to internationally recognised national sovereignty. These factors combine to create special challenges in the conduct of hydrographic surveys and the provision of comprehensive coordinated coverage of nautical charts.

2.0 STATUS OF SURVEYING AND CHARTING IN THE ANTARCTIC

2.1 According to the Council of Managers of National Antarctic Programs (COMNAP), “less than 1% of the sea area within the 200m contour has been adequately surveyed to meet the needs of contemporary shipping entering Antarctic waters. The channels and approaches to bases around the Antarctic Peninsula have seen the most intensive effort, yet even here, some 60% of the area within the 200m contour has never been systematically surveyed, while the remainder requires re-survey. Elsewhere, barely 1% of the area within the 200m contour has been systematically surveyed.”² The International Hydrographic Organization (IHO) continually monitors information on the status of surveying and charting world wide in its publication C-55. The purpose of which is “to present a clear picture of the worldwide coverage of surveys and nautical charts and of the extent of effective

organisations for the timely promulgation of navigational safety information”³. The latest figures in relation to the Antarctic are consistent with the COMNAP report.



IHO Regional Charting Areas

3.0 THE NEED FOR HYDROGRAPHIC SURVEYING AND CHARTING

3.1 There has always been a need for accurate surveys in the Antarctic. Whereas Mariners in temperate regions may use a good lookout, a high sun angle and polarised sunglassed to help them negotiate uncharted waters, the antarctic master is effectively blind when the surface of the water is covered with ice and ships are unable to use forward looking sonars due to the risk of ice damage. In recent years a number of factors have come to the fore which illustrate that the need for accurate data and nautical charts is more critical now than ever before. Increased risks demand improved charting, particularly given the increasing global concerns for preservation of the environment and support for Antarctic research into global warming.

3.2 Increase in vessel traffic

3.2.1 In the 2008-2009 Antarctic Austral Summer season, 37858 tourists visited the Antarctic region⁴, most of them by sea. The statistical data shows a steady increase in passenger numbers, particularly over the past decade and this trend is expected to continue into the future. The increase in vessel traffic and passenger numbers has far exceeded the hydrographic charting and survey effort. This increase, coupled with inadequate or inaccurate charts, raises the risk of a potential incident involving vessels in the area running aground or colliding with underwater hazards that have not been adequately identified.

3.3 Increase in vessel size

3.3.1 In the past decade the average size of tourist vessels entering the Antarctic region has increased, with some vessels carrying up to 1,000 passengers.⁵ With the increase in size of vessels there are higher risks relating to inadequate charting. Deeper drafts mean that the risk of vessels running aground or colliding with obstacles is greater. Where surveys are incomplete and areas poorly charted ships traditionally plan to pass over the same ground as previous voyages in order to minimise their risk. However with substantial increases in ship's draught even this principle offers little assurance of safety, as previous voyages were likely to be in shallower ships. More importantly, an increase in the size and passenger capacity will inevitably lead to a great human and environmental tragedy in the event of a collision or incident.

3.4 Increased Pressure on Tour Operators for New Sites

3.4.1 With the popularity of Antarctica increasing as a tourist destination, there has come increasing competition between tour operators. They seek to arrive at landing areas first and are thus encouraged to transit at higher speeds which may be considered imprudent, especially where ships are not ice strengthened and floating ice is present. There is also increased pressure on tour operators to take passengers to hitherto unvisited and increasingly more remote areas in order to avoid other tourist groups and to enhance the wildlife experience of the guests. This poses the greatest demand for new surveys and presents a particular risk as vessels will otherwise be entering waters which are potentially more dangerous because of little or no survey data being available.



3.5 Increased Global Awareness and Support for Protection of the Environment

3.5.1 In 1991 the Consultative Parties to the Antarctic Treaty adopted the Protocol on Environmental Protection to the Antarctic Treaty. This Protocol sets out environmental principles, procedures and obligations for the comprehensive protection of the Antarctic environment, and its dependent and associated ecosystems. However the important matter of navigational safety received little consideration in this Protocol.

3.5.2 The International Association of Antarctica Tour Operators (IAATO) was also created in 1991 to advocate, promote and practice safe and environmentally responsible private sector travel to the Antarctic⁶. Amongst their members they have adopted strict codes for management of tourism activities to aim for zero impact on the habitat and environment, this includes limiting their activities to adequately charted waters.

3.5.3 Globally the general public awareness and concern about protection of the environment has escalated over the past decade, particularly with the information revolution made possible by satellite communications and the internet. It means that virtually any incident, anywhere in the world can be available in people's living rooms in colour video within minutes.

4.0 ORGANISATIONAL CHALLENGES OF SURVEYING AND CHARTING THE ANTARCTIC

4.1 The Antarctic is generally considered to include the area south of 60 degrees South but actually includes some areas further north as it is defined as the whole area south of the Antarctic Convergence and includes the continent, off lying and oceanic islands, ice shelves, sea ice and the ocean.

4.2 The Antarctic region is subject to numerous international conventions and agreements. Pre-eminent among them is the Antarctic Treaty which entered into force in 1961. Australia was one of the 12 original signatories of the Treaty, the total number of parties currently stands at 47.⁷ A number of States have claimed territory within the Antarctic region, however other States have consistently refused to recognise any of these claims. Australia's Antarctic Territory claim was formalised in 1933, pre-existing the Antarctic Treaty. It is recognised by France, New Zealand, Norway and the United Kingdom. Article IV of the Antarctic Treaty, whilst in force, preserves the status quo in terms of Antarctic Claims. It states inter alia that: "Nothing contained in the present Treaty shall be interpreted as: a renunciation or diminution by any Contracting Party of any basis of claim to territorial sovereignty in Antarctica which it may have whether as a result of its activities or those of its nationals in Antarctica"⁸ but the article also prevents pursuance of actions to enhance claims stating that: "No acts or activities taking place while the present Treaty is in force shall constitute a basis for asserting, supporting or denying a claim to territorial

sovereignty in Antarctica or create any rights of sovereignty in Antarctica. No new claim, or enlargement of an existing claim, to territorial sovereignty in Antarctica shall be asserted while the present Treaty is in force”⁹.

4.3 Responsibilities for Surveying, Charting and Hydrographic Services

4.3.1 The Safety of Life at Sea (SOLAS) Convention which has been widely adopted world wide, defines the responsibilities and obligations of coastal states regarding the provision of hydrographic services. Chapter 5, Regulation 9 provides clear rules for contracting governments as to what is expected of them regarding the collection, compilation, publication, dissemination and keeping up to date of nautical information required for safe navigation to the limits of their territorial seas. In combination with the requirements of the United Nations Convention on Law of the Sea (UNCLOS) many of these requirements are extended to the Exclusive Economic Zones.

4.3.2 The responsibilities for these services in the high seas are however, not defined in international law. The IHO has implemented a cooperative approach towards coordinating the charting of international areas. Through a network of Regional Hydrographic Commissions (RHCs) consisting of States with territory in the region, consultation is encouraged and each RHC produces a schema of International Charts and agrees on the responsibility for production.

4.3.3 The Antarctic is a different case again, whilst multiple (in some cases overlapping) territorial claims exist there are no universally recognised sovereign States and so no State can be held to have territory in the region. Accordingly, the responsibilities for Hydrographic Services defined in SOLAS cannot be effectively applied and even the concept of a Regional Hydrographic Commission does not neatly fit. To overcome this dilemma the IHO has defined a Hydrographic Sub-Committee on Antarctica which allows membership to any State who has acceded to the Antarctic Treaty, signed the statutes of the HCA and contributes to the surveying and charting of the Antarctic. At the time of writing there are 19 Antarctic Treaty Parties participating in the HCA¹⁰, there are also a number of affiliated organisations which have observer status. The statutes of the HCA attempt to overcome the lack of specific accountabilities of States with respect to surveying and charting in the Antarctic. The HCA pursues the goal of continually improving the standard of nautical charting in the region in order to provide the essential information to allow safe navigation of ships. The HCA’s aims include to: “promote technical co-operation in the domain of hydrographic surveying, marine cartography and nautical information in the region...to implement the INT chart scheme for the region.....to facilitate the exchange of information between Hydrographic Authorities.”¹¹

4.4 Coordination of Surveying and Charting Effort

4.4.1 The HCA has proven to be a reasonably effective organ to coordinate the international charting scheme for the Antarctic region. Many States have been willing

to take on the responsibility for production of International Charts and there is a comprehensive large and small scale nautical chart scheme covering the region. To support this scheme it promotes the open and efficient sharing of hydrographic surveying data particularly to ensure that the State responsible for the production of each international nautical chart is provided with any data collected by any other State. However, in practice this goal is far from achieved and some States have been unwilling to share their data, thus tending to undermine this otherwise very effective organisation. An Electronic Navigation Chart schema has also recently been produced. However the quality of the charting remains generally poor, due to the sparsity of hydrographic information. The elephant in the room is the requirement for substantial investment in hydrographic surveying activities to provide the necessary data.

4.4.2 Whilst States have shown a willingness to contribute to the altruistic goals of improved safety of navigation, ultimately they will prioritise their actions in their own national interest. Without the obligations that arise from sovereignty over a particular area within Antarctic, States have generally been reluctant to invest significant time and resources into undertaking surveying and charting activities which do not directly benefit them. Such survey and charting cannot be held to be a national obligation, regardless of the existence of a territorial claim. Hydrographic surveying is both expensive and time consuming. Treaty Member States are likely to have higher priority survey taskings within their recognised areas of maritime jurisdiction, so survey taskings in Antarctica may not be addressed.

4.4.3 The HCA has been actively engaging with other international groups to encourage national investment in hydrographic surveying in the Antarctic. The XXVI meeting of the ATCM (Madrid) adopted Resolution 3 (2003) which included a call for national authorities to “redouble their efforts to:....coordinate their hydrographic and charting activities through the IHO’s Hydrographic Commission on Antarctica,.....support and contribute to the ongoing development of the INT chart scheme.” Five years later, an HCA presentation to ATCM XXXI (Kyiv) supported the adoption of Resolution 5 (2008) which included the specific recommendations to “forward any Antarctic hydrographic and bathymetric data collected to the relevant international producer for charting action; and endeavour to find additional resources towards improving hydrographic surveying and charting in the Antarctic region.”¹² Despite these positive outcomes, progress continues to be slow.

4.4.4 Opportunistic data collection is another source of hydrographic information to update charting. The IHO is the single point of collection for any passage sounding data provided by participating national or tourist vessels. The HCA through cooperation with COMNAP and IAATO has updated the instructions for collecting and rendering of hydrographic information and promoted its use.

4.4.5 Despite these efforts there is no doubt that a great deal of hydrographic information for the Antarctic region has not been shared and so has not been used to update nautical charts. An initiative to seek out and capture all possible bathymetric

information to create an International Bathymetric Chart of the Southern Ocean is being undertaken with the support of the International Oceanographic Commission Regional Mapping Program and the Geosciences Expert Group from the Scientific Committee on Antarctic Research. The project has already identified a number of datasets that have not been included in international nautical charts.

5.0 PRACTICAL CHALLENGES OF ANTARCTIC HYDROGRAPHIC SURVEYING

5.1 A Very Limited Survey Window

5.1.1 Antarctica is well known as a place of great beauty as well as being one of the most hostile environments on Earth. Adverse and extreme oceanic and meteorological conditions make the task of hydrographic surveying particularly challenging. Collection of survey data is subject to favourable weather and the absence of ice. In many coastal areas the survey season is limited to one or two months per year when the area is relatively ice free. Even within these periods grounded icebergs can restrict access and onshore winds can move broken pack ice back to obstruct the survey area. This means that there is only a very limited window of opportunity to collect hydrographic data in the region.



Pack Ice on the Approach to Mawson Station

5.2 Hostile Environment

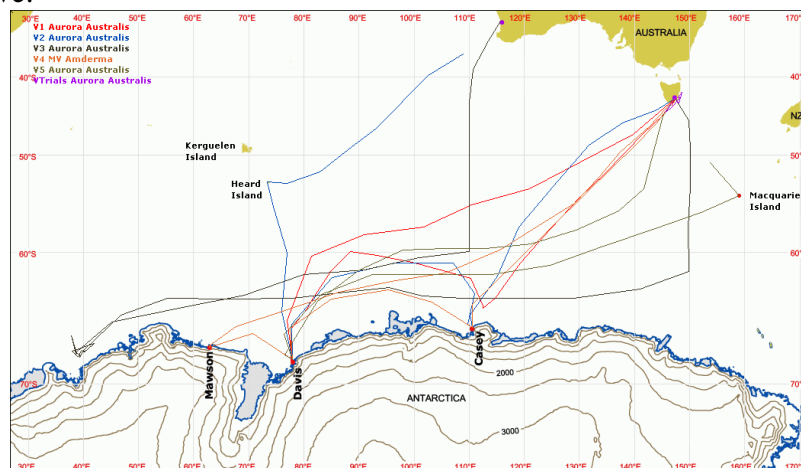
5.2.1 The Antarctic is an area of extremes and conditions can change rapidly, strong katabatic winds are a regular feature. Small survey boats, which are required for operations in unsurveyed, dangerous areas are far more susceptible to high winds and sea conditions than larger ships. Accordingly, their operations are restricted and they require close support from larger vessels. This is not always possible if the resupply support ships have other priority tasks – the result is further reduction to the survey output. Strong winds, freezing temperatures and ice floes present high risks to survey equipment as well as to personnel. Personnel require special training in safety and survival and whilst careful planning can help to ensure appropriate spares are available any catastrophic equipment failure can result in the loss of an entire survey season.



Survey Boat Caught in High Winds

5.3 Remote Locality

5.3.1 From the Australian perspective the Antarctic is especially remote. The Australian Hydrographic Service has no ice capable ships and has to rely on Australian Antarctic Division resupply ships to transport and support their 9 metre Antarctic survey vessel. Survey deployment programmes are dictated by the busy summer station re-supply shipping schedules which are promulgated 12 months in advance. The transit from mainland Australia to survey areas in the vicinity of Australian Antarctic bases takes in 12-14 days and when no support ship is available survey operations are restricted to within 15 km of the shore base. The survey team is sometimes deployed for 3 months awaiting a return passage on the resupply ship but unfavourable ice conditions may prevent survey operations for long periods. Any unexpected equipment failures can result in the entire deployment being unproductive.



Australian Antarctic Voyages 2008-2009 Season

6.0 CONCLUSIONS

6.1 Less than 1% of the sea area within the 200m contour has been adequately charted to meet the needs of contemporary shipping entering Antarctic waters. It is clear that there is a well established need for accurate and reliable nautical charts of the Antarctic region to support safe navigation, scientific research and increasing levels of adventure tourism. This need is becoming more urgent as the trend to increasing size and numbers of ships visiting the region continues. Hydrographic data collection is also important to scientific studies for the good of mankind. "The Southern Ocean bathymetry is of great importance for the modelling and understanding of ocean gateways and barriers, the nature of the thermohaline circulation with Antarctic bottom water formation, and the relevance of the Antarctic Circumpolar Current for Antarctica's glaciation. The sea floor topography controls ocean circulation and ocean mixing - and has strong influence on global climate."¹³

6.2 The unique political circumstance of the Antarctic, with no territorial claims being recognised whilst the Antarctic Treaty remains in force has two main outcomes: there are no universally recognised coastal states who can regulate the movements of shipping within the region, and there are no enforceable national obligations for the provision of nautical information and hydrographic services to ensure safety of navigation. The net result is that the pursuance of improved survey and charting of the Antarctic can only be achieved through international cooperative efforts. While there is strong international "in principle" support for committing additional resources to hydrographic surveying in the Antarctic, the propensity of States to act in their own national self interest will prevail and no substantial increase is likely in the near term.

6.3 The IHO HCA has been successful in establishing a framework for cooperation and information sharing and there is a reasonably comprehensive scheme of nautical charts covering the Antarctic region, however the majority of the charts are based on inaccurate or incomplete hydrographic information. The agreed principles of information sharing have not yet been realised as well as they might, this is an area that requires further effort.

6.4 In addition to these organisational difficulties, the Antarctic represents unique challenges for hydrographic surveying from a practical perspective. There is a very limited annual survey season and even during this period its harsh climate and rapidly changing weather conditions create high risk to both personnel and equipment and limit the effectiveness of survey operations.

6.5 The challenge of hydrographic surveying and charting the Antarctic will be with us for generations to come.

Endnotes:

- ¹ Council of Manager of National Antarctic Programs (COMNAP). *Overview of Antarctic Charting and Hydrography*. Retrieved 20/01/2010 <https://www.comnap.aq/operations/charting/>
- ² COMNAP. ATCM XXX/IP50 *International Coordination of Hydrography in Antarctica: Significance to Safety of Antarctic Ship Operations*. May 2007.
- ³ International Hydrographic Organisation (IHO). Publication C-55, Executive Summary. Retrieved 21/01/2010 http://www.iho.shom.fr/PUBLICATIONS/S-55/S_55.htm
- ⁴ International Association of Antarctica Tour Operators (IAATO). *IP89 UPDATED REVISION Overview of Antarctic Tourism: 2008-2009 Antarctic Season and Preliminary Estimates for 2009-2010 Antarctic Season*. Retrieved 20/01/2010 from <http://www.iaato.org/info.html>
- ⁵ IAATO. *Scope of Antarctic Tourism- A Background Presentation*. Downloaded 09/04/2008 from http://www.iaato.org/tourism_overview.html
- ⁶ IAATO. Objectives. Retrieved 21/01/2010 from <http://www.iaato.org/objectives.html>
- ⁷ Antarctic Treaty Secretariat. *The Antarctic Treaty*. Retrieved 20/01/2010 from http://www.ats.aq/e/ats_treaty.htm
- ⁸ Article IV – 1.b, *The Antarctic Treaty 1959*, Retrieved 21/01/2010 from <https://www.comnap.aq/treaty>
- ⁹ Article IV – 2, *The Antarctic Treaty 1959*, Retrieved 21/01/2010 from <https://www.comnap.aq/treaty>
- ¹⁰ International Hydrographic Organization (IHO). *IHO Hydrographic Commission of Antarctica*. Downloaded 10/04/2008 http://www.iho.shom.fr/REG_HYD_COM/HCA/HCA.htm
- ¹¹ International Hydrographic Organization (IHO). *Statutes of the IHO Hydrographic Commission on Antarctica*, Paragraph 3. Downloaded 21/10/2010 from http://www.iho-ohi.net/mtg_docs/rhc/HCA/HCA_Misc/HCA_STATUTES.pdf
- ¹² Antarctic Treaty Consultative Meeting XXXI (Kyiv), Resolution 5 (2008) retrieved from
- ¹³ International Bathymetric Chart of the Southern Ocean. *The Significance of Southern Ocean Bathymetry*. Retrieved 21/01/2010 from <http://www.ibcso.org/why.html>

REFERENCES

- Antarctic Treaty Secretariat. *The Antarctic Treaty*. Retrieved 20/01/2010 from http://www.ats.aq/e/ats_treaty.htm
- Council of Manager of National Antarctic Programs (COMNAP). *Overview of Antarctic Charting and Hydrography*. Retrieved 20/01/2010 <https://www.comnap.aq/operations/charting/>
- COMNAP. ATCM XXX/IP50 *International Coordination of Hydrography in Antarctica: Significance to Safety of Antarctic Ship Operations*. May 2007.
- International Association of Antarctica Tour Operators (IAATO). *IP89 UPDATED REVISION Overview of Antarctic Tourism: 2008-2009 Antarctic Season and Preliminary Estimates for 2009-2010 Antarctic Season*. Retrieved 20/01/2010 from <http://www.iaato.org/info.html>
- IAATO. *Scope of Antarctic Tourism- A Background Presentation*. Retrieved 09/04/2008 from http://www.iaato.org/tourism_overview.html
- International Hydrographic Organization (IHO). *IHO Hydrographic Commission of Antarctica*. Downloaded 10/04/2008 http://www.iho.shom.fr/REG_HYD_COM/HCA/HCA.htm

BIOGRAPHICAL NOTES

Commodore Roderick Nairn [MA (Strategic Studies), B.Surv (Hons), Cert. Prof. Hydrographic Surveyor Level 1, SSSI] is currently Hydrographer of Australia and Director General Navy Hydrography and METOC Branch. He joined the Royal Australian Navy in 1975 and his seagoing career encompasses hydrographic surveying experience around Australia, New Zealand, the South West Pacific, the English Channel and the Norwegian Sea. Career highlights include four sea Commands, the operational introduction of the worlds first Laser Airborne Depth Sounder, commissioning of HMA Ships Melville and Leeuwin and the successful introduction of multi-crewing to the Royal Australian Navy.

Commodore Nairn is currently Chairman of the Australasian Hydrographic Surveyors Certification Panel, the Permanent Committee on Tides and Mean Sea Level and the Ports Australia Port Surveyors Working Group.

CONTACTS

Commodore Roderick Nairn
Royal Australian Navy
Australian Hydrographic Service
Locked Bag 8801
Wollongong, NSW, 2500
AUSTRALIA
Tel. +61 2 4223500
Fax +61 2 4223599
Email: international.relations@hydro.gov.au
Web site: www.hydro.gov.au