4. ADVANCING TECHNOLOGY

4.1 As the primary cause of marine incidents is human error, emerging technology that can minimise human error has the potential to improve the provision of safety and navigation services in the GBR.

4.2 Technological improvements such as the Automatic Identification System (AIS), electronic charting, real-time displays, datalinks and improved communications will allow watchkeeping officers and shore based Vessel Traffic Service Officers to make better assessments of developing hazards and allow warnings and corrective actions to be taken earlier.

4.3 Recent amendments to the International Convention for the Safety of Life at Sea 1974 (SOLAS) require international shipping to carry additional navigational equipment commencing on 1 July 2002 through to 2008. IMO agreed to a phase-in implementation schedule for different types/sizes of ships for shipborne navigational systems and equipment in general and for AIS in particular. New ships built after 1 July 2002 will be required to be fitted with AIS. For ships built before that date, the requirement will initially apply to passenger ships and tankers one year after 1 July 2002, with the implementation for other types of ships phased in over a seven-year period.

Risk Assessment

4.4 The DNV risk assessment[36] found that there would be demonstrable improvements in safety with the adoption of a suite of technological aids. The effect of these technological improvements would dominate in reducing risk in the Torres Strait, but significant safety gains also can be made on both the Inner Route and the various passages.

4.5 Reductions of risk were lower for each of the individual safety measures than for a fully integrated package of 100% adoption of AIS, electronic chart display and information systems (ECDIS), radar, Differential Global Positioning Systems, ship and shore based alarms and a pro-active vessel traffic management system.

4.6 DNV noted that the shipping industry is benefiting from rapid technological innovation which helps to reduce risks of incidents. However, it notes that technology will improve the performance of the quality operators in the first instance. These are the ship operators most likely to adopt new technologies. Shore based monitoring is therefore important to identify, track and advise the lower quality vessels. The potential for risk reduction as a result of shore based monitoring, vigilance and guidance was found to be significant.

[36] DNV, 2001, *Assessment of Ship Safety Controls in the Torres Strait and Great Barrier Reef*

Early introduction of Automatic Identification Systems

4.7 The AIS is a shipboard broadcast transponder system that is capable of automatically sending ship information (such as identity, position, course, speed, ship length, draught, ship type and cargo details) to shore and to other ships or suitably fitted aircraft. It is also capable of receiving such information from similarly fitted ships and to monitor and track ships, including the exchange of data with shore-based facilities. A diagrammatic representation of AIS is at Figure 4.1.

4.8 AIS originally was conceived as a shipboard collision avoidance tool. It has since been extended to incorporate shore based functionality and information exchange. There is now greater interest in extending its uses to include traffic monitoring and management.

4.9 AIS operates in the VHF maritime band and therefore has propagational advantages over radar. This provides an ability to detect other AIS fitted vessels behind obstacles such as islands, rainstorms, etc and to detect AIS tracks through sea clutter. It offers highly accurate near real-time positional information and near instantaneous indications of ship course alterations.

4.10 While IMO has adopted a schedule for installation of AIS on ships, equipment standards are still being developed. These are expected to be finalised by the end of 2001. The IMO mandate does not apply to the implementation of coastal AIS equipment.

4.11 AMSA is conducting a series of trials to gain experience of the technology and to evaluate the effectiveness of AIS when integrated with the existing mandatory Ship Reporting System (SRS), known as REEFREP, that covers the Torres Strait and the Inner Route of the GBR. Preliminary reports of the trials show encouraging results for the ability to track and monitor shipping in the GBR. As not all ships will have AIS in the short term, a second series of sea trials is being conducted to provide data on the capability of portable AIS transponder units for carriage by pilots aboard ships.

4.12 GBRMPA and the Queensland Government supported moves to advance the mandatory introduction of AIS in the GBR region ahead of the IMO schedule.[37] Such proposals have to be considered in the context of the need for IMO approvals for special measures, the availability of type approved equipment and the take up rate of the equipment by the international shipping industry.

4.13 The shipping industry supports phased introduction of AIS, but argues that Australia should not advance the introduction ahead of the international program. It also suggested that AIS should be fitted to all fishing and small craft to assist navigators and enhance safety.[38]

[37] Submission No 30 GBRMPA and No 49 Queensland Government
[38] Submission No 6 Australian Chamber of Shipping

4.14 GBRMPA also noted that large numbers of fishing craft operate in restricted passages through the northern area of the Reef and present a collision risk with trading ships. Many fishing vessels carry Vessel Monitoring Systems (VMS), which use an INMARSAT C transponder which, when interrogated, transmits its identity, position, course and speed. GBRMPA suggested integration of VMS into REEFREP would provide additional information and assist their safe passage through the area.[39]

4.15 Incident statistics indicate that the great majority of collisions are between trading ships and fishing vessels, rather than between two trading ships. Incident reports generally show that collisions are often caused by a failure to maintain an adequate lookout.

4.16 In the ship to ship mode, AIS information primarily assists in decision making for collision avoidance. Since collision is not a primary contributor to risk within the relatively sparsely trafficked GBR study area, DNV found its benefit to overall risk reduction when implemented in isolation is only around a 5% reduction in risk. If implemented in concert with other measures discussed below, the effectiveness increases to around a 20% reduction in risk across the GBR area.[40]

4.17 The DNV analysis assumes 100% AIS uptake by trading ships alone. Effectiveness could be further enhanced by integration of fishing vessel VMS information into REEFCENTRE.

4.18 If trials of pilot packs prove effective, together with coastal base station and network infrastructure, AMSA may be able to fast track the introduction of AIS in the GBR region. AMSA and Queensland Transport have a responsibility to maintain the currency of the Ship Reporting System and to position it to take advantage of new sources of real time shipping information from AIS.

4.19 At the international level, however, several aspects of shore-based applications of AIS remain unresolved and fast tracking AIS introduction could result in additional technical difficulties and high costs due to the immaturity of AIS technology. Associated issues are the need for integration of technology with Queensland port requirements, network engineering and equipment availability in what is a very remote region of Australia – particularly from Cairns to the Torres Strait.

Recommendation 17

The review recommends AMSA and Queensland Transport prepare by March 2002 an AIS implementation plan for the Great Barrier Reef for shipping participating in the Ship Reporting System. The plan should address the capacity for introducing a vessel management system within the Great Barrier Reef. A mid term review should be conducted in

[39] Submission No 30 GBRMPA
[40] DNV, 2001, *Assessment of Ship Safety Controls in the Torres Strait and Great Barrier Reef, p39*

2003-04 to take account of uptake of AIS by international shipping and technological advances.

Automated Position Reports

4.20 The ship encounter information is regarded as the most valuable information provided by REEFREP. The system calculates ships' positions and course based on last known reporting point and dead reckoning. Information is displayed to SRS operators to read to ships when they report at the declared reporting points.

4.21 Technologies such as radar and AIS provide some opportunities to improve estimation of individual ship positions. However, only a small proportion of the SRS region is monitored by existing radar, at the major entry/exit points. The major routes through the GBR have no radar coverage. AIS is still undergoing trials and it is unlikely that there will be total ship to shore coverage throughout the region in the foreseeable future.

4.22 The limitations of the current system mean that it is not always able to provide real time information to operators. The information can be anywhere from minutes to several hours out of date. It is therefore not able to provide ships of encounter information on all ships they may encounter on the next leg of their journies, and information may provide a false picture of where vessels actually are. In addition to potential incidents, this gives rise to credibility problems for REEFCENTRE and provides difficulties for planning and management purposes.

4.23 The use of automated pre-programmed position reports would provide an enhanced understanding of the main routes taken by shipping and improve the ability to monitor vessels that may be in increasing risk of grounding in shallow waters outside areas with radar coverage.

4.24 The use of Inmarsat C in the fisheries industry has clearly demonstrated it to be a reliable, cost effective method of obtaining near real time positions from vessels. Position reporting intervals can be programmed from 5 minutes upwards, providing for rapid and constant updating of data.

4.25 The review notes that Inmarsat C provides an opportunity to complement both radar and AIS technology throughout the SRS. Its use would have little impact on the shipping industry as most vessels operating under the mandatory reporting provisions of the SRS already have Inmarsat C installed as part of GMDSS requirements. Consideration could be given to exempting masters and pilots from mandatory VHF reporting if Inmarsat C position reporting is introduced.

Recommendation 18

The review recommends that the use of Inmarsat C be required for all vessels subject to mandatory reporting requirements, to complement other technologies in providing near real time positions for vessels

throughout the SRS. The voluntary use of Inmarsat C should be encouraged for all other vessels.

Ship Reporting System Management Role

4.26 Ship Reporting Systems (SRS) are used by coastal authorities to keep track, via radar and radio, of ships in the area, to provide navigational and marine safety information, and to respond quickly if there is an emergency. Information obtained may be used for search and rescue, marine pollution prevention and vessel traffic services.

4.27 IMO Resolution A.857(20) – *Guidelines for Vessel Traffic Services* indicates three levels of service provided by a VTS:

- an Information Service to ensure essential information is available in time for on-board navigational decision making, as is currently provided by REEFREP;
- a Navigational Assistance Service to assist on-board decision making and to monitor its effects. This incorporates both information provision and participation in decision making by giving navigational advice at the request of a vessel or if deemed necessary by a VTS centre, eg if a vessel is sailing into danger; and
- a Traffic Organisation Service providing for safe and efficient movement of traffic and preventing development of dangerous situations.

4.28 Each level requires progressively higher degrees of intervention and investment in appropriate staff skills and equipment.

4.29 The Ship Reporting System in the GBR, known as REEFREP, is largely equivalent to a VTS Information Service. REEFREP was formally recognised and adopted by the IMO under Regulation V/8-1 of the SOLAS Convention.

4.30 REEFREP is a joint initiative of AMSA and Queensland Transport to effectively manage the GBR Particularly Sensitive Sea Area. It was established in 1997 with the aim of significantly enhancing navigational safety in the area, thereby reducing the risk of a marine accident, environmental pollution and damage to the marine environment.

4.31 REEFREP operates through a joint AMSA-QT ship reporting centre at Hay Point, near Mackay. The centre is known as REEFCENTRE.

4.32 REEFREP is mandatory for the following categories of ships:

- All ships over 50 metres length;
- All oil tankers, liquefied gas carriers, chemical tankers or ships coming within the INF Code, regardless of length; and

- Ships engaged in towing or pushing where either ship is a ship prescribed above, OR where the length of the tow, measured from the stern of the towing ship to the after end of the tow, exceeds 150 metres.

4.33 Prescribed ships are required to report to REEFCENTRE on VHF at various designated reporting points in the ship reporting area, when entering, transiting, or leaving the ship reporting area and when leaving or entering ports in the area (Figure 4.2). The reporting area covers Torres Strait and the whole of the Inner Route. Radio reports are supplemented by remote radar coverage of the major entrance channels for mandatory reporting and compulsory pilotage areas within the Inner Route. However radar coverage is limited to five locations and is impractical in terms of covering the whole extent of the GBR.

4.34 REEFCENTRE in turn provides ships with information relevant to their safe passage through the area, such as weather conditions, concentrations of fishing vessels and small craft, navigation warnings and hazards and other shipping movements.

4.35 Information to ships is provided only as broad guidance. Responsibility for taking navigational decisions based on this information rests with the ship's Master. REEFREP is not declared as a Vessel Traffic Service under IMO guidelines and Regulation 8-2 of SOLAS Chapter V, and REEFCENTRE operators are not qualified navigators.

4.36 The Australian Transport Safety Bureau report[41] on the *Bunga Teratai Satu* incident recommended that REEFCENTRE:

- review the "alert" message system, the prioritising of messages and the current extent of the restricted areas south of the compulsory pilotage zone, and

- review the role of REEFCENTRE and the current ship reporting system to determine the feasibility of providing a full advisory service.

4.37 GBRMPA supported establishment of a vessel management system for the GBR similar to aviation air traffic control. The Queensland Government supports a higher level role for the SRS in managing ship movements in the GBR and note that there is scope for improving current technology and operational procedures that will enhance its capacity to monitor traffic and take on more of an advisory service. However, they note significant training and resource issues would be involved.[42]

4.38 The REEFCENTRE, with improved radar coverage and full AIS technology, when available, and the use of Inmarsat C transponders, (AMSA SRS 1/8/01) would be able to perform a traffic management role, enabling continual monitoring and intervention when required.

[41] ATSB, 2001, Incident Report No 162, *Bunga Teratai Satu, p32*
[42] Submission No 30 GBRMPA, No 49 Queensland Government

4.39 The DNV risk analysis notes, however, that a vessel traffic control system that parallels the air traffic control operation is an extremely large undertaking.[43]

4.40 In a passive VTS system, such as an Information Service or a Navigation Assistance Service, ship Masters and pilots retain most of the decision making about ship navigation. Under active VTS such as a Traffic Organisation Service, their responsibilities are more limited. Active VTS requires planning, authorisation, surveillance and recording of ship movements by the VTS authority. It stipulates routes to be taken and speed limits to be observed.

4.41 Important legal and operational differences exist between air and maritime traffic control arrangements. Organisation of ship guidance services involves a far reaching revision of public international law and centuries old maritime customs, particularly the right to freedom of navigation and the sole responsibility of the Master for navigation decisions.[44]

4.42 A significant concern with provision of a full traffic control system is the extent of the Government's exposure to liability in the event of an accident involving a ship under the direction of a traffic control service. At present, international law places liability on a ship's owner and master for damage caused by the vessel, although there are provisions under various conventions allowing an owner to limit his liability. If the ship were operating in accordance with mandatory traffic control instructions, however, it would seem likely that an owner would seek to pass to the Government liability for any costs resulting from an accident.

4.43 The REEFREP SRS Management Group recently initiated a review to determine the feasibility of overlaying the current SRS with a Coastal Vessel Traffic System (VTS) providing a Navigational Assistance Service. The review will include a full description of the proposed service, an assessment of the requirements, implications and emerging technologies, a cost-benefit analysis and a draft implementation plan. It is expected to be completed by the end of 2001.

4.44 The issue of cost effectiveness is significant. A VTS with full Navigational Assistance Service may be uneconomical given the significant development and on-going costs and the relatively low volume of traffic in the area. The associated costs may not be fully recoverable from the maritime industry and consideration will be required of how such costs should be met.

4.45 A further consideration is the need for appropriate levels of endorsement by IMO. Specifically, Chapter V of SOLAS requires that no VTS "should prejudice the rights and duties of governments under international law". On this basis a VTS may only be made mandatory in sea areas within a State's territorial waters. The question then arises whether a VTS which is an

[43] DNV, 2001, *Assessment of Ship Safety Controls in the Torres Strait and Great Barrier Reef*, p22
[44] Boisson, P. 1999, *Safety at Sea – Policies, Regulations and International Law*, Bureau Veritas, Paris, p472-474

extension of an existing mandatory SRS could be made mandatory, particularly in Torres Strait.

4.46 This review strongly supports augmentation of the Ship Reporting Service to incorporate a Coastal Vessel Traffic System (VTS) providing a Navigational Assistance Service as a means of enhancing navigational safety in Torres Strait and the GBR.

4.47 The review supports the proposed upgrade of the role of REEFCENTRE, pending a full cost-benefit analysis of adopting such an approach and drafting of an implementation plan.

Ship Monitoring in the GBR and Torres Strait

4.48 The majority of trading ships transiting the GBR are professionally run and strictly adhere to their onboard safety procedures. Given the competitive pressures on international shipping, it is important that these operators are not disadvantaged or discouraged from continuing to strive for best practice.

4.49 There is a case for implementing variable levels of ship monitoring and reporting based on assessments of their operational status. The best operated ships, for example, are likely to use the latest technologies and to adopt official recommendations for pilotage, whereas it can be expected that the lower quality operators will not take up such 'best practices' so readily. The quality of passage planning, Bridge Resource Management and watchkeeping can also be expected to vary.

4.50 Accordingly, ship monitoring in the GBR could better target the lower quality ships. For example, unpiloted ships could be required to report more frequently and be more closely monitored than piloted ships. Procedures in the SRS would need to be reviewed to implement such a differential arrangement.

4.51 As well, the ATSB report into the *Bunga Teratai Satu* incident identified a number of features of the current SRS operations that could be improved.

Recommendation 19

The review recommends that a reassessment of the role of REEFCENTRE be conducted, which should examine:

- **the upgrading of SRS monitoring capacity,**
- **reporting points for the SRS,**
- **operation of the alert system,**
- **restricted areas, and**
- **the impact of the planned adoption of AIS technology.**

4.52 Concerns have been expressed that ship watchkeepers do not always take due care in exercising their responsibilities. It has been suggested that all ships should be required to advise to REEFCENTRE the names of their watchkeeping officers on duty during the ship's transit of the GBR and that

the SRS could call duty watchkeepers at regular intervals on their passage through the GBR.

4.53 The DNV risk assessment indicates that the greatest gains in reducing risk can be made in the Torres Strait, where pilotage is recommended rather than compulsory and the take up rate of pilots is still relatively low. At present there is only partial radar coverage in Torres Strait. Enhancement of radar in this area would improve the ability of the SRS to monitor and intervene with ships that do not use pilots in advance of the adoption of AIS by all ships under the IMO timetable. Statistically, however, there have been no groundings in the Great North East Channel. Higher risk areas are already covered by radar at present.

4.54 Supplementation of radar coverage in Torres Strait also would deliver safety improvements through a more interventionist role of the SRS sooner than proposals to seek IMO endorsement of compulsory pilotage in the region.

4.55 The review recognises that improving radar coverage in the Torres Strait would add to the overall monitoring of shipping transiting this region. However the cost of an additional radar is estimated at about $1 million per site in remote areas. The review recommends this action only if other alternatives suggested in this report are unviable.

Recommendation 20

The review recommends improving radar coverage in the Torres Strait to enhance overall monitoring of shipping transiting this region, in consultation with indigenous communities.

Electronic Navigation and Charting

4.56 There is a growing demand for digital hydrographic information from scientific, commercial and defence organisations. From mid 2002, amendment to the SOLAS Convention will support greater demand for and use of electronic chart information by the international shipping industry. When displayed in an appropriate Electronic Chart Display and Information System (ECDIS) with input from satellite positioning, Electronic Navigation Charts (ENCs) provide a comprehensive navigation aid that includes automated warnings of impending course alterations and shoal water.

4.57 The use of Electronic Chart Display and Information Systems (ECDIS) is seen as a positive way to improve navigation safety and reduce human error.

4.58 In 1998 the Australian Hydrographic Service (AHS) of the Royal Australian Navy commenced the compilation of a vector based Electronic Navigation Chart (ENC) for the shipping routes in Torres Strait and the Inner Route of the GBR. In draught critical areas this data base is being sourced from the original highly detailed surveys and will provide a quantum leap in detail available to the mariner.

4.59 The ENC is currently completed from Weipa, through Torres Strait and south in the Inner Route to about 90 nautical miles south of Cape York. It is available in the form of evaluation data and is being trialled by commercial vessels operating in the GBR. The ENC for the remainder of the GBR will be progressed as resources permit.

4.60 However, AHS estimates that current production capability is 40% deficient due to limited resources. Approximately 50% of AHS cartographic staff presently are engaged on production of official ENCs, and wherever possible AHS supplements its capacity through appropriate outsourcing. Quality control and production management are key Commonwealth responsibilities and resources in these areas are presently overstretched.[45]

4.61 The provision of ENCs will only be useful if ships are fitted with an approved ECDIS. The use of ECDIS cannot yet be mandated and AMSA does not have in place a regime to regulate its use in Australia. There needs to be a widespread education and awareness campaign demonstrating the benefits of ECDIS. This could be conducted in concert with a campaign to improve awareness of other technologies such as AIS, DGPS and GMDSS, and of recommended pilotage areas.

Recommendation 21

The review recommends that ENC/ECDIS development be given the highest priority to complete the ENC for the Prince of Wales Channel, the Great North Eastern Channel and the Inner Route of the Great Barrier Reef within a specified timeframe. This could involve either improving resources for the Hydrographic Office or the Hydrographic Office engaging commercial contractors to expedite the current rate of production.

Recommendation 22

The review recommends an extensive education and awareness campaign be commissioned to promote the benefits and uptake of ECDIS onboard ships.

Other Technologies

4.62 The quality of traditional navigation aids in the Torres Strait and across the Inner Route is rated high by stakeholders.[46]

4.63 The availability of Global Navigation Satellite Systems Positioning Systems and the more accurate Differential Global Navigation Satellite Systems (DGNSS) provide highly accurate satellite based radionavigation.

4.64 The Global Positioning System (GPS) is a satellite based system operated by the US Government. It is available for navigation purposes on a non-discriminatory basis and is free to all users with appropriate receivers. GPS

[45] Submission No 9 Australian Hydrographic Service
[46] DNV, 2001, *Assessment of Ship Safety Controls in the Torres Strait and Great Barrier Reef*, p44

provides for positional accuracy to better than 20 metres, which is expected to improve with the implementation of the GPS modernisation program by the United States Government over the next decade.

4.65 Similar services are provided by the Russian GLONASS system, although its usefulness is diminishing due to an increasing number of inoperable satellites. The European Community is developing a third satellite based system called Galileo that is expected to be fully operational by 2008.

4.66 AMSA initiated a Differential Global Positioning System (DGPS) program to provide a service for commercial vessels equivalent to and compatible with those available elsewhere in the world. DGPS provides a navigational accuracy better than 10 metres, as well as integrity monitoring of the GPS system. DGPS corrects the accuracy of GPS signals and has the ability to alert users when suspect position information from a particular satellite is received. In close quarter navigation and hazardous areas it provides essential position, heading and speed information for traffic displayed on ECDIS and AIS applications.

4.67 AMSA's DGPS service is provided by a network of coastal stations covering areas of the Australian coast that are identified as being environmentally sensitive, navigationally restricted waters or having high traffic densities. Seven DGPS broadcast stations are installed on the Queensland coast, providing total coverage of the Torres Strait and the Inner Route of the GBR. The system provides the maximum practical overlapping coverage by DGPS stations to enhance reliability of the system.

4.68 AMSA user surveys of commercial vessels calling at Australian ports monitor the uptake rates of new technologies and usage of AMSA navigation services:

- Awareness of DGPS has increased to 55% in 2000 from 40% in 1998;
- Vessels able to use DGPS signals rose from 4% in 1995, 10% in 1998 to 15% in 2000;
- Fewer than 1% of vessels had no GPS and 54% had two or more GPS receivers;
- 92% of respondents believe DGPS is sufficient for safe navigation in confined waters as opposed to 54% who believe GPS is sufficient;
- Only 12% of users had either ECDIS or Electronic Chart Systems, largely due to the fact that such systems have not yet been approved as a a replacement for paper charts and there is not a complete ENC database for Australian waters.

4.69 These findings reveal that there is still considerable scope for industry to adopt better navigation tools that are generally available to them. Continued efforts to educate and build awareness of users on the benefits of these technologies are required.

4.70 Other emerging technologies that may assist with vessel monitoring in the future include high resolution satellite imagery and unmanned airborne surveillance systems.

4.71 Studies have shown that satellite imagery can be used to successfully detect and monitor ships and oil spills, including identification of location and direction. It offers advantages in surveillance access and capacity in remote areas and over large areas. Unmanned aerial vehicles also offer potential for monitoring over wide areas, either for specific tasks or regular patrols.[47]

4.72 AMSA has previously investigated the use of satellite imagery in the context of oil spill monitoring. AMSA found that it is a high cost option for continuous surveillance and stand-by rates are also high cost with a reduced timeliness of service.

[47] Submission No 5 Australian Surveying and Land Information Group, No 35 Kingfisher Unmanned Aviation Systems Aust Pty Ltd

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