

## Managing the Safe Operations of Shipping in the Great Barrier Reef and Torres Strait

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The environmental and cultural significance of the Great Barrier Reef and Torres Strait Region are recognised nationally and internationally. The protection of the outstanding natural qualities of the region was enhanced with the establishment of the Great Barrier Reef Marine Park in 1975. It was inscribed on the World Heritage List in 1981, and was designated by the International Maritime Organisation (IMO) as one of the world's first Particularly Sensitive Sea Areas in 1990.

REEFREP was established in 1997 to enhance navigational safety in the Torres Strait and the inner route of the Great Barrier Reef, thereby minimising the risk of marine accidents and consequential pollution and damage to the marine environment. Facilitating improved safety and environmental protection along almost 2,500km of coastline (Figure 1), including areas that are extremely remote, is a significant task.

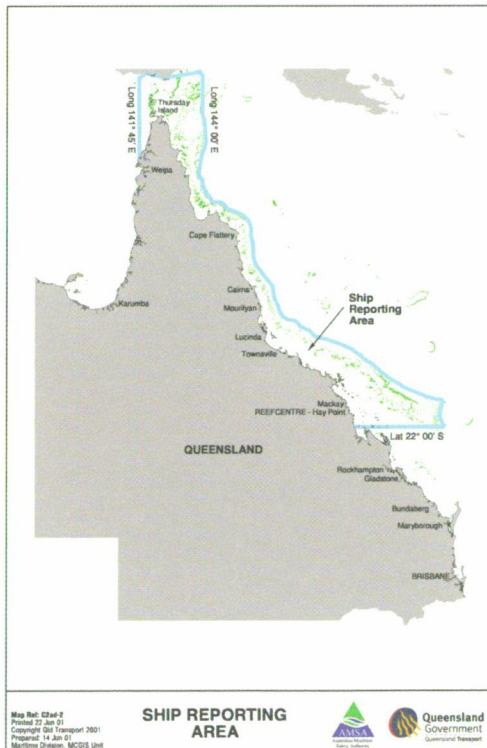


Figure 1: REEFREP region

Ship traffic information is regarded as the most valuable information provided to REEFREP participants. Maximising the delivery of relevant, timely and accurate information over such a large area in a manner that is both affordable and appropriate for the environmental and cultural sensitivities inherent in the region presents a challenge requiring innovative solutions that embrace cost effective and complementary technologies. Improved service delivery is crucial to the ongoing success of REEFREP and this can be maximised by ensuring that the service is:

- Desirable and relevant to the client base
- Deliverable through current technology
- Flexible and modular to accommodate emerging technology and future needs

Two technologies recommended in the recent Review of Great Barrier Reef Ship Safety and Pollution Prevention Measures 2001, Automated Information Systems (AIS) and Inmarsat C, are currently being evaluated in terms of their application to enhance ship traffic information within the REEFREP region under the above framework.

## The Great Barrier Reef and Torres Strait Region

### Great Barrier Reef

The Great Barrier Reef (GBR) is internationally recognised as a unique marine environment. It is the largest coral reef ecosystem and the world's largest living structure. It extends over 2,300 kilometres from Lady Elliot Island off the coast south of Gladstone to the tip of Cape York Peninsula in the north.

The protection of its outstanding natural qualities was enhanced with the establishment of the Great Barrier Reef Marine Park in 1975. This is the world's largest marine park, covering an area of 345,000 square kilometres, and is under the management of the Great Barrier Reef Marine Park Authority (GBRMPA).

In addition to its environmental and cultural significance, the GBR has important economic significance. It supports a billion dollar sector of the tourism industry and a \$A250 million sector of the fishing industry.



Figure 2: Major shipping routes



In total the GBR is estimated to contribute around \$A2 billion per annum to the Queensland economy. Accordingly, the legislative and management arrangements for the Marine Park provide for its multiple use management in a way that ensures conservation and scientific research while also allowing reasonable use of the GBR region and its resources for commerce and recreation.

Indigenous communities have a close association over thousands of years with the coastal and marine environment in the GBR region for both cultural and economic purposes. Measures impacting on the management of the region need to recognise the continuing use and interest of indigenous communities in pursuit of their culture and protection of their heritage.

The GBR was inscribed on the World Heritage List in 1981 under the 1972 Convention Concerning the Protection of World Cultural and National Heritage. The IMO designated the Great Barrier Reef Marine Park in 1990 as one of the world's first Particularly Sensitive Sea Areas (PSSA). This provided international recognition by the shipping industry of its unique ecology and environmental sensitivity, and allowed implementation by Australia of associated special protective measures to control shipping operations. These include restrictions on discharges from ships, adoption of ship routing measures near or in the area in accordance with IMO general principles on ships' routing, and other navigational measures, such as compulsory pilotage and vessel traffic management systems.

### **The Torres Strait**

The Torres Strait between Cape York and Papua New Guinea adjoins the northern boundary of the Great Barrier Reef Marine Park and is an important international shipping lane, as well as containing significant fishing grounds. It is similarly an environmentally sensitive area. Its waters are essential for the livelihood of the Torres Strait Islander people and the coastal communities of Papua New Guinea, whose spiritual and cultural heritage and economic needs are inseparably linked to the marine ecology of this region.

There are over 100 islands and numerous coral cays, exposed sandbanks and reefs in Torres Strait. Approximately 8,000 people living throughout the Strait in 19 small island communities, of which about 6,000 are Torres Strait Islanders and Aboriginal people. The communities are all remote, approximately 1,000 kilometres from the nearest city, and highly interactive with the marine environment to support their way of life and cultural heritage.

The Torres Strait is a major shipping channel for Australia linking the Coral Sea (Pacific Ocean) in the east with the Arafura Sea (Indian Ocean) in the west. It is one of few parts of Australia sharing a border with another country and therefore the issues of surveillance and defence are a major consideration.

The Torres Strait Treaty between Australia and Papua New Guinea, that entered into force in February 1985, defines the border between the two countries and provides a framework for the management of the common border area.

## **Shipping in the Great Barrier Reef**

### **Shipping Routes**

The main navigational shipping routes through the Torres Strait are the Prince of Wales Channel and the Great North East Channel (Figure 2).

There are two major shipping routes in the GBR region:

**The Inner Route** extends north-south between the GBR and the Queensland coast from Torres Strait to Gladstone in the south. The northern section from Torres Strait to Cairns is most restricted and passage through these waters involves navigation within confined waters for a long period, normally 40 hours. The inner route is well charted and marked with navigational aids.

**The Outer Route** commences at the eastern limit of the Torres Strait (the Great North East Channel) continuing southwards through the Coral Sea and rejoining the Queensland coast near Sandy Cape south of Gladstone. The outer route was surveyed and charted to international standards in 1997 encouraging a greater number of vessels, particularly crude oil tankers, to use the outer route.

There are some operational advantages for ships to use the inner route in preference to the outer route. The distance from Booby Island (in the western approaches to Torres Strait) to Sandy Cape (north of Brisbane) via the outer route is 1,344 nautical miles compared to 1,220 nautical miles via the inner route. The outer route involves an additional transit time of about half a day for an average trading ship, but taking account of the likelihood of heavy seas and strong winds, ship operators may allow an extra day's steaming time. In addition, ships using the inner route are allowed to load to their Tropical Loadline between 1 April and 30 November each year in recognition of the inner route's more protected waters. The Tropical Loadline indicates the maximum depth of loading during the fine weather season in certain zones in the tropics. Its extension beyond the fine weather season allows ships to carry greater loads than apply if they are required to load to their Winter or Summer Loadlines.

Ships may traverse the GBR at Grafton Passage near Cairns, Palm Passage near Townsville, and Hydrographers Passage near Mackay and in the south through the Capricorn Channel.

The navigational task along the Inner Route, in Torres Strait and its transit passages is demanding because of some 2,900 reefs, including 760 fringing reefs, 360 coral cays and 618 continental islands. The region also is subject to strong trade winds, occasional cyclones, and complex tidal streams within the GBR. Ships encounter limited water depths, reduced visibility in the wet season, and narrow restricted shipping lanes in certain parts of the GBR.

The Torres Strait also is an area of limited depth and complex tidal streams, and transit is subject to tidal constraints for large ships. Additional navigation demands arise from the operation of numerous fishing, tourism and recreational craft in the area.

## Shipping Movements

There is a significant level of shipping traffic in the Great Barrier Reef and Torres Strait area, with a number of commercial ports located within the region. These include Cape Flattery, Cairns, Mourilyan, Lucinda, Townsville, Abbot Point, Mackay, Hay Point, Port Alma, Gladstone, and Bundaberg.

Approximately 8,000 ship movements of large vessels in excess of 50 metres in length occur within the GBR region every year. Most of these vessels use the inner route with the rest entering or departing through Hydrographers, Palm and Grafton Passages.

Most vessels using the GBR are bulk carriers (42 per cent) carrying significant tonnages of export cargo, including coal, bauxite, nickel ores, raw sugar, alumina and silica sand. The major bulk ports are Hay Point, Abbot Point and Gladstone. Between 5 per cent and 10 per cent of ships are oil tankers, with most on northerly transits, either in ballast or carrying refined product to service Queensland ports north of Brisbane. Remaining trading vessel traffic consists of container vessels (24 per cent), general cargo (22 per cent) and other types.

Numerous types of recreational and commercial fishing vessels also ply the Queensland coast on a regular basis. It is estimated that there are some 1,500 tourism vessels and 25,000 commercial and recreational fishing vessels operating in the GBR.

## Shipping Incidents

During the period 1985 to 2000, there were 11 collisions and 20 groundings within the inner route of the GBR, which represents over two incidents each year. This is a relatively small rate of incidents given that over 2,500 ship movements occur in the northern section of the inner route annually, but still considerably higher than anywhere else on the Australian coast. None of the incidents in the past 15 years has resulted in significant oil pollution, loss of life or structural damage to the ship.

Incident statistics (Queensland Transport (Maritime) analysis of incidents) over a fifteen (15) year period indicate that 47 per cent of incidents on the Queensland coast involved either groundings or collisions. Most incidents are caused by human error. Many, particularly collisions between a trading vessel and a fishing vessel, are caused by a failure to keep a proper lookout. Six of the eight groundings in the Inner Route and Torres Strait between 1995 and 2000 occurred with a coastal pilot on board.



## The REEFREP Ship Reporting System

REEFREP was one of the world's first mandatory ship reporting systems formally adopted by the IMO. The objectives of REEFREP are to enhance navigational safety and thereby minimise the risk of a maritime accident and consequential marine pollution and major damage to the marine environment. REEFREP provides a monitoring capability ashore which interacts with shipping, allowing the provision of improved information on the presence, movements and patterns of shipping in the area.

Under the terms of regulation V/8-1 of the International Convention for the Safety of Life at Sea (SOLAS) 1974 it is mandatory for the following categories of ships to report by VHF at designated reporting points in the REEFREP region and when entering and leaving ports in the area:

1. All ships of 50 metres or greater in length
2. All oil tankers, liquefied gas carriers, chemical tankers or ships coming within the INF Code, regardless of length
3. Ships engaged in towing or pushing where the towing or pushing ship or the towed or pushed ship(s) is a ship prescribed above; OR where the length of the tow, measured from the stern of the towing ship to after end of the tow exceeding 150 metres

It also provides ships with information relevant to their safe passage through the reporting area (Torres Strait and the whole of the GBR Inner Route)

## Current Technologies

The system was established in 1997 with three core modules to enable REEFREP to gather, process and display essential information on shipping operations in the region and to interact with participating ships to provide the benefits of a traffic information service. The three modules include:

- VHF Reporting Points
- Radar Systems Module
- Traffic Information Module

### VHF Reporting Points

There are 39 VHF Reporting Points within the REEFREP region. The Voice Communications System (VCOMS) that supports this is based on 14 remote unmanned maritime VHF stations located throughout the REEFREP region. A single VHF receiver at each site is designated to a dedicated duplex maritime channel, and also has the capacity to operate on simplex Channel 16.

Given the remoteness of much of the REEFREP region the availability of existing infrastructure was a key consideration in installing these sites. Many of the sites are solar powered and some are only accessible by helicopter. A satellite based VHF system has also been installed for three remote locations within the REEFREP region that are outside the available terrestrial telecommunications network.

At ReefCentre, an audio switching system provides a touch screen computer-based operator interface to control each site. There is also audio recording capability which includes instant replay of VHF transmissions, should this be required by the operator, as well as a conference facility which enables ships to be linked to the shore incident management team in the event of an emergency.

### Radar Systems Module

The Radar Systems Module (RSM) consists of five remote land-based marine radar sites. These were selected primarily to provide report monitoring at focal points in the region (i.e. to monitor compliance via the entry/exit points) and provide enhanced ship traffic information at these locations.

Radar sites are located in the Torres Strait (Sue and Hammond Island), Green Island, Penrith Island and Pelorus Island. The Hammond Island site has been established on an abandoned former WW2 radar

bunker site, while the Sue and Green Island sites are located at existing remote telecommunications tower sites.

At Penrith Island the radar (and VHF transceiver) has been integrated with an existing aid to navigation light. It is also completely powered from a solar supply consisting of a large solar frame and sufficient autonomy to maintain the site throughout the low light monsoonal weather patterns experienced in the region during the Australian summers.

Each of the radar sites contains either an X band or S band ATLAS marine radar Type 9600 complete with all associated specialised microprocessor-based radar processing and tracking equipment suitably tailored for land use (ATLAS Type 9730 series). All sites have been designed with appropriate infrastructure to withstand the high wind forces that occur during the tropical cyclones that frequent these areas during the summer months.

### **Traffic Information Module**

The Traffic Information Module (TIM) is the key tool used by ReefCentre Operators to monitor shipping activities. It is also the 'face' of REEFREP, providing the information that is passed onto clients by the ReefCentre Operators.

There are two major components of the TIM:

- The REEFREP (or Forms) Display
- The Sirius Track Display

The REEFREP Display allows the VHF reports provided by masters/pilots at the defined Reporting Points to be entered into the system. It is also responsible for generating Operator Alerts, such as ships being due or overdue to report, a ship entering a restricted area, or an anchored ship leaving its anchorage area. Where an expected report is not received within a certain amount of time, the ship changes from being 'Compliant' to 'Non-compliant' and the ship changes colour on the display.

The Sirius Track Display shows the positions of all reporting ships (either as a DR position or a radar position when fused by the operator, and more recently as either an AIS or Inmarsat C target).

Reporting vessels provide the system with a list of future waypoints—derived either from standard legs defined in the system or specified by the vessel and digitised by the operator. All other vessels are compared with the reporting vessel and the possibility of an encounter (vessels being within a system defined distance of one another before the next report) is determined. Further analysis of vessel positions, directions, speeds etc. are made to produce Traffic Encounter Information.

Traffic Encounter Information (TEI) and Maritime Safety Information (MSI) are collectively referred to as Ship Traffic Information (STI). When a vessel reports to Reefcentre and provides its current position and predicted route, STI is generated for ReefCentre operators to read to the reporting vessel. Pilots and masters generally regard the traffic encounter information as the most useful routine information provided by ReefCentre, particular in the more complex and narrow parts of their voyages.

Traditionally, the positions used by the TIM to generate STI have been those reported at the VHF Reporting Points, or where ships are within range of the five radar sites, the fused radar target for the ship concerned. More recently, the TIM has been enhanced to automatically receive and integrate AIS and Inmarsat C position reports to the generation of STI.

### **Emerging Technologies – Enhanced Ship Traffic Information**

The recent Review of Great Barrier Reef Ship Safety and Pollution Prevention Measures 2001 concluded with 41 recommendations to improve ship safety and environment protection in the GBR region and the Torres Strait. Importantly, the report reflects the considered views of a wide range of community and professional interests, including those of the shipping industry, environmental and Indigenous groups, coastal pilots and pilotage providers and the general public.

One of the key terms of reference for the review was to develop strategies that would address 'Advancing



the introduction of technological developments to track and monitor shipping operations'. Technologies identified in the review as applicable to tracking and monitoring shipping operations include:

### **AIS**

The review concluded that 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.

### **Inmarsat C**

The review noted that the provision of automated position reports via Inmarsat C provides an opportunity to complement both radar and AIS technology throughout the REEFREP region. Its use would have little impact on the shipping industry as most vessels operating under the mandatory reporting provisions of REEFREP already have Inmarsat C installed as part of GMDSS requirements.

Both AIS and Inmarsat C are currently being evaluated in terms of their application to enhance ship traffic information within the REEFREP region.

### **Why Inmarsat C**

The reliance on VHF Reporting Points (8-16 hours apart) and pre-defined Dead Reckoning (DR) routes and associated legs results in the TIM not always being able to generate timely or accurate STI throughout the REEFREP region for operators to advise ship operators. In summary, the picture of where ships are at any point in time that is used to generate STI and present the information to operators can be many hours old and/or not the actual position of the vessel/s. Factors that contribute to this situation include:

- The characteristics of individual vessels (speed)
- The relative lengths of defined legs in the area involved (for example, the reporting points for the High Peak to Edward and Gubbins to Barnard legs are approximately 140nm apart).
- Vessels deviating from nominated routes
- Vessels not nominating which leg they will take between reporting points, and
- Vessels not maintaining the speed nominated at their last reporting point for a defined leg and failing to advise ReefCentre accordingly

Technologies such as Radar and AIS provide an opportunity to enhance this situation by providing a mechanism to update individual vessel positions and subsequently the STI. However, it must be acknowledged that:

- Only a small component of the REEFREP region is monitored by the existing radar installations. These have been installed at the major entry/exit points of the region – other major routes throughout the region have no radar coverage, and
- 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. Further, the proposed long-range capabilities for AIS are still in their infancy.

\* Although it is unlikely that there will be total ship-to-shore AIS coverage throughout the REEFREP region in the foreseeable future it is reasonable to expect that AIS and Inmarsat C technologies will complement each other to provide enhanced STI for large areas of water such as REEFREP. For example, ship-to-shore AIS may be implemented to complement or replace radar for localised areas where 'real time' traffic information is required (e.g. 2 second position reporting intervals) and Inmarsat C

used to provide 'near real time' traffic information throughout the region (e.g. 15 minute position reporting intervals).

Inmarsat C is a technology available today that offers opportunities to compliment existing REEFREP technologies (VHF Reporting Points and Radar) by providing 'near real time' positions of vessels throughout the REEFREP region.

Preliminary results indicate that Inmarsat C can be utilised to provide enhanced Ship Traffic Information throughout the REEFREP area by incorporating 'near real time' position reports independently of the operator (master or pilot) and at the discretion of REEFCENTRE.

## Conclusion

Facilitating improved safety and environmental protection along almost 2,500km of coastline, including areas that are extremely remote, is a significant task. Maximising the delivery of desirable, relevant, timely and accurate information over such an area in a manner that is both affordable and appropriate for the environmentally and culturally sensitivities inherent in the region presents a challenge that requires innovative solutions that embraces cost effective and complimentary technologies.

Improved service delivery is seen as crucial to the ongoing success of REEFREP and this can be maximised by ensuring that the service is:

- Desirable and relevant to the client base
- Deliverable through current technology, and
- Flexible and modular to accommodate emerging technology and future needs

Inmarsat C and AIS are being evaluated as a technology readily available today which can provide an opportunity to complement existing technology throughout the REEFREP region. The use of Inmarsat C to provide enhanced STI would have little impact on the shipping industry as most vessels operating under the mandatory reporting provisions of REEFREP already have Inmarsat C installed as part of their GMDSS requirements.

Preliminary results indicate that automated pre-programmed position reports can provide an enhanced ship traffic information throughout the REEFREP region and a greater 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.

Human error is the primary cause of marine incidents in the Great Barrier Reef. Emerging technology is seen as a key means for reducing the risk of marine incidents caused by human error. The Australian Maritime Safety Authority in company with Queensland Transport, as co-sponsors of the Ship Reporting System, are working closely together to trial new technology to improve the system and afford greater protection to the Great Barrier Reef and Torres Strait.

## Biographies

Neil Trainor is Manager Great Barrier Reef and Torres Strait Ship Reporting System (REEFREP). Neil joined maritime in March 2001. Since then he has been involved in a major review of REEFREP and the evaluation of new technologies to enhance the delivery of Ship Traffic Information to vessels transiting the Region.

Prior to joining maritime Neil had almost 20 years experience with both Federal and State fisheries agencies in Australia, including extensive experience aboard both domestic and foreign fishing vessels. Previously as Manager, Fisheries Information Services with the Queensland Fisheries Management Authority he managed the development and introduction of the Vessel Monitoring System (VMS) to major Queensland fisheries.

In addition to a strong background in systems development and project management his fisheries expe-



rience is diverse and includes the management of areas such as assessment and monitoring, surveillance, resource management, licensing, and information technology. Neil has a BSc (Zoology, Geography) and a Graduate Diploma in Resource Management.

Jim Huggett, born in 1959, is the current Principal Advisor Nautical with the Maritime Division of Queensland Transport. Jim graduated in Surveying from the Queensland University of Technology in 1984. Following graduation he was selected for a Short Service Commission with the Royal Australian Navy Hydrographic Service and has surveyed many areas of the Australian coast.

Prior to his appointment as Principal Advisor Nautical, Jim headed the Marine Environment Protection Unit of Queensland Transport, which develops policy for the environmental protection of the Queensland coast and Great Barrier Reef. He was awarded the Australia Day honours medallion in 2001 for services rendered to environmental protection.

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