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# PROCEEDINGS

## *Global Navigation*

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# GLOBAL NAVIGATION

# Global Navigation

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ViceChair: *Mr. José Manuel Díaz, Centro Jovellanos, Spain*



## Session 3.2

Chair: *Mr. Mahesh Alimchandani, Australian Maritime Safety, Australia*
ViceChair: *Mr. Michael Cousquer, CEREMA, France*

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*Ahmad Parhizi. Ports and Maritime Organization, Iran*

Annually more that 60,000 ships are passing the strait of Hormuz out of which more that 45 % are the Oil Tanker, Chemical and Gas Carrier which require the great amount of the safety measures to be in place to prevent the any kind of incident/accidents in the Strait of Hormuz. It is also worthwhile to be noted that the level of military traffic in this strategic location is increasing steadily which we experienced so far few number of incidents caused by this kind of this vessel which can pose a grave danger to the safe navigation of the Strait of Hormuz. The Strait of Hormuz is a regional strait shared by the three states such as IR. Iran, United Arab Emirates and the Sultanate of Oman and also all the inbound and outbound vessel that are bound to one of the Persian Gulf Ports are using this Strait. In order to enhance the Maritime Safety Issues in the Strait of Hormuz taking into account the level of traffic and to be able to supervise and monitor the shipping activity in the Traffic Separation Scheme (TSS) of the Strait of Hormuz, there is suggestion in the region to enhance and expand the existing VTS system in the Bandar Abbass of IR. Iran in order to fully monitor and control all inbound and outbound traffic in the strait by the cooperation and coordination of the mentioned states and the Marine Emergency Mutual Aid Centre (MEMAC) as the regional Organization responsible to manage all the emergencies in the Region . in the other hand it is intended to implement the mandatory reporting system for all the ships entering Strait of Hormuz by submitting a documents to the NAV Sub-committee of the IMO in order to seek the IMO approval in this issue.

The objective of this project is to:
- Monitor all the traffic in the Strait of the Hormuz
- The prevention of accident and incident in the Strait of Hormuz
- To enhance the Maritime Safety Issues in the Strait of Hormuz

Anualmente más de 60 000 barcos atraviesan el estrecho de Ormuz. De ellos, más del 45 % son petroleros y buques de transporte de productos químicos y gas que requieren que haya establecidas una gran cantidad de medidas de seguridad para prevenir cualquier tipo de incidente/accidente en el estrecho de Ormuz. También cabe destacar que el nivel de tráfico militar en este punto estratégico está aumentando de manera constante y que aunque hasta el momento se han producido solo unos pocos incidentes causados por esta clase de buques, el aumento de este tipo de tráfico puede suponer un grave peligro para la navegación segura por el estrecho de Ormuz. El estrecho de Ormuz es un estrecho regional compartido por tres estados, República Islámica de Irán, Emiratos Árabes Unidos y Sultanato de Omán, y todos los buques que entran y salen con rumbo a alguno de los puertos del Golfo Pérsico utilizan este estrecho. Con el fin de mejorar la seguridad marítima en el estrecho de Ormuz teniendo en cuenta el nivel de tráfico y ser capaces de supervisar y controlar la actividad del tráfico marítimo en el Sistema de Separación de Tráfico (TSS) del estrecho de Ormuz, existe una propuesta en la región para mejorar y ampliar el sistema VTS existente en el puerto de Bandar Abbass de la República Islámica de Irán con objeto de supervisar y controlar totalmente todo el tráfico entrante y saliente en el estrecho mediante la cooperación y coordinación de los mencionados estados y el Centro de Ayuda Mutua ante Emergencias Marinas (MEMAC) como organización regional responsable de la gestión de todas las emergencias en la región. Por otro lado, se pretende implementar el sistema de informes obligatorio para todos los barcos que entren en el estrecho de Ormuz mediante la presentación de documentos al Subcomité NAV de la IMO con el fin de obtener la aprobación de la IMO en este asunto.

El objetivo de este proyecto es:
- Supervisar todo el tráfico en el estrecho de Ormuz
- Prevenir accidentes e incidentes en el estrecho de Ormuz
- Aumentar la seguridad marítima en el estrecho de Ormuz
- Mejorar la protección del medio ambiente marino en la región

*Plus de 60 000 navires passent chaque année le détroit d'Hormuz, dont plus de 45% sont des pétroliers, des gaziers, des porteurs de produits chimiques, qui demandent l'existence de nombreuses mesures* *de sécurité pour prévenir toutes sortes d'incidents/accidents dans le Détroit d'Hormuz. Il est aussi utile de noter que le trafic militaire dans ce passage stratégique est en constante augmentation. Jusqu'à présent nous n'avons eu que quelques cas d'incidents, mais ce type de navires peut mettre en danger la sécurité de la navigation dans le détroit d'Hormuz.*

*Ce détroit est régional et partagé par les navires de trois pays : l'Iran, les Emirats Arabes Unis et le Sultanat d'Oman et aussi par les navires qui se dirigent vers ou proviennent du Golfe Persique. Pour améliorer la sécurité de la navigation dans ce détroit, et compte tenu du niveau de trafic dans le cadre de Séparation de Trafic, on suggère, au niveau régional, d'améliorer et d'étendre le VTS existant dans le Bandar Abbass d'Iran pour pouvoir mieux surveiller et contrôler le trafic maritime dans le détroit et dans les deux sens. Et ceci avec la coopération et la coordination des trois Etats cités et d'un Centre d'entre-aide d'Urgence Maritime (MEMAC), responsable de la gestion des urgences dans la région.*
*D'autre part, il est question d'installer un système de compte rendu obligatoire pour tous les navires entrant dans le détroit, après soumission de ce projet au Comité NAV de l'OMI, avec les objectifs suivants :*
- *surveiller tout le trafic dans le détroit,*
- *prévenir les accidents et incidents dans le détroit,*
- *améliorer la sécurité maritime dans le détroit,*
- *améliorer la protection de l'environnement marin dans la région*

# The role of coastal VTS in enhancing maritime safety and marine environment issues in the Strait of Hormuz

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# The role of coastal VTS in enhancing maritime safety and marine environment issues in the Strait of Hormuz

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## 1. INTRODUCTION

Persian Gulf is a semi-enclosed water-body with intensely hot summers and short cool winters, extensive air and water temperature fluctuation and relatively high salinity. It is also characterized by high turbidity and low exchange of water with open sea.

This is the area from the Strait of Hormuz to the northern coast with a length of about 1000 km, and surrounded by high mountains on the Iranian side and low-lying land on the Arabian side (Iraq- State of Kuwait- Kingdom of Saudi Arabia- State of Qatar- Kingdom of Bahrain- United Arab Emirates- Sultanate of Oman). It is a shallow embayment having a mean depth of about 35 meters with a maximum depth of between 90 and 100 meters at its northeastern side near the coast of Iran, and about 100 meters near the narrow Strait of Hormuz connecting to the Gulf of Oman and the Indian Ocean. The maximum width of the inner part of the region is 338 km. It takes about four years to change the water mass (8000 km3) in the inner RSA.

The Persian Gulf is a major oil and gas producing area in the world, with more than 45,000 Oil, Chemical, Gas tankers and General Cargo Vessel passing Strait of Hormuz and visiting the region every year with its steady grow for the coming years. A considerable amount of oil is spilled into the sea every year as a result of discharges from ships, and from the region's 800 offshore oil and gas platforms. Tanker and cargo vessel traffic generates substantial amount of ballast water discharged in the RSA. In addition, former military activities in the region have contributed massive inputs of various pollutants in the past.

The area also had a witness to several Incidents/Accidents especially in the vicinity of Strait of Hormuz which could cause massive environmental and humanitarian disaster that could impact the smooth flow of traffic in the Strait.

### 1.1 Strait of Hormuz

The Strait of Hormuz is the single access passage to the Persian Gulf. At its most narrow position the Strait of Hormuz is 21 nautical miles (38.89 km) wide, bordered by the territorial seas of IR. Iran, Sultanate of Oman and the United Arab Emirates.

Traffic is organized via a Traffic Separation Scheme (TSS) consisting of a two, two mile wide channels for inbound and outbound ship traffic, as well as a two miles wide buffer zone.

90 percent of the oil exports from the Persian Gulf and 45 per cent of globally traded oil pass the Strait of Hormuz with on average 15 tanker daily carrying 16.5 to 17 Mio barrels, the cargo valued at approximately 1,700,000,000 USD (2012). The majority of the remainder are large commercial vessels (LCVs) such as container ships and bulk product carriers, Non-tanker passages through the Strait of Hormuz amounted about 30,000 vessels equal or larger than 300 GT in 2012. The Strait of Hormuz represents the economical lifeline of the Persian Gulf Member States.

Irrespective of geo-strategic and military considerations the right of unimpeded "innocent" and "transit passage" of merchant ships through the Strait of Hormuz is beyond dispute.

However, passing the Strait of Hormuz is not a classical "transit passage", i.e. passing a strait to reach a destination elsewhere (Turkish strait/Bosporus, Malacca/Singapore strait, etc.). Instead, passing the Strait always means heading for, or departing from a port, terminal, anchorage, repair or offshore facility in one of the Persian Gulf Member States – or metaphorically speaking: passing the bottleneck the entire bottle is affected.

Insofar, as there are no channels, rivers or other alternative marine shipping routes to reach the Persian Gulf than the Hormuz Strait, all Persian Gulf States may be referred to it as "strait bordering States".

According to UNCLOS' International Straits Regime, States bordering straits may adopt laws and regulations on Safety of Navigation and regulation of Maritime Traffic through the strait, and on the prevention, reduction and control of pollution (UNCLOS article 43) in order to safeguard the economical interest of all Member States and to enhance the Maritime Safety and also to improve the Marine Environment protection of Persian Gulf.

This unique geographical chokepoint situation in combination with the joint regional approach of the Member States for maritime safety and marine environmental protection, as represented by the Kuwait Convention and Protocols, offers a variety of opportunities to monitor, to supervise and to manage vessel traffic in the inner and middle of Persian Gulf backed-up by UNCLOS, and resulting in an advanced level of proactive Safety measures and pristine coastal and marine protection of the Persian Gulf.

The ROPME Sea area was given Special Area Status under MARPOL 73/78 Annexes I and V in 2008 by International Maritime Organization (IMO) in recognition of its Regional environmental importance and its unique, sensitive and abundant biodiversity. The area is home to an extraordinarily diverse array of marine mammals, sea birds, fishes and invertebrates, including many species that are particularly sensitive to the impacts of spilled oil or other hazardous materials. The Strait of Hormuz is also located in an area of critical importance to the conduct of maritime commerce, which is a major component of the regional economy.

Vessel traffic within the Strait of Hormuz was a major issue of concern raised during the Special Area designation process. The historical record of spills indicates that the total number of spills from transiting vessels is relatively small in number, but the potential impacts can be enormous given the number and volume of these vessels and the potential size of a spill.

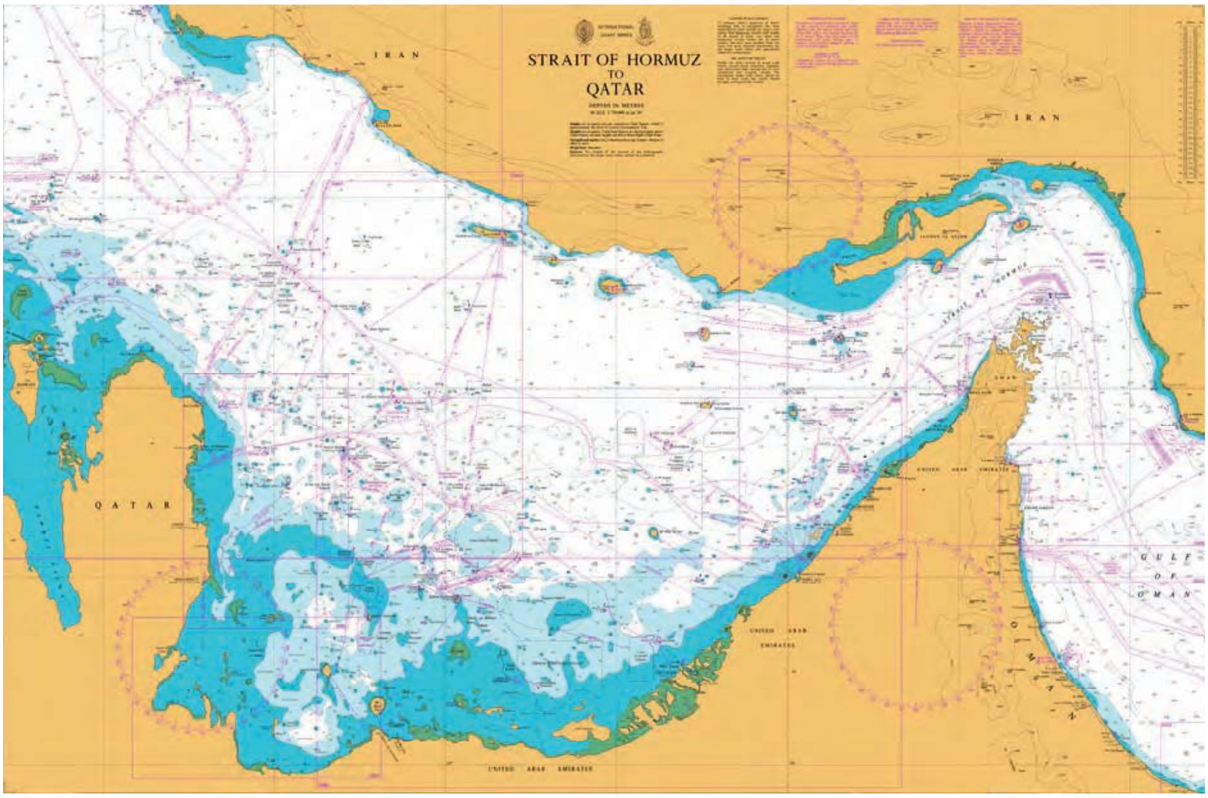
ROPME Sea Area Ministerial Council directed the Marine Emergency Mutual Aid Centre (MEMAC) to evaluate potential threats from spills of oil or other hazardous materials to Strait Of Hormuz TSS and possible ways to reduce those threats. The Marine Emergency Mutual Aid Centre (MEMAC) under its Regional Steering Committee consists of all ROPME Sea Area Member States review existing practices and risks, and to recommend a package of strategies which could be presented for ROPME Council review.

The study's goal is to provide a vessel traffic management system that maximizes protection of Strait of Hormuz resources while allowing for the continuation of safe, efficient and environmentally sound transportation.

## 2. OBJECTIVE

The objectives of this study are as follow:

- To enhance the Maritime Safety and Security
- To protect the entire region Marine and Coastal environment
- To manage and monitor incoming and outgoing traffic
- Prevention and Management of Incident/Accident
- Improving how the information is shared with stakeholders
- To Protect Economic viability of the Region
- To avoid massive repercussions on the world economy



## 3. EXISTING REGIONAL MECHANISM AND INSTRUMENTS

All regional coastal states have been aware and concerned over the state of marine environment in the RSA for a number of years. It was also understood that substantial environmental improvements would require a political will, practical involvement of all parties (governments, industries, and public) and enhanced cooperation between the states. As a first step in 1970's, ROPME Sea Area States with the strong assistance from the United Nations Environment Programme (UNEP), undertook to develop appropriate legal framework and an action plan for the prevention, abatement and combating pollution of the marine environment. Within the span of four years the preparatory work was completed and resulted in development of three draft legal instruments that were adopted by the plenipotentiaries of eight countries of the Region on 24 April 1978.

- Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution;
- Protocol concerning Regional Cooperation in Combating Pollution by Oil and other Harmful Substances in Cases of Emergency (MEMAC);
- Kuwait Action Plan for the Protection and Development of the Marine Environment and the Coastal Areas.

### 3.1– Kuwait Regional Convention

The Convention is a major legal instrument requiring for its members to coordinate their activities in the field of protection of the marine environment. The Convention entered into force in July 1979 and the following protocols and instruments further expand countries' regional environmental commitments:

- Protocol concerning Regional Cooperation in combating Pollution by Oil and other Harmful Substances in Cases of Emergency, 1978 (MEMAC);
- Protocol concerning Marine Pollution resulting from Exploration and Exploitation of the Continental Shelf, 1989;
- Protocol for the Protection of the Marine Environment against Pollution from Land-Based Sources, 1990;
- Protocol on the Control of Marine Transboundary Movements and Disposal of Hazardous Movements of Hazardous Wastes and other Wastes, (to be clarified);
- Legal Instrument on biological Diversity and Establishment of Specially Protected Areas,

These instruments represent an important legal framework for harmonizing policies activities and sustainable environmental development of the RSA member states as well as provide for the enhanced level of cooperation among them. As stipulated by Article XVI of the Kuwait Regional Convention the Regional Organization for the Protection of the Marine Environment (ROPME) responsible for the implementation of the Regional Plan and relevant Protocols was established in 1979.

ROPME and MEMAC are closely cooperating with IMO and IHO on a number of safety and environmental projects. One of the ongoing undertakings is focused on bringing the Region into the mainstream of MARPOL 73/78 regime and activities. To achieve this ROPME in cooperation with private sector is currently implementing a project designed to improve the situation with reception facilities for ships generated wastes.

As part of the Regional(ROPME SEA Area) Master Plan, and the establishment of the "Maritime Emergency Response and Salvage Co-ordination Unit (MERCU)" for example provides for the establishment of response centers directly adjacent to the Strait of Hormuz, located at Fujairah(UAE) and Bandar Abbas (IR. Iran).

Besides the manning and equipment with the necessary pollution response equipment, standby towing and Salvage vessels and etc. the scope of services assigned to those two centers could be expanded by means of the establishment of:

- **Vessel Traffic Management and Information System (VTMIS)**
- **The expansion of existing TSS in the Strait of Hormuz**
- **Compulsory Pilot services**
- **Mandatory ship reporting and routing**
- **Emergency towing capacities**

Taking into consideration the ongoing vessel traffic passage through the Strait of Hormuz and the lesson learned from previous incident in the vicinity or in the Strait the Marine Emergency Mutual Aid Centre (MEMAC) in cooperation with the Regional State decided to undertake a comprehensive study in order to enhance navigation Safety issues in the Strait of Hormuz. There are approximately 50,000 transits of the Strait each year by large vessels. Approximately 40% of these transits are crude oil Tanker and Chemical and Gas Carriers. Patterns of vessel traffic transit detected by the AIS stations installed in the Region are shown in ***Figure 1***.

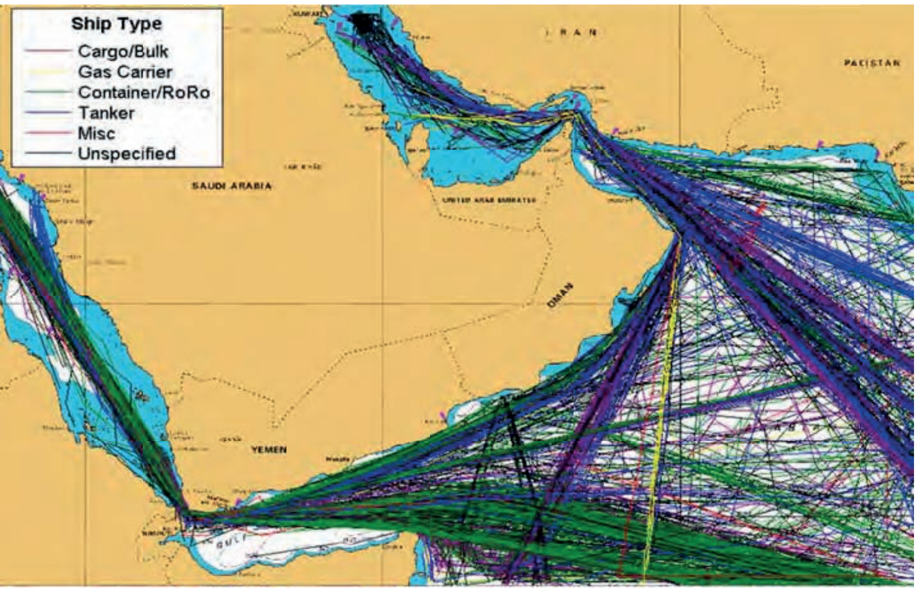



*Figure 1: Traffic pattern in the Strait of Hormuz*

Recognizing that spills can potentially occur from any transiting vessel carrying crude oil, bunker fuel, or other hazardous material, and the role of this Strategic waterway in the economy of the entire Region and any disruption in the routine flow of Traffic might cause the tremendous effect in the livelihood of the people in the Region, MEMAC was instructed by the Regional Steering Committee to established a working group consist of IR. Iran and the Sultanate of Oman two neighboring countries surrounding Strait of Hormuz, to conduct a study on the various aspects of the improving Safety of Navigation issues in the Strait of Hormuz taking into account the existing Aids to navigation capabilities and other necessary means, and to provide a comprehensive report to the Steering Committee, and also to the ROPME Council Ministerial meeting for their consideration and approval. Once the project is approved by the ROPME Council Meeting, then a proposal with regard to the issues that requires the NAV-COMSAR sub-committee approval will then be submitted for the adoption at the IMO.

## 4. BASIC PRINCIPLES

The working group is going to be tasked and focused on the four major categories of vessels:

a) Vessel carrying all liquefied substances Laden/ Unladen carrying crude oil, black oil or other persistent liquid cargo

b) Hazmat ships carrying hazardous materials in bulk, such as chemicals, explosives/munitions, ore concentrates, liquefied gases, and refined petroleum products;

c) Other Vessels

d) Military Vessel including Submarines

e) Working group is instructed to provide the Regional Steering Committee with a set of strategies reflects a balance of factors combined to provide protection for the Strait, reduced risk of vessel groundings and collisions, and efficient vessel operation, while minimizing the economic burden to industry. The working group is also instructed to take into their consideration the following:

1) **Traffic Separation Schemes (TSS)**: Modifications and expansion of the exsiting Strait TSSs, the lanes which help organize vessels as they approach major ports in both direction,

2) **Monitoring and Reporting**: Timely implementation of an Automated Information System (AIS), an electronic system that reports a vessel's position, which is compulsory on board all ships of 300 GT and upwards engaged on international voyages and cargo ships of 500 GT and upwards not engaged in int'l traffic, and passenger vessels irrespective of size, is also considered to increase capabilities for tracking and communicating with vessels as they transit the Strait and for assessing compliance with the recommended tracks.

3) **Near-miss Reporting**: Timely implementation is to be considered for a "near-miss" reporting system. This system would provide valuable insight into dangerous conditions before they precipitate an accident.

4) **Vessel Traffic Management and Information System (VTMIS)**: basic elements of the VTMIS are vessel traffic services (VTS) (SOLAS Reg. V/12) and automatic identification system

(AIS) (SOLAS Reg. V/19), Both tools are intended to enhance safety of navigation and the protection of environment, SAR operations, and investigations in marine accidents, security, and the efficiency of traffic. To get an overall picture, to be able to forecast the risks, to know about the situation outside the Strait and areas of specific VTSs and to carry out risk analysis, the benefits of establishing a VTMIS are widely acknowledged as to data exchange, early warnings on ship movements, target tracking and target handover between adjacent VTS Centres, redundancy in ship reporting, pollution incidents/accidents etc. VTMIS can be based on short range transponders, i.e. AIS, but may also incorporate a Long Range Identification and Tracking (LRIT). VTMIS allows detecting the development of potential dangerous situations and allowing for well-directed corrective action, thus reducing the risks associated to groundings, collisions, black out etc. potentially resulting in pollution hazards.

5) **Compulsory Pilot** services: in the absence of a fully operational VTMIS the management safety of navigation may be supported by compulsory (sea) pilot services for all inbound and outbound vessels of certain sizes carrying dangerous goods including hazardous and noxious substances (HNS) as cargoes. This will require a significant amount of work and preparation and yet to be decided.

6) **Mandatory ship reporting and routing**: the implementation of a mandatory ship reporting system for the Strait of Hormuz would allow for data on ship movements in the region, and, in combination with port statistics and data ship specifics, for the full picture. As similar mandatory reporting systems show, for example STRAITREP at Malacca/Singapore Straits, the level of precaution and preparedness could be tremendously improved for the benefit of enhanced safety at sea and marine environmental protection.

7) **Rescue Vessel Network**: Development of a Rescue Vessel Network is recommended to enable response agencies to more quickly identify and direct the nearest potential rescue vessel to the location of a distressed vessel.

8) **Education**: The overall vessel management package will include a strong education campaign for mariners to provide information on the sensitivity of Sanctuary resources, details on the new management measures and the importance of compliance.

The overall package of strategies will work together to ensure safe, effective, and environmentally sound vessel traffic management in the Strait of Hormuz. Completion of this Project among diverse agencies, environmental groups and the shipping industry, and its subsequent approval at the international level is an excellent example of the collaborate approach to resource management in Regional Marine Strait.

## 5. VTS SET UP IN THE STRAIT OF HORMUZ

According to UNCLOS article 42, States bordering straits may adopt laws and regulations on Safety of Navigation and regulation of maritime traffic through the strait, and on the prevention, reduction and control of pollution. UNCLOS International Straits Regime requires for cooperation in safety & pollution prevention of bordering States (Iran, Oman,) and "user states.

At present two VTS are working in the vicinity of Strait of Hormuz. IR. Iran has a commercial VTS operating since 2004, although this VTS is not covering the Strait of Hormuz, but the plan is to improve the existing VTS in IR. Iran, by adding necessary antenna and the work station which is due to be installed in the Larak Island.

The S. Oman VTS was established only for the military purposes but during the working group discussion and meeting it will be decided not only to improve the existing Oman VTS but also to use that for the commercial purposes as well.

By using and improving these VTS, the plan is to give the responsibilities of the inbound vessel control and monitoring to IR. Iran, and the responsibilities of the outbound vessel control and monitoring to S. Oman. Once this plan is agreed upon by both states, then a study is to be initiated in order to enhance the necessary equipment and the manpower of these to VTS Stations.

The requirements for enhancing the existing capabilities of these two VTS stations required a great deal amount of resources, due to be provided by the MERCU financial mechanism in order to remove the financial burden to the concerned states.

The establishment of (cross border) ship routeing systems, as well as vessel traffic management and information systems (**VTMIS**), will also cover the wider coastal and offshore areas.

The overall system will be entirely in line to the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), related guidelines, therefore VTMIS in the Strait of Hormuz can be classified in:

- Information services
- Navigational assistance service
- Traffic organisation service
- Operating rules and regulations
- Co-operation with allied services.

Without doubt, all these provisions represent a strong line of defense to handle pollution incidents and accidents and to reduce possible hazards to human health, properties and the environment not only in Strait of Hormuz but also in entire ROPME Sea Area.

This will also be a good and unique example for the Regional Cooperation and coordination by utilizing the VTS in the most strategic shipping routes in the world, in order to improve the maritime Safety and the protection of the marine Environment as stipulated in the International Conventions.

## 43 VTS FEHMARN BELT – A DANISH/GERMAN PROJECT

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*Niels Jakob Mygind. Danish Maritime Administration, Denmark*

The Kingdom of Denmark and the Federal Republic of Germany conclude a treaty on a fixed link across the Fehmarnbelt in September 2008 . Since this date the plannings of the bilateral project are in progress. In consequence of several investigations the countries decided to cross the Belt with a tunnel instead of a bridge. As a result from the formal safety assessment for safe navigation in the sound between Denmark and Germany a Vessel Traffic Service System (VTS) shall be installed for the construction phase to reduce the danger to the shipping by accidents between ships as well as ships and construction gear of about 60 per cent. The responsible Danish and German Authorities agreed to implement an independent temporary VTS-Center in the pemises of the VTS-Center Travemünde. The advantages are obvious. The agreed solution reduces costs and stimulates the teamwork between the VTS "Fehmarn Belt" and the adjacent VTS-sectors of the VTS Travemünde. A Danisch/German administration group (DenGer-Adm. Gr.) concluded to man the VTS "Fehmarn Belt" by Danish and German personnel in parity headed by one manager of each country. The communication language inside of the VTS-Center as well as external communication will be english. The operating proceedures, the technical equipment and the education of the staff will be in accordance to the international requirements. This Danish/German project demonstrates the close cooperation between the maritime authorities of two adjacent neighbouring countries to ensure the vessel traffic in common sea areas.

El Reino de Dinamarca y la República Federal Alemana concluyeron en septiembre de 2008 un tratado para la construcción de un enlace fijo a través del estrecho de Fehmarnbelt. Desde esta fecha se están realizando los planes del proyecto bilateral. Como resultado de varias investigaciones ambos países decidieron cruzar el estrecho mediante un túnel en lugar de con un puente. Como consecuencia de la evaluación formal de seguridad para la navegación segura en el estrecho entre Dinamarca y Alemania se instalará un sistema de Servicio de Tráfico de Buques (VTS) durante la fase de construcción para reducir en aproximadamente un 60 % el peligro para el tráfico marítimo por accidentes entre barcos y entre barcos y equipos de construcción. Las autoridades danesas y alemanas responsables acordaron implementar un centro VTS temporal independiente en las instalaciones del centro VTS Travemünde. Las ventajas son evidentes. La solución acordada reduce los costes y estimula el espíritu de equipo entre el VTS «Fehmarn Belt» y los sectores VTS adyacentes del VTS Travemünde. Un grupo de administración germano-danés (DenGer-Adm. Gr.) pactó por unanimidad la paridad de personal danés y alemán en el VTS «Fehmarn Belt», dirigidos por un jefe de cada país. El idioma de comunicación en el interior del centro VTS así como en las comunicaciones externas será el inglés. Los procedimientos de funcionamiento, el equipo técnico y la formación del personal deberán estar en concordancia con los requerimientos internacionales. Este proyecto germano-danés demuestra la estrecha colaboración entre las autoridades marítimas de dos países vecinos para garantizar el tráfico de buques en áreas marítimas comunes.

*Le Royaume du Danemark et la République Fédérale d'Allemagne ont conclu, en septembre 2008, un accord sur un lien fixe traversant le Fehmarn Belt. Depuis cette date, ce projet bilatéral progresse. Après de nombreuses investigations, les deux pays ont décidé que ce lien fixe serait un tunnel et non un pont. Après une évaluation de la sécurité de la navigation entre le Danemark et l'Allemagne, il a été reconnu nécessaire d'installer un VTS pendant la construction pour réduire d'environ 60% les risques d'accidents entre navires et entre engins de construction et navires. Les autorités responsables danoise et allemande ont accepté d'installer un centre VTS temporaire et indépendant dans les bâtiments du VTS de Travemünde. Les avantages sont évidents. La solution retenue réduit les coûts et stimule le travail d'équipe entre le VTS de Fehmarn Belt et les secteurs adjacents du VTS de Travemünde. Un groupe administratif danois/allemand comprenant en parité du personnel danois et du personnel allemand avec deux chefs, un de chaque pays, gère le VTS de Fehrmarn Belt. Au centre VTS, ainsi que pour les communications avec l'extérieur, on parlera anglais. Les procédures, les équipements, la formation du personnel, respecteront les règles internationales. Ce projet souligne la coopération entre services maritimes de pays voisins qui existe pour assurer le trafic maritime dans des zones communes.*

# VTS Fehmarn Belt – A Danish/German project

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# VTS Fehmarn Belt – A Danish/German project

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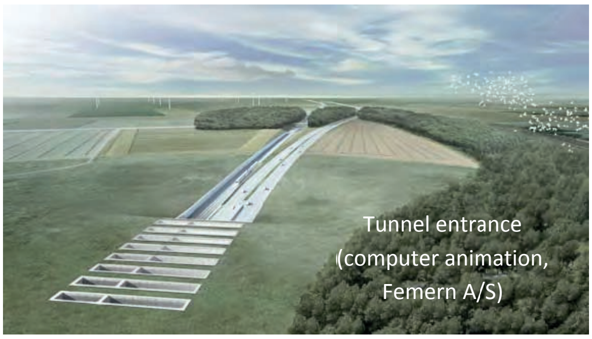
## 1. INTRODUCTION

A Fehmarnbelt Fixed Link realises the dream of a fixed, close and direct connection between Scandinavia and continental Europe. By uniting the populations in areas such as science, business, the labour market and culture, it will promote the continuous integration of Europe.

Beginning at least as early as 2000, German and Danish transportation planners pushed for a "fixed link" – either a bridge or a tunnel – across the Fehmarn Strait. A bridge was widely regarded, for years, as the most likely scheme. In late 2010 further intensive investigations offered the possibility of an immersed tunnel solution.

The fixed link will considerably reduce the travel time between Scandinavia and continental Europe: Whilst the current ferry transit takes 45 minutes (plus waiting time), train passengers will require only seven minutes, car drivers no more than ten. With a tunnel the duration of a train journey between Hamburg and Copenhagen will be cut short from about four and a half to merely three hours.

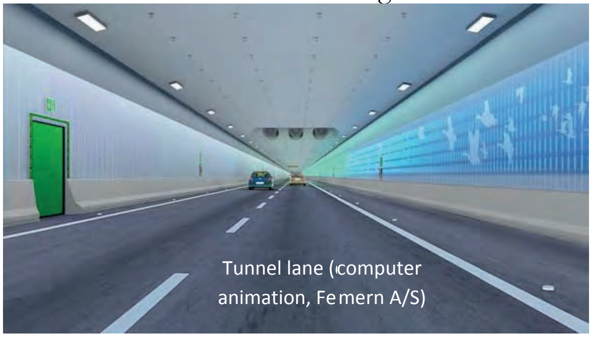
So Denmark and Germany have concluded an agreement by treaty to establish a fixed link across the Fehmarn Belt. It has been decided to build an immersed tunnel between Rødby on the Danish island Lolland and Puttgarden on the German island Fehmarn. As the owner of the future tunnel



Tunnel entrance (computer animation, Femern A/S)

Femern A/S has cooperated for a number of years with the maritime authorities in Denmark and Germany about the conditions of Safety and efficiency of traffic in connection to the project.

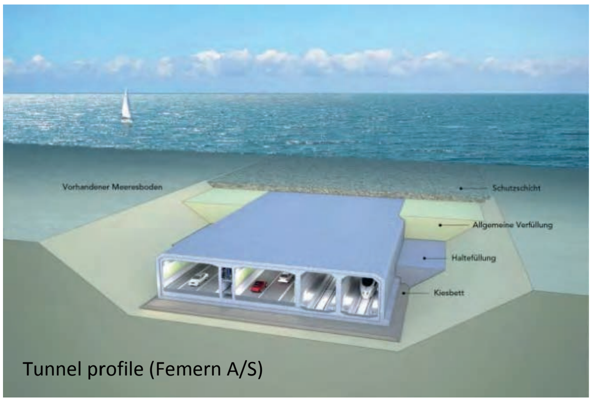
The immersed tunnel with a planned length of 17.6 km will be the longest combined road and rail tunnel ever constructed. The deepest section of the Fehmarn Belt Trench is 35 metres, thus the dredging barges will need to be capable of reaching depths of over 45 metres. The precast concrete tunnel sections will have a rectangular cross-section



Tunnel lane (computer animation, Femern A/S)

# VTS Fehmarn Belt – A Danish/German project

Hartmut H Hilmer, Federal Waterways and Shipping Agency, Germany, Niels Jacob Mygind, Royal Danish Navy, Gerhard Müller-Hagen, Federal Waterways and Shipping Agency, Germany



Tunnel profile (Femern A/S)

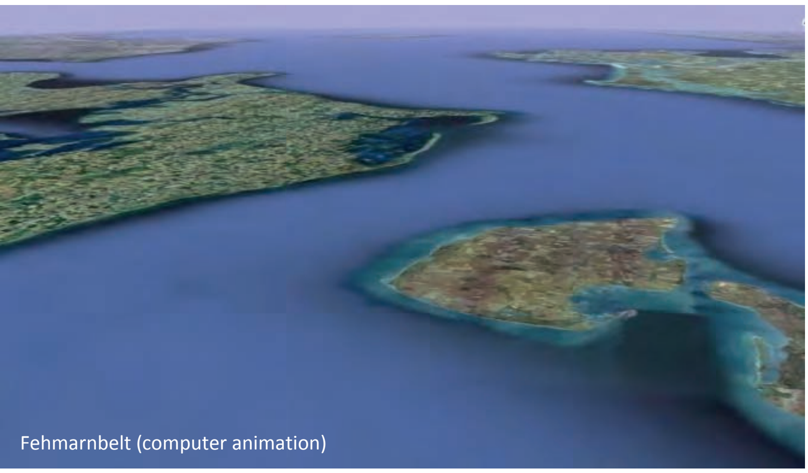
that is about 42 metres wide, 217 m lenght and 10 metres high. The weight will be 72.000 to.

An immersed tunnel requires comprehensive building measures under water by numerous floating gear in a very high frequented waterway. On account of the construction operations as well as the construction crafts and the supply vessel the risks for a safe navigation in the Fehmarn Belt will increase for passing traffic.

## 2. PRESENT SITUATION

The Fehmarn Belt is geographically situated in the southern Baltic between the Danish island Lolland and the German island Fehmarn. Today the 10 nautical miles wide sound is frequented by about 55.000 ships in direction northwest and southeast. Additionally the islands are connected by several RO/RO-ferries with about 33.000 passages per annual.

Vessels sailing from several directions towards the sound are converged before entering the area and diverged after leaving the area. In the sound the available traffic area is reduced so that the shipping is compressed. That leads to crossing and opposing traffic and to increasing risks for the safety of navigation.


Fehmarnbelt (computer animation)

On the German side the traffic is observed by the VTS-C Travemünde. Mariners are provided with navigational information and supported with navigational recommendations if necessary.

In Denmark the Danish Maritime Authority is responsible for Safety of navigation – as well as being the Competent Authority for Vessel Traffic Services.

In addition the Royal Danish Navy is responsible for maritime surveillance, the protection of the marine environment – and is also the only Danish VTS Authority for operating VTS.

The primary objectives for the Danish Maritime Authority are those of the flag-state – whereas the Navy focuses mainly on those of the coastal state. Both organizations have been taking part in the Formal Safety Assessment as well as the preparation of the Vessel Traffic Service concerning the Fehmarnbelt project.

In Germany the Federal Waterways and Shipping Agency and its subordinated Waterways and Shipping District Offices is in charge of safety and efficiency of the traffic as well as the prevention of dangers for the maritime environment caused by shipping along the German coast including the German Exclusive Economic Zone.

In addition the Waterways and Shipping Agency maintains and develops the waterways in navigable conditions.

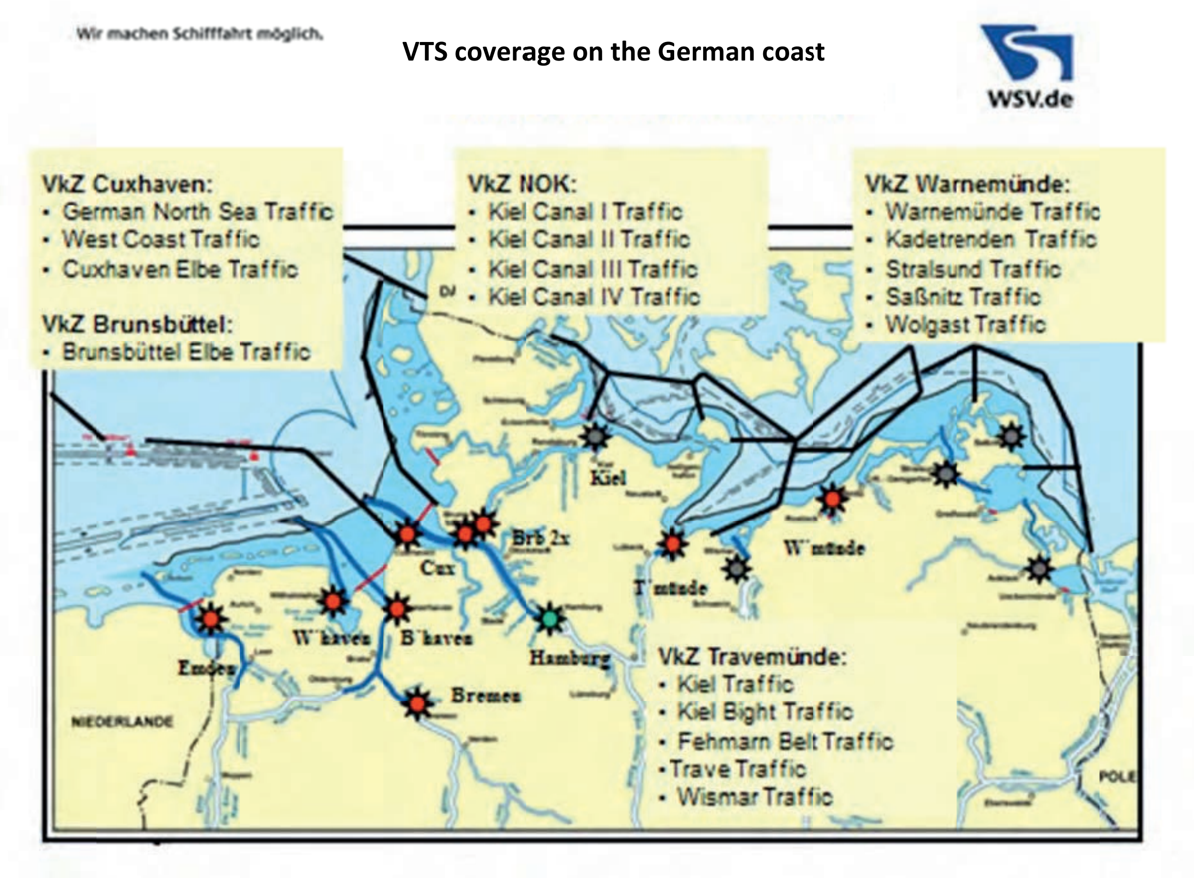
These responsibilties include the establishment and operation of Vessel Traffic Service and their tasks of:


Fehmarnbelt (photo)

1. safety and efficiency of shipping,
2. safety of life at sea respectively onboard,
3. emergency measures in case of an incident and
4. contact point for shipping for all navigational questions.

Automatic alarms will be given in determined dangerous situations. When an alarm is activated the ship concerned is contacted by VTS.

VTS Travemünde is assumed to give an accident reducing effect of 30% for all accident scenarios in the area covered by the present risk assessment (part of Fehmarnbelt and Kiel Bight). In contrast, an accident reducing effect of 60% is assumed in the manually monitored areas close to the coast, for example Travemünde, Kiel and Wismar. It should be emphasized that the effect of 30% is applicable for scenarios without construction activities.




At this stage the traffic in the western part of the German Baltic area is monitored by the existing VTS Travemünde; including the entrances to the ports, Fehmarnbelt and Kiel Bight. Areas close to Travemünde, Kiel and Wismar ports on the German coast are manually monitored based on AIS data, radar data and partly camera surveillance by three VTS operators who communicate directly with all ships. They are licensed to give instructions to shipping in the territorial waters.

The main task of VTS Travemünde is to provide information to the ships. General information is broadcasted every hour containing information on traffic situation, meteorological and hydrological conditions, obstacle and construction operations, etc.

Fehmarnbelt and Kiel Bight are not radar but AIS covered. Generally the areas are automatically monitored by the VTS Travemünde. That means the traffic is generally observed by computers.

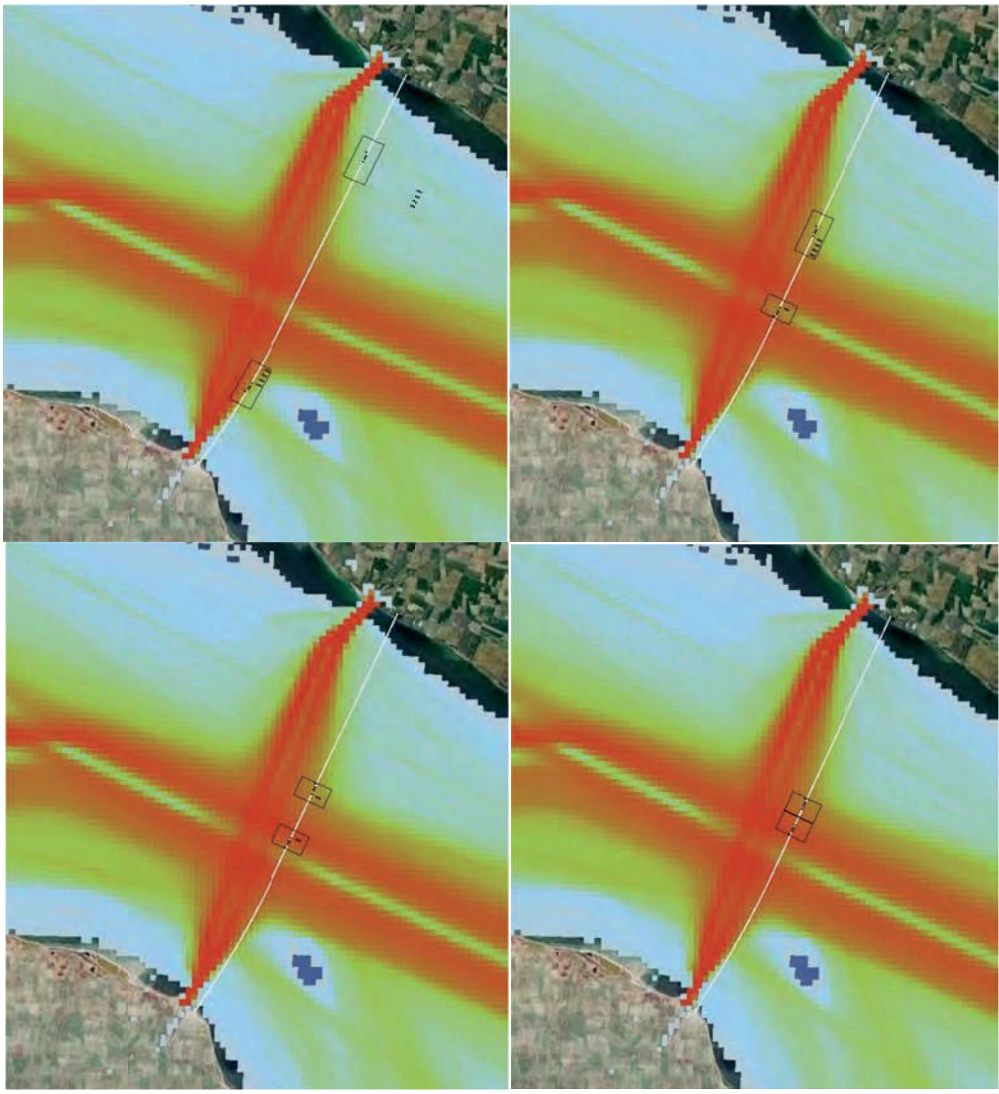
The Danish Maritime Authority, the Danish Royal Navy and the Waterways and Shipping Agency Germany have established a bilateral group called the DenGer-Administration Group (DenGer Adm. Gr.).

This is a standing maritime authority group for coordination of their common effort to maintain safety and efficiency for ship traffic in the adjacent German and Danish waters not only during the construction phase of the fixed Fehmarn Belt Crossing.

## 3. CONSTRUCTION PHASE

As already mentioned an immersed tunnel requires comprehensive building measures under water by numerous floating gear in a very high frequented waterway in comparision to a drilling tunnel. Additional to the compressed traffic flow shipping will be restrained by dredgers and a lot of working gear operating between shore and the working areas. It is planned to install two working areas at once. These hazards have to be compensated by appropriate measures.

In the Fehmarnbelt Fixed Link project the DenGer Adm. Group is dedicating their work to maintain safety and efficiency for the non-construction ship traffic in Fehmarn Belt during the construction phase. The DenGer Adm. Group will be the acting authority (representing both German and Danish authorities) in the process for realization of the risk control options which were decided. On a regular basis the DenGer Adm. Group coordinates with Femern A/S.



*Movement of the construction areas (Femern A/S)*

Femern A/S hired a consultant company, Ramböll, to carry out the Formal Safety Assessment, during which both radar and AIS data were analysed.

The present risk assessment is concerned with the interactions between the passing traffic and the offshore construction activities related to the construction of an immersed tunnel across Fehmarnbelt. All passing ship traffic will be sailing throughout

the construction period; i.e.

- commercial traffic on the T-route through Fehmarnbelt,
- ferry traffic between the islands,
- commercial traffic on main navigational routes in the western part of Fehmarnbelt, and additional
- traffic with smaller ships in the area (local commercial ships, fishing boats and pleasure crafts).

A hazard identification and risk control options workshop was conducted to identify and describe potential hazards related to the offshore construction activities and the non-construction ship traffic in Fehmarnbelt. A ship risk model is developed based on the identified hazards and used as the basis for the risk assessment of the tunnel construction phase in Fehmarnbelt. The model itself is based on a ship risk model used for the development of the Formal Safety Assessment for a bridge across the Fehmarnbelt. However, new objects and ship types are modeled to include the presence of different types of construction equipment.
Beside others the primary findings were that:

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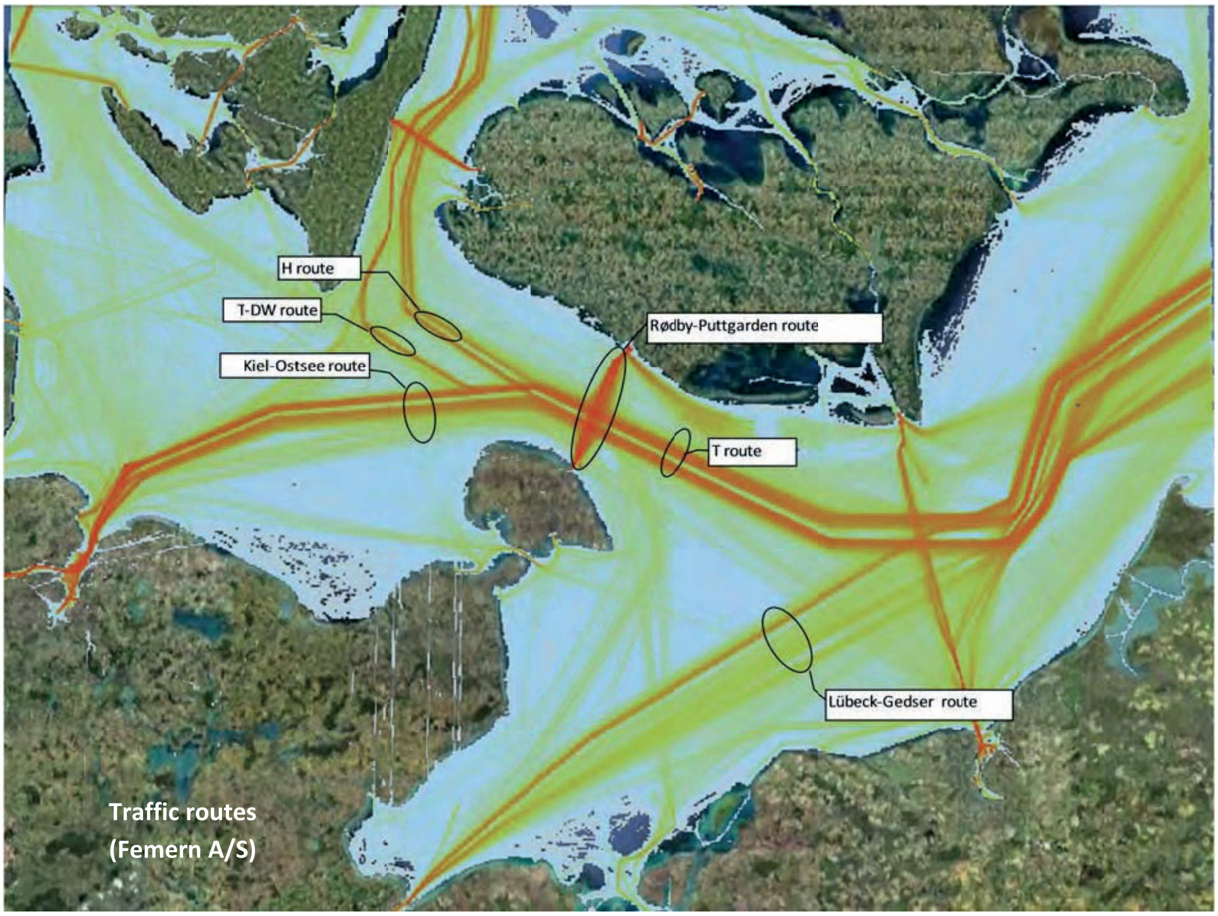



- app. 55.000 vessels are passing the area yearly with – max size of about 300.000 GT and a maximum draught of 15-16 meters
- today there are no natural obstructions
- during the construction phase a maximum of two construction sites will be moving in the construction area - obstructing the navigation – together with around 100 work vessels.
- risks increases during the construction phase

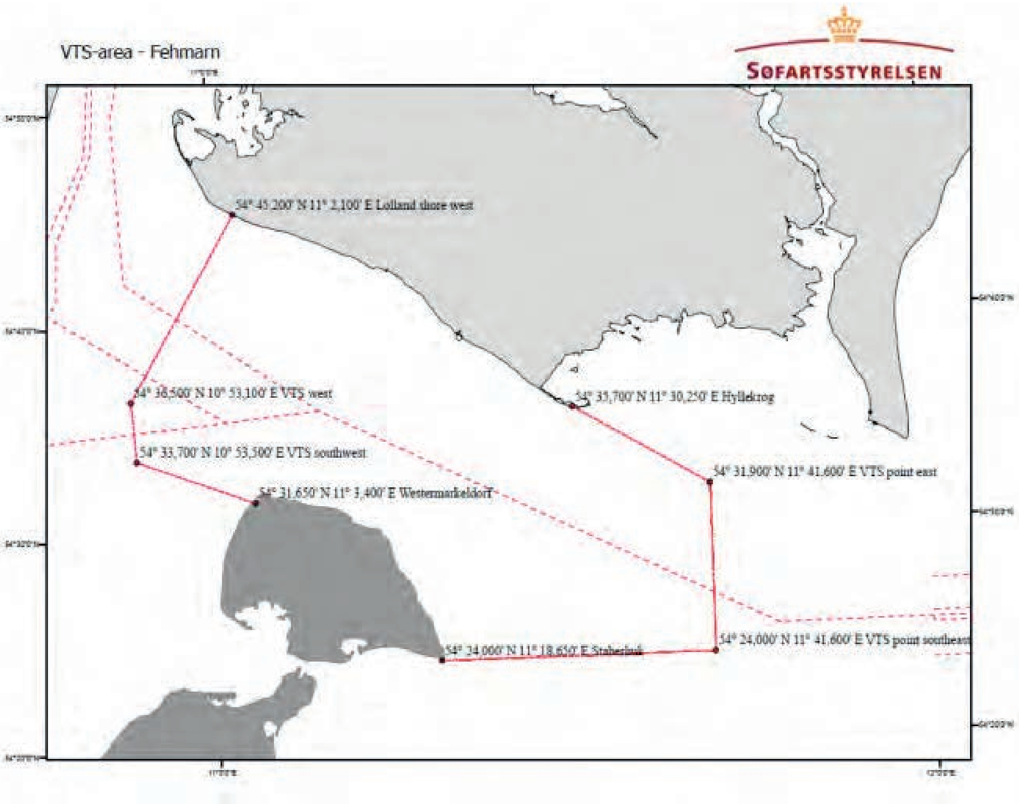
## 4. RISKS REDUCTION MEASURES

Five risk control options were formulated and recommended in the Formal Safatey Assessment:

- **VTS**
  A temporary VTS system will be established in Fehmarnbelt. This system will include manual surveillance of the traffic and provide information to ships in the area. The temporary VTS system will be active during the construction period and will be implemented as a layer on top of the existing automatic surveillance performed by VTS Travemünde, which covers part of Fehmarnbelt.
- **Guard ships**
  The work areas will be to be watched by guard ships.
- **Safety zones**
  The work areas and the holding areas for tunnel elements will be surrounded by clearly marked safety zones. Ships not involved in the construction activities will have to stay clear of these zones.
- **Work Vessel Coordination**
  It is assumed that the movements of tugs/barges and other construction traffic are coordinated by a work vessel coordination center.
- **Coordination**
  Continuous monitoring and improvement of risk control options during the construction
- **Light buoys**
  Light buoys marking the "corners" of each construction site

Beside others a temporary VTS system with manual surveillance, and guard ships with an authority representative onboard in connection with each offshore work area as well as marked work areas and a work vessel coordination (WVC) center will reduce the risks.

The consultant calculated that merely a VTS-System will avoid 60-90% of all accidents.




After the Competent Authorities decided the need for a VTS, it was also soon decided that it should be a joint VTS. Therefore solutions like operating one part of the area from one location and another part somewhere else were quickly discarded.


The two VTS authorities agreed subsequently that the operative word should be "JOINT" – that is

- One area
- One set of procedures
- One training program
- One language

Further investigations of the responsible authorities and discussions between the parties resulted in a joint VTS established in the premises of the existing VTS Travemünde on the German side.

Irrespective of the Fixed Fehmarnbelt Link a new VTS-Center in Travemünde had been under construction by the Federal Waterways and Shipping Agency and the subordinated Waterways and Shipping District Office Lübeck for some time.

The decision to implement the temporary VTS Fehmarnbelt in the premises of the new center took place at the very end of the construction phase of the VTS-C. So VTS Fehmarnbelt will be established as a layer on top of VTS Travemünde in such a way that during the construction phase VTS Fehmarnbelt is the acting authority in assisting the non-construction ship traffic in the area covered by VTS Femern.

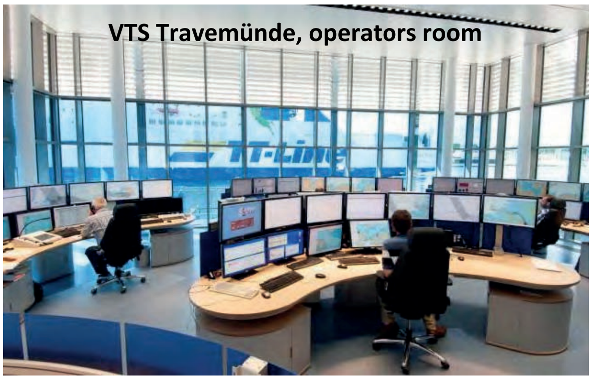
To cover this area VTS Femern will have 3 VTS workstations continuously manned. The three workstations are physically placed in the VTS Travemünde operational room. Four operators (two German and two Danish) will be on duty all the time to keep the three operator stations continuously manned. The manning will be done according to German and Danish procedures. It is expected that operation of VTS Fehmarnbelt will require a total staff of around 26 operators (German and Danish) and 2 managers (one German and one Danish).

The VTS operators will get their information about the ship traffic in Fehmarn Belt from the following main sources:

- coastal radars,
- land based AIS,
- VHF radio direction finder (VHF RDF)

- and communication by VHF or mobile telephone.

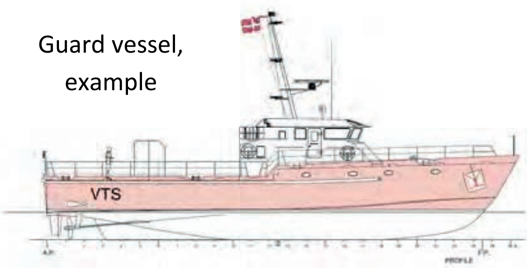
The primary objective of the VTS will be to get the participating vessels safely through the area to avoid dangers to the shipping, to the population and to the environment.




The VTS will provide Information Service to participating vessels – regarding

- position of work sites,
- recommended passing,
- traffic situation in the Belt,
- general Information for example weather, visibility and hydrographic conditions,
- etc.

Although there will be focus on the construction area, the VTS will also assist vessels East and West of this area to solve navigational problems between vessels before they reach the construction are. It will be easier for those vessels to pass the construction area safely.




During the construction phase guard ships will assist VTS Femern. Two guard ships will be acting under the authority of VTS Fehmarnbelt.

The DenGer Adm. Group decided that the guard vessels:

- The guard ships must have the necessary facilities to accommodate two authority representatives 24 hours a day
- One guard ship per work area has to be available at all times to assist the non-construction ship traffic
- The guard ships must be manoeuvrable under all weather conditions expected in Fehmarn Belt.
- The guard ships must be fast enough to interfere with a non-construction commercial ship approaching a work area.
- The guard ships must have suitable equipment to be used in the attempt of attracting the attention of an approaching commercial ship.

The objectives and the tasks of the VTS Fehmarn Belt request professional knowledge about navigation and VTS-management but of course require also the technical infrastructure and a well educated staff.


One of the prior requirements of the VTS staff and the representatives onboard the guard vessels is that all personnel must have passed master mariners education.

Additional the staff will be educated as VTS-operators in accordance with the IALA Recommendation V-103. The education of the personnel can take place in Germany or in Denmark.

The development of an education concept, the recruitment of masters mariners and the VTS-education as well as the requested national education will take a lot of time.

So the next steps of the DenGer Adm. Gr. will be:

- finalisation of the education and the VTS working procedures concept for the VTS-Operators and the national representatives on the guard vessels in the middle of 2014
- beginning of the recruitment of the VTS personnel after completion of the education concept and the VTS-working proceedures
- start of the theoretical education phase including exercises in a VTS-simulator. For a training on the job VTS will operate in a silent mode first.

## 5. LEGAL ASPECTS

Beside the preparations to ensure a safe and efficiency shipping in the Fehmarnbelt during the construction phase the legal requirements in German and Danish waters have to be considered. The VTS area Fehmarn Belt extends on two different sovereign countries. Therefor the VTS Fehmarnbelt will be manned parity by Danish and German personnel.

In the routine work there will be no difference in the jobs of the VTS-operators. The Danish and the German operator will inform and assist the ships in the comprehensive area independent the territorial waters.

In situations when instruction will became necessary or when accidents will happen the operator of the concerned country will take responsibility and the necessary measures.

## 6. SUMMARY

- Denmark and Germany agreed to connect their countries by a fixed Fehmarnbelt link. On account of the detected risks to safety during the construction phase in the Fehmarn Belt the responsible authorities of both countries developed important measures to enhance safety of navigation.
- A significant measure is the implementation of a temporary joint VTS
- Fehmarnbelt in the premises of the VTS Travemünde. This VTS will be managed by a Danish and a German VTS-manager and be manned by Danish and German master mariners. The external as well as the internal communication will be in English.
- The education is based on international and national requirements and includes a theoretical part, simulations and a training on the job.
- The establishment of the DenGer-Administration Group to enhance the safety and efficiency of shipping in a shared sea area is a very good example for a close cooperation between two neighbouring countries.
- Particular the establishment and operation of a joint VTS managed by the VTS-authorities in Denmark and Germany during the construction phase of the fixed Fehmarnbelt link will make navigation and shipping safer and in the end will protect the marine environment on both sides of the Fehmarn Belt.

## 78 FINDING SOLUTIONS BEFORE ACCIDENTS HAPPEN

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The rules and regulations to ensure and enhance safety at sea are usually revised or developed after the investigation results of serious maritime accidents. But isn't it possible to do this before the accidents happen?

The same things that cause accidents cause near misses. By reporting and analysing near misses we can learn important lessons and take remedial action before a full scale accident occurs. Although the necessity of reporting near misses considered, there are various barriers that prevent to report them. In order to find solution to this problem a research has been done. At the first stage of the research, issues that stand near miss reporting were identified by questionnaire method. How to solve this problem was investigated at the second stage by using Delphi Technique. As a result, for an effective, efficient and sustainable near miss reporting system the system should be based on the elements of positive safety culture.

Key Words: Near Miss, Safety Culture, Just Culture

Generalmente, las normas y regulaciones para garantizar y aumentar la seguridad en el mar se revisan o desarrollan tras los resultados de la investigación de accidentes marítimos graves. Pero, ¿no es posible hacerlo antes de que se produzcan los accidentes?

Las mismas cosas que causan accidentes pueden causar incidentes. A partir de la información y el análisis de incidentes podemos aprender importantes lecciones y adoptar acciones correctivas antes de que se produzca un accidente a gran escala. Aunque se ha considerado la necesidad de informar de incidentes, existen diversas barreras que impiden que se hagan los informes. Con el fin de encontrar una solución a este problema se ha realizado una investigación. En la primera etapa de la investigación se identificaron temas que afectan a la información de incidentes mediante el método de cuestionario. En una segunda etapa se investigó cómo resolver este problema empleando una técnica Delphi. El resultado indica que para conseguir un sistema de información de incidentes eficaz, eficiente y sostenible, este debe basarse en elementos de cultura de seguridad positiva.

Palabras clave: Incidente, Cultura de seguridad, Cultura

*La réglementation qui assure et améliore la sécurité en mer est généralement révisée ou développée après les résultats d'enquêtes sur d'importants accidents maritimes. Mais serait-il possible de le faire avant que les accidents arrivent ?*

*Les causes d'accidents sont les mêmes que les causes de quasi-accidents. On peut beaucoup apprendre dans les rapports et analyses de ces incidents et en déduire les dispositions à prendre avant qu'un véritable accident arrive. Bien qu'on reconnaisse la nécessité de faire des rapports sur les quasi-accidents, on se heurte à plusieurs raisons de ne pas le faire. Une recherche a été effectuée pour trouver une solution à ce problème. Une première étape a été d'identifier les cas de quasi-accident justifiant un rapport par la méthode du questionnaire ; dans une seconde étape on a utilisé la Technique Delphi. Résultat : pour obtenir un système de rapports de quasi-accident effectif, efficace et durable, il faut qu'il repose sur des éléments de culture de sécurité positive.*

# Finding solutions before accidents happen

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## 1. INTRODUCTION

Since the first day of maritime transport, initiatives to ensure the safety at sea couldn't be fully successful to prevent all of the accidents. There were many such kind of accidents in the last century. The most well-known of these are; more than 1700 dead in Mississippi Sultana disaster in 1865, more than 1500 dead in 1912 Titanic disaster, 119.000 tons of oil pollution Torrey Canyon disaster in 1967, 287.00 tons of oil pollution Atlantic Empress disaster in 1979 and many others. But in the light of the information obtained from accident investigation, various rules and regulations were created to prevent recurrence of similar accidents.

It is a common saying in the maritime sector that:

- Titanic experience created the SOLAS,
- Torrey Canyon experience created the MARPOL,
- Amoco Cadiz experience created the MARPOL amendments and the STCW,
- Exxon Valdez accident gave us the OPA 90 (USA)
- Herald of Free Enterprise circumstance created the ISM Code [1].

Nowadays, modern technology and systems, to specify the rules, regulations and arrangements in order to improve the safety, is it necessary to wait for accidents? Isn't it possible to determine the precautions to be taken before accidents happened?

## 2. BASIC CONCEPTS

### 2.1 Near Miss

There are many definitions for "Near Miss (NM)" in different sources. Some of these are given below:

> *"A sequence of events and/or conditions that could have resulted in loss. This loss was prevented only by a fortuitous break in the chain of events and/or conditions. The potential loss could be human injury, environmental damage, or negative business impact (e.g., repair or replacement costs, scheduling delays, contract violations, loss of reputation)" [2].*
>
> *"A potential significant event that could have occurred as the consequence of a sequence of actual occurrences but did not occur owing to the system conditions prevailing at the time" [3].*
>
> *"A sequence of events which is prevented from developing further into undesired outcomes inflicting damage to people, property and/or the environment" [4].*
>
> *"A hazardous situation, event or unsafe act where the sequence of events could have caused an accident if it had not been interrupted" [5].*

As it is seen there is no common definition for 'near miss' but based on the definitions the basic elements of NM can be summarized as follows.

- Is likely to result in loss of that event or chain of events,
- At the end of the event or chain of events have not come out of any loss,
- At the end of this event or chain of events we have not faced any loss due to fortuitous / unconscious / unplanned / instant response – activities or situations.
- Expressed as loss is; loss of life, human health, the environment or property damages or commercial losses.

#### 2.1.1 The importance of NM reporting in enhancing of safety measures

The necessity of investigation of NM has emerged in after a study that conducted by Herbert William Heinrich in 1931 [6]. H.W. Heinrich is one of the pioneers of occupational health and safety issues in the world issued a study called "Industrial Accident Prevention". In this study he classified accidents according to severity and defined accident triangle, known also as the accident pyramid or safety pyramid as shown in **figure 1**. His report showed that for each serious-injury incident, we could expect about 29 minor injuries and 300 property-damage incidents (**Figure 1**).

Heinrich's aim in this study was to reveal the truth that in order to take preventive measures there is no need to wait for an accident. With his accident pyramid he mentioned that the preventive measures should not only be taken into account in the stage of severe consequences but also the lower level of the pyramid [7].

In the following years similar studies also showed that each major accident can be linked to a number of incidents that happened earlier. The same things that cause accidents cause NMs.

Reporting NMs by all employees, investigating the reports meticulously, developing and implementing recommendations is very important for breaking the chain of events leading to the accident. Based on this, it can be said that reporting and investigating NMs is just as preventing diseases by vaccines [8].


*Figure 1: Accident triangle (Heinrich, 1931)*

## 2.2 Safety Culture

In order not to make the same mistakes number of times, organizations want to learn from past mistakes and successes in the light of experience and expertise of their employees revealed utilizing their ideas and opinions. But to ensure this, safety-related issues should be dealt with in a systematic manner throughout the organization, like safety culture [9].

The term safety culture came into popular after the 1986 Chernobyl nuclear power plant accident. After this accident the International Atomic Energy Agency (IAEA) issued a report and mentioned the weakness of the organization's safety culture and it has been cited as one of the cause of the accident. After this report, to prevent the occupational accidents, safety culture has been a topic which should be emphasized [10]. Since that time, poor safety culture has been identified among the causes of numerous high-profile accidents in other industries, such as the sinking of the Herald of Free Enterprise, the disaster of the Space Shuttles Challenger and Colombia, the BP oil platform accident in Mexico Bay, etc. [11]

There are many different definitions for safety culture like as NM. In more formal terms safety culture is the product of individual and group values, attitudes, competencies and patterns of behaviour that determine commitment to, and the style and proficiency of, an organization's health and safety management [12].

According to Kletz (2001), if we talk about causes we may be tempted to list those we can do little or nothing about. For example human error is often quoted as the cause of an accident but there is little we can do to prevent people making errors especially those due to a moment's forgetfulness. If the question is "what is the cause?" then the answer will be only human error but if the question is "what should we do differently to prevent another accident?" we are led to think of changes in design or methods of operation. The word 'cause' has an air of finality about it that discourages further investigation [13].

In general, poor safety culture means that safety is sacrificed, even when people are saying that safety comes first – hence practice differs from theory or policy. Simple examples would be where staff concerns about safety are consistently not addressed; where there appears to be no learning from past events; where safety cases state the system is safe but operational people believe an accident is imminent; or where safety is believed to be someone else's responsibility. Safety Culture 'mismatches', where management and employees do not share the same beliefs about safety, or where their behaviours are in opposition, can often be detected in organizations.

A positive safety culture would be one where everyone knew their role with respect to safety, and believed that everyone in the organization was truly committed to safety, because there was clear safety leadership, activity, and commitment in terms of resources. Safety would be discussed frequently at all levels in the organization, and would be the first agenda item in the periodic meetings. There would be a clear safety strategy, and anyone could raise a safety issue with impunity; operational staff could also report events without fear of any recrimination or even of losing face amongst their peers.

Characteristics of positive safety culture are;

- **Reporting culture**, which encourages employees to divulge information about all safety hazards that they encounter.
- **Just culture**, which holds employees accountable for deliberate violations of the rules but encourages and rewards them for providing essential safety-related information.
- **Flexible culture**, which adapts effectively to changing demands and allows quicker, smoother reactions to off-nominal events.
- **Learning culture**, which is willing to change based on safety indicators and hazards uncovered through assessments, audits, and incident analysis.
- **Informed culture**, where a safety system integrates data from incidents, accidents and NMs and combines them with information

from proactive measures such as safety audits and climate surveys [14].

## 3. OBJECTIVE AND METHOD

Although the necessity of reporting NMs considered, there are various barriers that prevent to report them. In order to find solution to this problem a research has been done. At the first stage of the research, issues that stand NM reporting were identified by questionnaire method. How to solve this problem was investigated at the second stage of research by using Delphi Technique[1].

After first stage of research interpretation of the survey results for the solution of the identified problems, 5 questions were asked to 42 maritime experts at the first round of Delphi Technique. These questions are as follow;

1) The necessity of reporting NM considered by employees but they are concerned that they can stay in difficult situation, such as being reprimanded and even being subject to administrative investigation. How do you think this problem be solved?
2) Preparing NM report will take extra time and expected to produce additional work load. How do you think this problem be solved?
3) According to you who should investigate the reports and how?
4) According to you what kind of information should NM reporting form include?
5) What are your suggestions for effective and efficient NM reporting system?

The answers of 42 experts complied and classified under 4 main topics and Delphi 2nd round questionnaire prepared including 56 proposal questions. The 4 main topics were;

6) How to overcome the barriers of reporting NM?
7) How to evaluate the reports?
8) The needs for effective and efficient reporting system.
9) What information should be in the reporting form?

35 maritime experts participated to Delphi 2nd round.

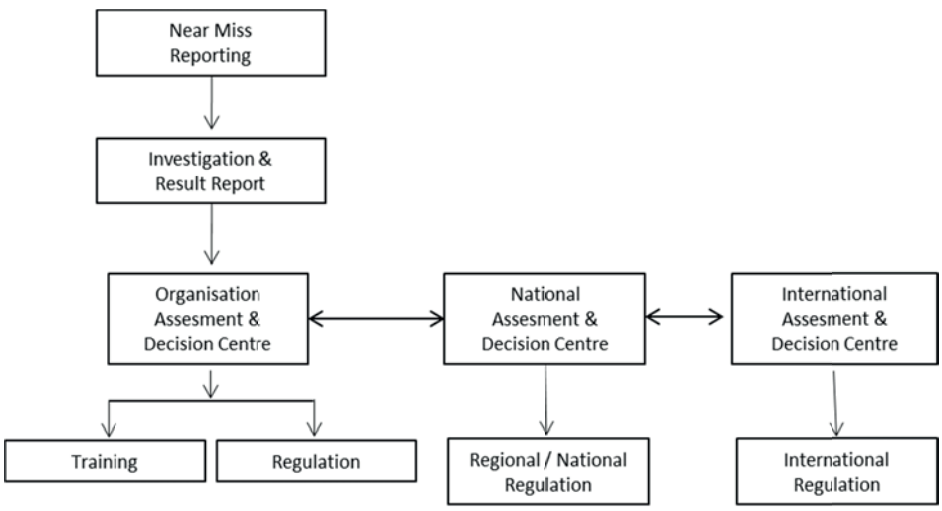


*Figure 2: The basic structure of reporting and sharing NM reporting system*

## 4. FINDINGS

In order to revising or creating new rules, regulations and arrangements it is not necessary to wait until serious accidents. Accidents investigation results are not the only way of to learn what is going wrong. By reporting and analysing the NMs we can understand what is starting to go wrong and we can introduce corrective action before the accidents actually occurs.

On the other hand it is very important to share the NM investigation results with all relevant national and international parties. The tragic example for the importance of sharing results happened in 1974. On December 1, TWA Flight 514 was inbound to Dulles Airport near Washington during the descent; the flight crew misunderstood the approach instructions and descended prematurely to the final approach altitude. The premature descent, coupled with limited visibility due to inclement weather, significantly contributed to the pilots flying the aircraft into a mountaintop, killing everyone on board. During the National Transportation Safety Board's accident investigation, a disturbing finding emerged. Six weeks prior to the accident, under similar conditions, a United Airlines flight crew had experienced a similar misunderstanding and had narrowly averted hitting the same mountain. After landing, the crew had reported the NM to their company's new internal reporting program, and an alert had been issued to all United Airlines pilots about the potential hazard. Because there was no established mechanism for sharing this information externally, the crew of TWA 514 was unaware of the hazard [15].

For creating a NM reporting system, it is not necessarily for an organization to wait any national or international system for NM reporting. Each organization or each country can create their own NM reporting system. But as it is seen above disaster, sharing investigation results is vitally important. The basic structure of reporting and sharing NM reporting system shown in **figure 2.**

The findings of research for the basic needs of NM reporting system are as follow.

- All senior managers should be adopted and accepted how important the system for increasing safety measures is.
- The company should have health, safety and environmental policy including the necessity of NM reporting.
- In this policy it should be clearly stated that; the purpose of NM reporting is not seek out the guilty or responsible it is only for improving safety and the only aim is to determine how the work can be done safely.
- Under this policy it should have guaranteed that the identity of all kinds of personal and technical details of NM reporters that may reveal will be kept confidential.
- Under this policy it should have mentioned that safety-related issues are the responsibility of all employees in the company.
- Before the start of implementation of NM reporting system all related managers and supervisors should be trained about the system and the policy.
- Procedures containing who will report the NMs and in what way; the investigation method of the reports, should be developed and these procedures should be accessible to every employee.
- After the completion of the above steps all employees should be trained about the NM reporting system.
- During the trainings, all employees should be informed about the necessity and the benefits of reporting NMs and they should be encouraged.
- During the trainings, it should espouse that NM reporting is a part of the work and enhancing safety as well.
- During the trainings, it should mention that all NM report will be investigated; the purpose of investigation is not seek out the guilty or responsible it is only for improving safety and the only aim is to determine how the work can be done safely.
- After the investigation of the reports the findings should be the subject of new trainings for the employees.
- Publishing the investigation results could motivate the employees and contribute to an increase of reporting.
- The basic training for the new staff should include NM reporting system.
- All reported NMs should be investigated by experts on the subject. Regardless of commercial, political, economic, etc. which are should only be made to contribute safety.
- The investigators should be experienced about the region that they investigate.
- Investigation results should be published to all relevant parties (both national and international). There should be an international standard for the investigation result reports in order to share them easily.
- The limit values of NM events should be defined according to the area (e.g. for narrow channel and open sea).
- NM reporting forms should be prepared in a format of easy to fill for avoiding time loss. This form should include the followings:
  - Time and place of the event,
  - Vessel(s) involved to the event,
  - All affected or might be affected parties,
  - Meteorological and hydro conditions,
  - Traffic density in the region,
  - Any technical malfunction in the system used during the event,
  - What might have been if it was an accident,
  - Frequency of occurrence,
  - Violated rules and regulations if any (national or international),

- The reason of the event according to reporter,
- According to reporter what should be done to prevent recurrence of similar events?
- Defining outlines of the event.

## 5. CONCLUSION

Important lessons could be learned and remedial actions have been taken before a full scale accident occurs by encouraging reporting of NMs. The concerns about reporting are the biggest problem in entry into force of NM reporting system. Therefore, priority should be given to this problem. A blame culture inhibits reporting, prevents the thorough examination of incidents, prevents learning, and has a negative effect on staff motivation. If the reports are used in order to punish the reporting person neither that person nor the others would want to make reporting anymore. In this case you will have a NM reporting system without any reports.

Some of NMs can be determined by technological means. For example, in a Vessel Traffic Service (VTS) area the criteria specified for some cases can be detected automatically via Automatic Identification System (AIS) data such as vessels passing each other so close with a risk of collision or vessels approaching to shallow water or ashore with a risk of grounding. But this method is very limited and possible to have only few kind of NMs. If it is required to be reported all NMs the best solution is creating safety culture in the organization.

For an effective, efficient and sustainable NM reporting system the system should be based on the elements of positive safety culture.

***By means of just culture***; an atmosphere of trust in which people are encouraged for providing essential safety-related information, but in which they are also clear about where the line must be drawn between acceptable and unacceptable behaviour.

***By means of reporting culture***; managers and operational personnel freely share critical safety information without the threat of punitive action. A reporting culture depends, in turn, on how the organization handles blame and punishment. If blame is the routine response to error, then reports will not be forthcoming.

***By means of informed culture***; management fosters a culture where people understand the hazards and risks inherent in their areas of operation. Personnel are provided with the necessary knowledge, skills and job experience to work safely, and they are encouraged to identify the threats to safety and to seek the changes necessary to overcome them. An informed culture relies on having a strong reporting culture.

***By means of learning culture;*** organisation must possess the willingness and the competence to draw the right conclusions from its safety information system and the will to implement major reforms. Reports are only effective if an organisation learns from them [16].

The establishment of a safety culture within an organization is one of the fundamental management principles necessary for the safe operations. Due to new values and practices that comes with safety culture those are inconsistent with the old cases, changes in managers' and employees' behavior can be seen such as advocacy, self-reaction, deflection or change the important information. This is the main problem for creating safety culture in an organization. But anyway, employees should feel that they are able to report issues or concerns without fear that they will be blamed or disciplined personally as a result of coming forward. .

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## 124 CLOSE-QUARTER SITUATIONS REPORTING BY USHANT VTS

*Jean-Charles Cornillou. CEREMA, France*

In case of a close-quarter situation detected by Ushant VTS, in compliance to the "rule of the road", it is not obvious to demonstrate an infringement for the rules 16 relative to the "action by the give-way vessel" should be balance with rule 17 relative to the "action of the stand-on vessel". Hence a mail is send to the company of the give-way vessel exposing the analysis of the situation by the VTS with documentary evidences including radar screen prints if necessary. A copy is send to the Flag State Authority and the Class Society delivering the ISM certificate.

For 6 years the procedure is in force, Ushant VTS has received positive feed-back from companies, Flag States and Class Societies. Internal feed-back is also very positive for operators training and the quality system of the centre. The number of close-quarter reporting has become a real indicator of the VTS activity.

En el caso de una situación de riesgo de abordaje detectada por el VTS de Ouessant, de conformidad con el «reglamento de circulación», no es fácil probar el incumplimiento de la regla 16 relativa a la «maniobra del buque que cede el paso» frente a la regla 17 relativa a la «maniobra del buque que sigue a rumbo». De ahí que el VTS envíe un correo a la compañía del buque que cede el paso exponiendo el análisis de la situación, con pruebas documentales incluyendo copias de pantallas de radar en caso necesario. Se envía una copia a la autoridad del Estado de pabellón y a la Sociedad de Clasificación emisora del certificado ISM.

Durante los 6 años en que está vigente el procedimiento, el VTS de Ouessant ha recibido información positiva de las compañías, Estados de pabellón y Sociedades de Clasificación. La información interna es también muy positiva para la formación de los operadores y el sistema de calidad del centro. El número de informes de riesgo de abordaje se ha convertido en un indicador real de la actividad del VTS.

*Dans le cas d'une situation rapprochée détectée par le STM d'Ouessant, conformément aux «règles de barre », il n'est pas évident de démontrer une violation des règles 16, relative à la «manœuvre du navire non privilégié», ou 17, relative à la «manœuvre du navire privilégié ». Ainsi, un courrier est transmis à la compagnie du navire non privilégié exposant l'analyse de la situation par le STM étayée de preuves documentaires y compris de copies d'écran radar si nécessaire. Une copie est envoyée à l'autorité de l'État du pavillon et la société de classification qui a délivré le certificat ISM.*

*Depuis 6 ans que cette procédure est en place, le STM d'Ouessant a reçu des réponses positives des compagnies, des États du pavillon et sociétés de classification. Le retour interne est également très positif pour la formation des opérateurs et le système qualité du centre. Le nombre de signalements de situations rapprochées est devenu un véritable indicateur de l'activité du STM*

# Close-quarter situations reporting by Ushant VTS

Jean-Charles Cornillou

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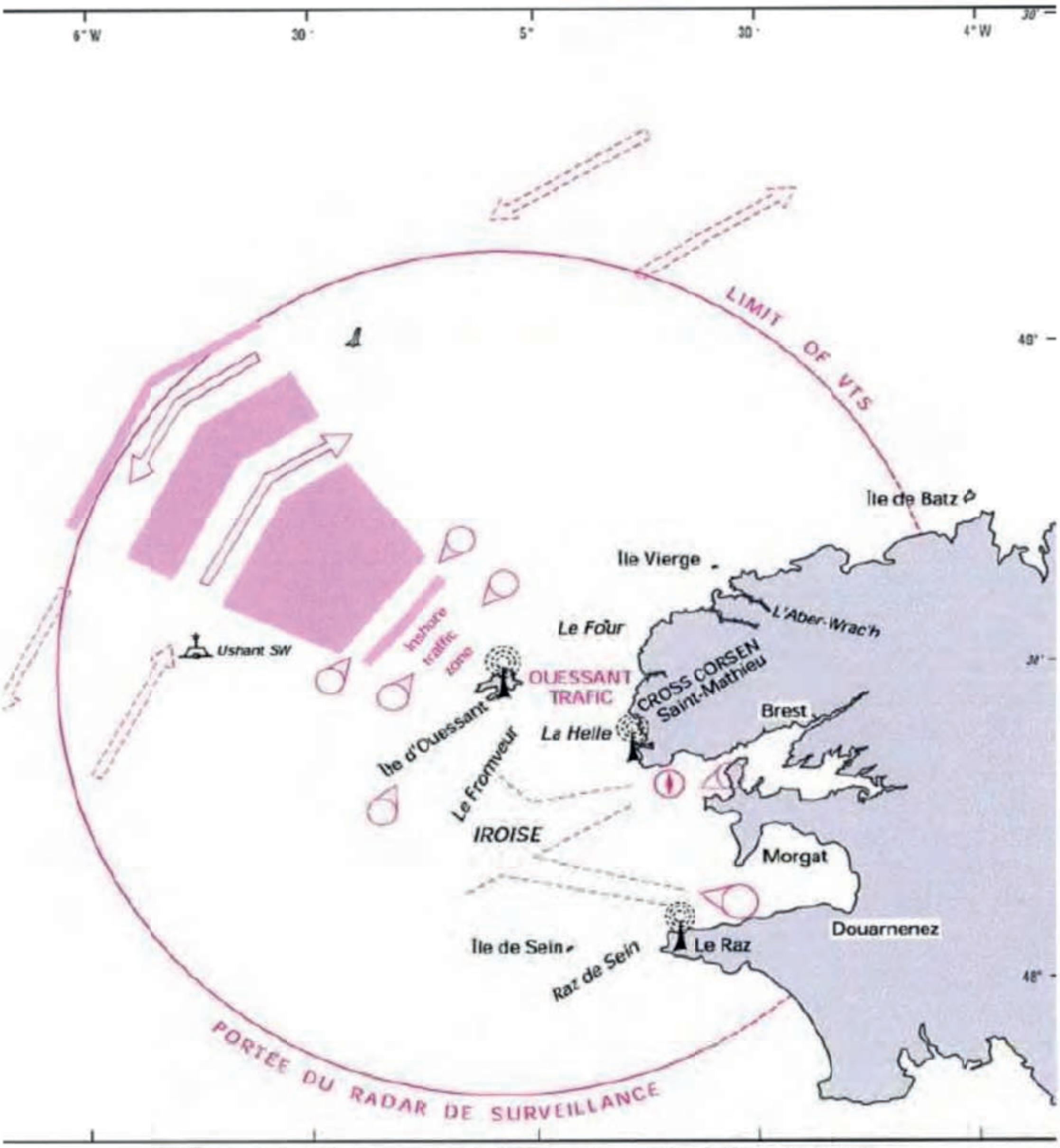
IALA·2014·AISM

XVIII Conference · A Coruña · Spain

# Close–quarter situations reporting by Ushant VTS

Jean-Charles Cornillou, CEREMA, France




Traffic separation scheme and VTS off Ushant, valid from 1 May 2003 at 00h00 UTC.

## INTRODUCTION

The future programme of the IALA VTS committee includes the task to produce a guideline on incident/accident reporting and recording, including near-miss situation. There are many types of incidents, accidents and near-misses generated by the maritime traffic. Amongst all these events, close-quarter situations are an interesting focus. All navigators talk about close-quarter situations, but nobody has defined it or has talked about what could be tough from close-quarter situations. It is often a good occasion to tell a nice sea story around a beer in a bar and learn the "rule of the road" in a lively manner from the mouth of experienced seafarers who have the sincerity to admit they missed something in their daily task of watch keeping. But nowadays, seafarers are not alone everywhere. In some area, traffic is regulated and monitored by vessel traffic services (VTS). And the anxiety generated by close-quarter situations is shared by the VTS operator as well. From the point of view of the VTS operator, a daily task is to watch the regulated area through sensors in order to avoid close-quarters situation as much as possible, and obviously to avoid collision.

This document is focusing particularly on close-quarter situation for this represents a dedicated near-miss situation in maritime traffic based on the understanding of a basic international regulation mandatory to all vessels at sea: the "rule of the road". The experience of Ushant VTS reporting of close-quarters situations is presented. It is explain how and to whom to report and what use could be made from all these records.

A ship is mobile in a hostile environment. The visual part of this environment is the surface of the sea and the coastline. The invisible part is the depth of water available under the keel. The officer of the watch's main task is to avoid collision with others vessels in the vicinity and to avoid stranding within the coast, bearing in mind that the "nearest coast is beneath the keel".

Accidents are often the accumulation of minor incident or near-misses. Then, why not take the chance to learn from the experience of near-misses?

Main near-miss cases in maritime traffic could be identified in 2 categories: near-stranding cases and near-collision cases. If the first category could be the result of a close quarter situation by diverting the course of one vessel to shallow waters[1], or the loss of propulsion or steering gear, this results in general to deviation in navigation. Hence the analysis of near-stranding cases are worth studying separately. Near-collision cases or close-quarters situation result in general in the way vessels involved are applying the "rule of the road". Nevertheless, dangers to navigation, such shallow waters, will interfere in the way to apply the "rule of the road". This document is focusing particularly on close-quarters situation for this represent a dedicated near-miss situation in maritime traffic based on the understanding of a basic international regulation mandatory to all vessels at sea: the "rule of the road".

## 1. DEFINITIONS

For the understanding of the present paper, the following definitions are used and proposed.

An ***incident*** or A ***marine incident*** means, as defined in MSC.255(84) known as Casualty Investigation Code: an event, or sequence of events, other than a marine casualty, which has occurred directly in connection with the operations of a ship that endangered, or, if not corrected, would endanger the safety of the ship, its occupants or any other person or the environment.

***Near-miss***, as defined in MSC-MEPC.7/Circ.7 Guidance on near-miss reporting: a sequence of events and/or conditions that could have resulted in loss. This loss was prevented only by a fortuitous break in the chain of events and/or conditions. The potential loss could be human injury, environmental damage, or negative business impact (e.g., repair or replacement costs, scheduling delays, contract violations, loss of reputation).

***Close-quarter situation***, proposition based on near-miss definition above: a sequence of events and/or conditions between different vessels that could result in a collision between vessels.

In order to clarify all wording, the term "collision" needs at last to be defined as well. The following definition is proposed to clarify the present paper developing close-quarters situation.

***Collision***: an interaction between two or more vessels at sea. It should be kept in mind that a collision between vessels does not lead necessarily to a direct contact between them. In some situation, the water displaced by a vessel can generate an accident on others vessels in the vicinity, hence this is considered as a collision. In others situations, the contact could be with a ship equipment or tow such as fishing gears, dredging gear, cable line, towing line or tow.

Of course the definition list would be complete by the term "vessel" as defined by COLREG Rule 3 (a): The word ***vessel*** includes every description of water craft, including non-displacement craft, WIG[2] craft and seaplanes, used or capable of being used as a means of transportation on water.

## 2 PREVENTION OF COLLISION AND ACTION TAKEN FOLLOWING A CLOSE–QUARTER SITUATION BY USHANT VTS

### 2.1 Ushant VTS

In compliance to IMO Res.A 857(20), point 2.3.3, Ushant Traffic VTS centre (in French: *Ouessant Trafic*) is dedicated to monitor the traffic in order to avoid dangerous situation. The area of Ushant VTS is a circle of 40 NM radius centre on Ushant island, including a TSS beyond territorial waters and fairways along the coastline and different islands and rocks within territorial waters (see map at the beginning of this presentation). The tower in Ushant Island supporting the VTS radar is the centre of the circle VTS area. The VTS centre is on the continent at the Corsen Point where the CROSS Corsen[3] is located.

Operators at Ushant Traffic must be aware of the limits of the different sensors they are using. The radar information is refreshed every 12 s and AIS information can be altered because AIS transceivers are not always properly fitted and set on ships. There are still direction finders (D/F) with a 0.5° precision to help operator to locate a ship-borne tranciever on VHF: one is located on Ushant at "*Créac'h*" lighthouse, and the other at "*Pointe du Raz*". Hence it is recommended to operators at Ushant Traffic to exercise a critical mind when jauging the information provided by radar, AIS or D/F.

*Stiff VTS radar tower (1979) & Stiff Lighthouse (1699) on the foreground on Ushant island (Brittany - France)*

*CROSS Corsen (1982) at Corsen Point (Brittany - France)*

In compliance to COLREG 72, rule 10, attention must be exercised at both ends of the TSS for the density of traffic and cross situations generate a lot of close-quarter situations as well as turning point. The weather conditions have to be taken into consideration, in particular the visibility. As a matter of experience in Ushant Traffic, it rises up to a compromise that a call on VHF can be effective to the give-way vessel at last 10 minutes before CPA.

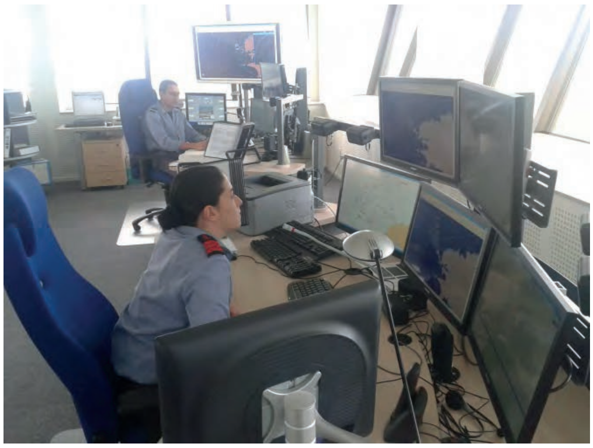
When a close quarter situation is detected, the operator tries to contact at first the give-way vessel on VHF 13 or 16 or with the help of a DSC at last. In compliance to IMO Res.857 A(20), the VTS centre has no manoeuvring order to summon to the ship. The task of the VTS is but to ensure that the watch-keeper on board ships have the information to decide the proper manoeuvring in order to avoid a close-quarter situation. A close quarter decision tree in annex 1 has been developed as an indication to VTS operator.

## 2.2 Precision on action taken beyond territorial waters

All of Ushant VTSS area beyond territorial waters is located in exclusive economic zone (EEZ). Despite the freedom of navigation in force in this area[4], UNCLOS gives rights to the coastal State to adopt laws and regulations in order to prevent pollution and also, if necessary, to implement traffic circulation schemes. This right, contrary to the one implemented on the territorial waters, is nevertheless limited by approval of IMO[5].

Moreover, UNCLOS requires obligation of reporting to coastal State when the ship is considered to have committed an infringement to the environment protection regulation. The reporting concerns amongst other things, the ship identity, port of registry and any other relevant information required to establish whether a violation has occurred[6].

It should be recalled that Ushant Traffic VTS has been established after the stranding of VLCC AMOCO CADIZ in 1978. And when coastal State considers a particular area of the EEZ requires special obligatory measures to prevent pollution by ships, it can adopt law and regulations in order to ensure the marine environment protection. This process may be consistent with international law when the areas covered by these measures are recognized as special by the IMO through technical argumentation provided by the coastal State and the measures taken are consistent with measurements made applicable by IMO in this type of area.



*Ushant Traffic VTS operation room in CROSS Corsen (Brittany - France)*

Advancing the cause of protection of the marine environment, coastal States may therefore establish various provisions to ensure the safety of navigation in the EEZ although this area is placed under the freedom of navigation.

In consequence, the sea area off Ushant island is the most representative in the application of UNCLOS opportunities for surveillance of navigation in territorial waters and EEZ example. France, as a coastal State, has established a Traffic Separation Scheme associated with a system of mandatory reporting. This area is also under the supervision of a vessel traffic service (VTS).

### 2.3 Action taken in case of infringement to COLREG 72

In case of infringement to COLREG 72 in the VTS, a report to the Flag State is established with all documentary evidences: radar screen prints and VHF records if necessary. The report is forwarded to the Flag State through central office and foreign affairs ministry. A related message can be allocated to the ship in THETIS, the data base of Paris Memorandum of Understanding on Port State Control.

French merchant vessels which would be taken in infraction would be prosecuted under the French regulation. Concerning fishing vessels or yachts the report of contravention to COLREG is transmitted directly to the administrative office of the port of registry for administrative prosecution.

Concerning navy ships, if any, this report is a nice way to indicate a non conformity in the "safe" management of the navy ship.

But a repressive action has very limited impact for different reasons. On one hand, the United Nations Convention on the Law of the Seas (UNCLOS) limits the action of the coastal State on the High Sea, that is to say beyond territorial waters. This is up to the discrepancy of the Flag State to take sanction on the base of evidences provided by the coastal State. The procedure has to go through the diplomatic channel which is not the quickest to attract the attention of the navigator charged by the contravention.

On the other hand, a blaming and repressive behaviour does not help to go ahead and try to understand why the infraction occurred. This is in no way a positive action to create a "safety culture".

### 2.4 Action taken in case of a close–quarter situation

#### 2.4.1 Close–quarter situation

In case of a close-quarter situation detected in the VTS area, in compliance to COLREG 72, it is not obvious to demonstrate an infringement to the rules of the road for the rule 16 relative to the "action by the give-way vessel" should be balanced with rule 17 relative to the "action of the stand-on vessel"; hence the following action are carried out:

1) The masters of the ships involved in the close quarter situation are invited to make a sea-report to their Flag State Authority;
2) A "dangerous situation notice" (report to annex 2) is established with an analysis of the situation;
3) A mail is sent to the company of the give-way vessel with documentary evidences including the dangerous situation notice and radar screen prints if necessary. A copy is sent to the Flag State Authority, the Class Society delivering the ISM certificate and to the company of the stand-on vessel in case of the latter makes any complain to Ushant Traffic following the manoeuvring of the other vessel.

As MSC-MEPC.7/Circ. 7 guidance on near-miss reporting has been included in the ISM Code since 2010, the idea of the above action taken is:

1) To make watch keepers of merchant ships, fishing vessels and any other type of ship aware to navigate with caution in a VTS;
2) To make companies of merchant ships aware on the management of the competency of their personnel in charge of watch-keeping;
3) To inform Flag State authorities and Class Society acting on behalf of them of the situation in order to exercise attention in a future audit of the company and the ship on the resources and personnel point of the ISM, in particular for personnel in charge of watch-keeping on the bridge.

#### 2.4.2 Reporting

There are many barriers related to the reporting of near-misses. In many cases, close-quarter situations are only known by the VTS but not the vessels involved in the close-quarter situations. The main reason is the VTS monitors in general a wider area than a single vessel can do. Moreover Vessels involved in close-quarter situations are not necessarily flying the flag of the coastal State where the VTS is located, thus there is no direct interest for the VTS to inform the companies and navigators. Moreover, in compliance to UNCLOS, there is no reason in the convention to take action by the Coastal State.

The letter of reporting should then be positive and not blaming. This is the most difficult part of the exercise, for the reporting may not be understood. A print picture of the VTS system display consolidated with the past track following positions of ships could help to make understand the close-quarter situation from the point of view of the VTS. The layout obtained gives a clear vision of the ships manoeuvring. The idea is to encourage a direct share of information to promote feature of a "just culture" in an atmosphere in which the behaviour of all the actors of the shipping traffic is that of co-operation.

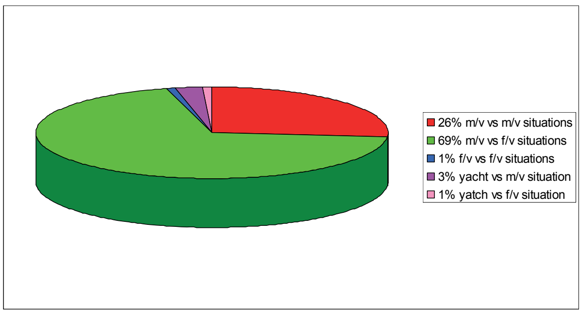
## 2.5 Feedback & others initiatives

From 2008 to September 2013, that is to say 68 months, 120 close-quarter situations have been reported. Ushant Traffic has received positive feed-back from companies, Flag States and Class Societies until now for 6 years this procedure is in force. Internal feed-back is also very positive for operators training and the quality system of the centre. The procedure was first warmly welcome by the external auditor of the VTS centre. The feed-back from companies, flag-State Authorities or Class-Societies to the reporting is now a clear indicator of the VTS process.

Without any consultation, it appears that Dover VTS has implemented the same procedure of close-quarter reporting.

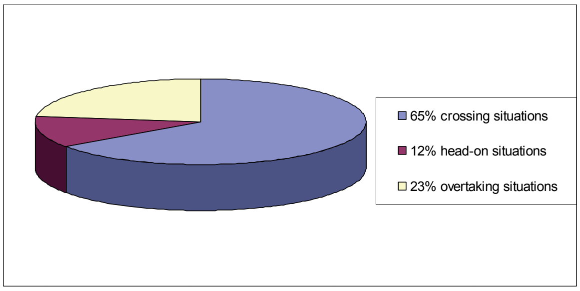
In reference to the close-quarter decision tree of Ushant Traffic VTS (annex 1), all reporting cases of close-quarters situations meet the following two conditions: a CPA less than 0.5 NM, and a time to CPA within next 10 minutes.

*Distribution of close quarter situation in Ushant Traffic VTS area during the above mentioned period:*



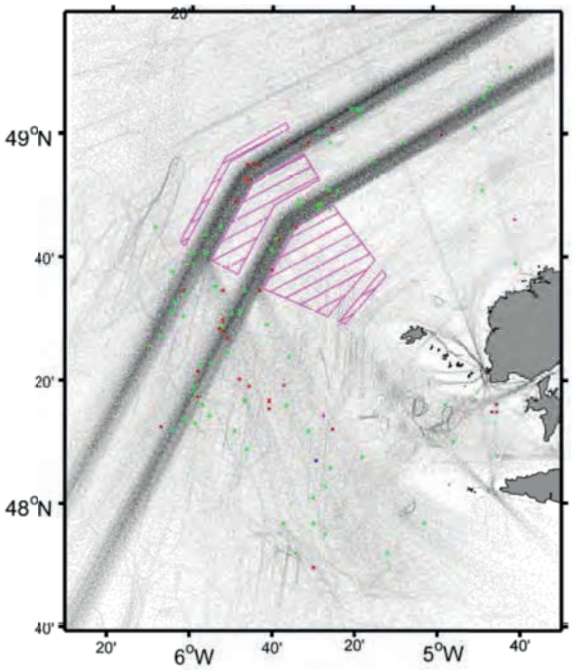

| | |
|---|---|
| 1) merchant ship versus merchant ship (m/v vs m/v) : | 26% |
| 2) merchant ship versus fishing vessel (m/v vs f/v): | 69% |
| 3) fishing vessel versus fishing vessel (f/v vs f/v): | 1% |
| 4) yacht versus merchant ship (yacht vs m/v): | 3% |
| 5) yacht versus fishing vessel (yacht vs f/v): | 1% |

*Type of close quarter situations recorded from 2008 to September 2013:*




- 65% crossing situations
- 12% head-on situations
- 23% overtaking situations

The following chart indicates the geographic distribution of the close-quarter situations within the VTS area, during the period from 2008 to September 2013. In the foreground the record of 2012 traffic based on AIS detection (source Romain Gallen -Cerema/DTecEMF/DT/PTI-information processing centre) as a reference to the general traffic in the VTS area.




- M/V-M/V
- M/V-F/V
- F/V-F-V
- S/V-Div : close-quarter situ ations of yachts with merchant ships or fishing vessels (4 cases)

# 3 REPORTING ENFORCEMENT

## 3.1 The interest to analyse near–misses

The quality ISO standard 9001, was supposed to bring a spirit of quality in all activities. The ISM Code is fully inspired from ISO 9001, simply because the standard is adapted for any kind of product whether manufactured (like car, aircraft or ship construction) or a service (like insurance, safety or security). Meanwhile there are diversions of the use of quality certification for pure commercial purpose at all cost, the goal of quality is often forgotten. But the quality ISO standard gives tools to monitor rationally a product. It implies measurements, analyses and improvement in order to enhance the product.

In the International Safety Management Code (ISM Code) there are clear issues on the quality procedures of the Safety Management in a shipping company:

> *"The safety management system should include procedures ensuring that non-conformities, accident and hazardous situations are reported to the company, investigated and analysed with the objective of improving safety and pollution prevention."*[7]

> *"The company should carry out internal safety audits on board and ashore at intervals not exceeding twelve months to verify whether safety and pollution-prevention activities comply with the safety management system. In exceptional circumstances, this interval may be exceeded by not more than three months."*[8]

Another good reason to report and analyse near-miss is purely statistical. If we are expecting only the occurrence of accidents, there are definitely few materials to make general conclusion to enhance a system. On the contrary, if we collect the reporting of near-misses, there is much more materials to help for conclusion in order to enhance any system. This is the case in the nuclear industry were obviously there are few accidents, for when they occur everyone knows it in the newspapers. And when we know that accident in general is often the accumulation of minor incidents, it is then better to concentrate on the analysis of the different potential causes of accident.

There are also psychological reasons to concentrate on near-miss than on accident. On the contrary of accident, there is no injury nor fatal injury or damage in a near-miss. Consequently, there is no legal investigation to determine the responsibility of the event. And legal investigators know that the testimony of witnesses of an accident will depend on the responsibility they have in the event. A very human behaviour is to minimize the responsibility in the light of justice. Then it is very difficult to determine the truth through all these testimonies.

On the contrary, in case of near-misses there is no legal burden on the witnesses and they should be more talkative. The biggest difficulty in the case of a near-miss is to make people aware that they have to report, for they generally minimize the importance of the event just because nothing happened, or sometimes they do not realize what has happened.

In conclusion, the collection of reports and analysis of non-conformities, accidents and hazardous occurrences developed by the ISM Code is a good tool to report near-misses. As a matter of fact, MSC-MEPC.7/Circ.7 relative to guidance on near-miss reporting has been included to the ISM Code in 2010. But the ISM Code is a relatively new idea in the maritime world. The origin of the goes back to the late 1980s, when there was mounting concern about poor management standards in shipping. Investigations into accidents revealed major errors on the part of management, and in 1987 the IMO Assembly adopted resolution A.596(15), which called upon the Maritime Safety Committee to develop guidelines concerning shipboard and shore-based management to ensure the safe operation of ro-ro passengers ferries[9]. The ISM Code entry into force on 1 July 1998, with the 1994 amendments to the SOLAS 74, which introduced a new chapter IX into the convention, the International Safety Management Code.

But ISM as well near-miss reporting are purely company procedures and do not involve any other stakeholder of the maritime community. There should be a way in order to share a safe-culture not only within the shipping companies but within all stakeholders in maritime safety. And VTS are in a good position to witness near-misses and report them, for sometimes crews do not realize they face a near-miss.

### 3.2 The ICAO near–miss procedure

There are as many differences as there are similarities between aviation and the maritime world. In terms of safety, the aviation has developed a bigger cultural background and a safety culture since the beginning of its history. On the contrary, fatality is still in force in the mind of many seafarers and the public when a marine accident occurred. As mentioned earlier, IMO has adopted the ISM Code in merchant shipping after major disasters less than 20 years ago.

The international Convention of Civil Aviation of Chicago, adopted on 7th December 1944, entered into force on 4th April 1947. Fifty years before the adoption of the ISM Code by IMO, the international convention of civil aviation established fundamental principles which still drive the aviation safety: accident investigation (article 26) and standards and recommended practices (SARP – article 37)

There are 18 annexes to the Civil Aviation convention, annex 13 is dealing in detail of aircraft accident and incident investigation. On 12 December 1972, the Air Navigation Commission adopted amendments to annex 13 in order to notify and exchange information on incidents.

But one important document of ICAO covering near miss situations is the safety management manual (SMM). Chapter 7 of the SMM is dealing with hazard and incident reporting and chapter 17 is about air traffic services.

ICAO has developed basic principle for effective incident reporting systems. As mentioned in the ICAO SMM, people are understandably reluctant to report their mistakes to the organization that employs them or to the government department that regulates them. Too often following an occurrence, investigators learn that many people were aware of the unsafe conditions before the event. For whatever reasons, however, they did not report the perceived hazards, perhaps because of embarrassment in front of their peers; self-incrimination, especially if they were responsible for creating the unsafe condition; retaliation from their employer for having spoken out; or sanction (such as enforcement action) by the regulatory authority[10].

Then, ICAO requires that States establish a mandatory incident reporting system to facilitate the collection of information on actual or potential safety deficiencies. In addition, States are encouraged to establish a voluntary reporting system and adjust their laws, regulations and policies so that the voluntary programme:

a) facilitates the collection of information that may not be captured by a mandatory incident reporting system;
b) is non-punitive; and
c) affords protection to the source of the information[11].

Concerning hazard and incident reporting, ICAO has developed a mandatory international Accident/incident Data Reporting (ADREP) system. And as indicated in the ICAO SMM the rule to report an incident is basic: *"if in doubt – report it"*. When ADREP reports are received from States, the information is checked and electronically stored, constituting a databank of worldwide occurrences. Amongst the types of serious incidents of interest to ICAO there are near collisions and other serious air traffic incidents as regard the application of the "rule of the air", the reporting of these incidents are named "Airprox".

Lessons learnt from incidents are shared to the all aviation community: companies, constructors, national Authorities and media as well when relevant. This transparency culture of safety is nowadays important considering the large number of air passengers. The civil aviation needs to develop confidence with the public by using obvious incident cases that shows safety is secured.

ICAO is focusing in particular on near collisions requiring an avoidance manoeuvre to avoid a collision or an unsafe situation or when an avoidance action would have been appropriate. This is similar to the idea of close-quarter situation reporting by VTS.

In order to understand how the reporting of near-miss in civil aviation works, I visited air traffic control (ATC) centre located in Loperhet close to Brest. This ATC is in charge of the European western approaches and monitors 15 radars and 17 radio stations. There is a dedicated quality system department (QS) where air traffic controllers are despatched regularly during some months in order to make the safety management system work. The base of investigation is the event notification sheets filled by the air traffic controllers. This sheet is similar to the "dangerous situation notice" presented in annex 2.

2 500 event notification sheets are generated in average per year in the ATC. The QS analyses the different events with the help of the video recording of the air traffic. Based on national and local rules, the QS write directly to the company of the aircraft involved in an incident. Some Airprox, because of their nature are selected to a national office for closer analysis and feed the international Accident/incident Data Reporting (ADREP) system. It occurred sometimes the Air Force is involved in an "Airprox". The latter, contrary to the Navy with VTS, is used to this feed back from civil aviation and has also developed a safety management system. Near-miss reporting is finally in the safety culture of aviation, whether civil or military.

It is interesting to notice that overtaking situation concerned 30% of Airprox and are not obvious to be detected. In comparison, overtaking situation at sea is considered the most dangerous situation that can involve more than two vessels[12]. But there is yet no data from VTS to evaluate the occurrence of overtaking situations.

## CONCLUSION

The ultimate objective of close-quarter situation reporting and investigating is to identify areas of concern and implement appropriate corrective actions to avoid collision at sea, at least in VTS area. To do so requires that reports are to be generated, shared, read and acted upon. VTS should be encouraged to inform companies and Flag State to consider close quarter-situation reporting as a way to enhance safety of navigation in general.

It may take years for safety trends to be discerned, and so reporting must be archived and revisited on a timely basis. Near-miss reports should be considered along with actual collision or incident reports to determine trends. These should be consistent in the identification and nomenclature of causal factors across close quarter situation and collision reports. Archives on close-quarter situations can provide detailed knowledge of the services provided by a VTS centre and be part of practical training and experience in the tasks. The following actions, based on recording of close-quarter situation reports, could be done:

1) Improvement of the ISM system of companies on manning and resources, in particular for the officers in charge of the watch;
2) Clue for Flag State and Class Society delivering ISM certification for auditing;
3) Return of experience for VTS and training for VTS operators;
4) Material for the Training of merchant marine cadet officers & officers;
5) Setting decision support tools for VTS.

Detection of close-quarter situations is in the heart of VTS missions. VTS are windows of coastal States open to the international maritime traffic, in particular coastal VTS beyond territorial waters. Collection and analyse of close-quarter situations are interesting and a clear indicator of the VTS activity. Reporting close-quarter situations promote a “safety culture” amongst all stake-holders of the maritime community and not only companies as it is in the present situation with the ISM code. The collection of voluntary reporting of close-quarter situations on an international data-base would greatly enhance data on accidents and incidents and help decision makers for data would be more important to make a better picture of the traffic situation.

The process of reporting could be enlarged to any other near-misses. But close-quarter situations are interesting for the application of COLREG 72 to all ships. This is a long-term process, but patient work collects fruit and the analysis of close-quarter situations could help a coast State in reviewing its safety of navigation infrastructures or regulations. Reporting close-quarter situations and near-misses in general by VTS would fill a “cultural gap” of safety at IMO and rises up the requirement to the equivalent logic implemented already by ICAO. ■

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1 This special situation is worth to be studied as a close-quarter situation.

2 WIG craft : Wing-In-Ground craft, report to COLREG Rule 3 (m).

3 CROSS Corsen is a coastal VTS and a MRCC as well.

4 UNCLOS art.58.1

5 UNCLOS art.211.1

6 UNCLOS art.220.3

7 Point 9 of the ISM Code: reports and analysis of non-conformities, accidents and hazardous occurrences.

8 Point 12 of the ISM Code: company verification, review and evaluation.

9 Capsizing of ferry HERALD OF FREE ENTREPRISE in 1987 and fire on ferry SCANDINAVIAN STAR in 1994.

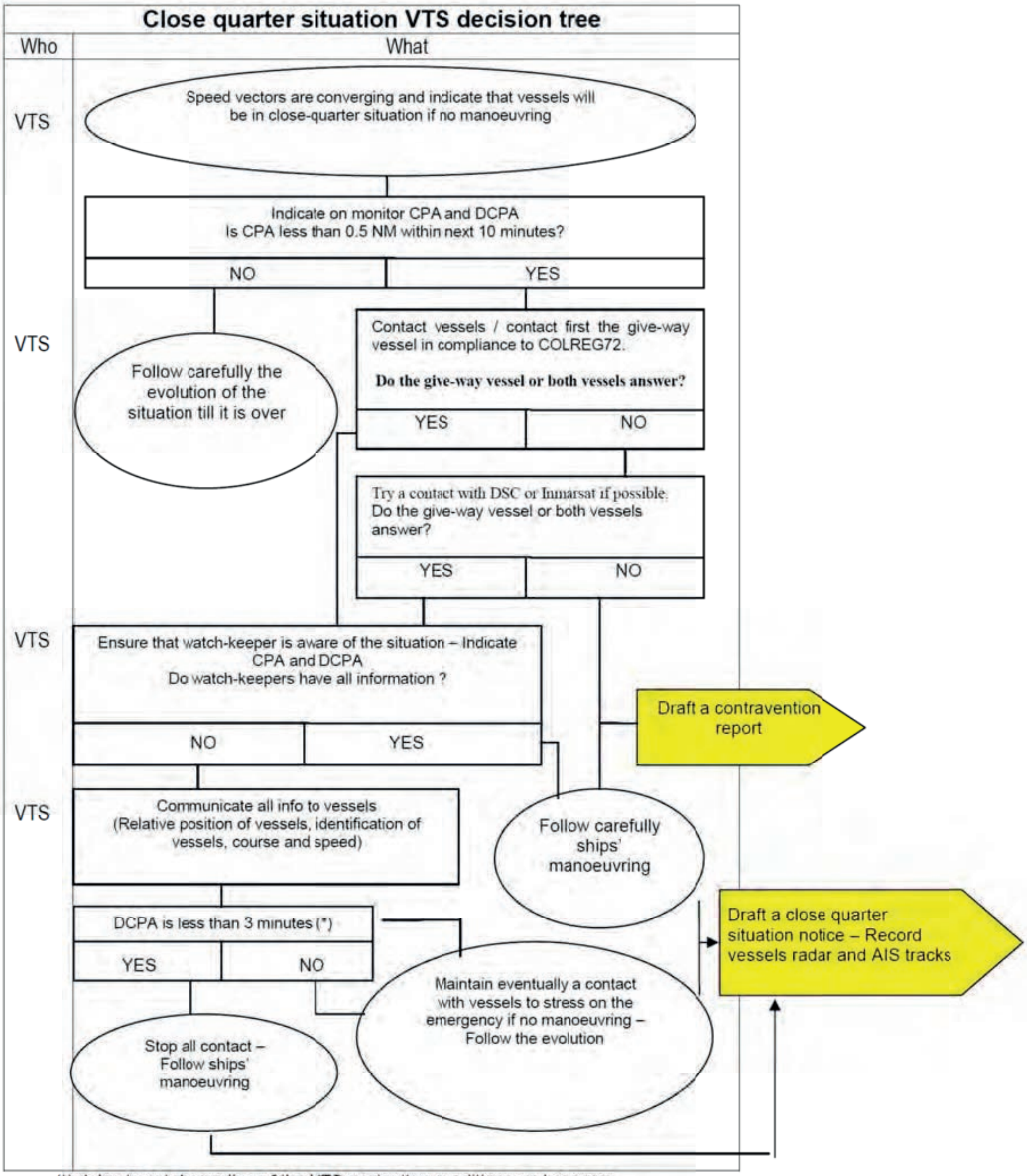
10 ICAO Safety Management Manual

11 ICAO Safety Management Manual

12 The collision of m/v TRICOLORE on 14th December 2002 involved 3 vessels.

## *Annex 1*

## *Close quarter situation Ushant VTS decision tree*




(*) delay to set depending of the VTS navigation conditions and sensors

## *Annex 2*

## *Dangerous situation notice at Ushant VTS*

**Dangerous situation notice**

1- Nature of the situation Date / time :

dangerous situation ☐ close quarter situation ☐ collision ☐

2- Vessels involved

| Ship's name | IMO n° or Registration n° | FLAG | Type of ship | LoA (m) | Position (longitude & latitude) | Speed (kt) | Course |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

3- Description of the event

**Most critical situation :**

CPA :
TCPA :
Position relative to a mark ashore :
Visibility

Evolution of vessels

4- Analyse

5-Conclusion

6-Enclosed documents

radar & AIS monitor print ☐ vessels' data ☐ other : ☐

**Conclusion on the action of the VTS :**

Does the vessel(s) change course following VTS information?

Yes ☐ No ☐ Vessel does not answer☐

## 128 THE SPANISH MARITIME SAFETY AGENCY - VTS IN SPAIN

*Juan Luis Pedrosa. The Spanish Maritime Safety Agency, Spain*

The services of search and rescue, maritime traffic control, and pollution prevention and response are provided by the 20 Maritime Rescue Coordination and VTS Centres of the Spanish Maritime Safety Agency. The operators are certified to undertake their VTS duties according to IALA and IMO recommendations. They follow a training course at Jovellanos Centre and a "on the job training period" at the MRCC.

MRCCs are equipped with state of art monitoring systems and communication technologies to give VTS in the Traffic Separation Schemes and in the Particular Sensitive Areas in which vessel reporting is mandatory. The MRCCs also monitor the traffic in some ports with which there are Agreements in place. Different tools store this information, required to prevent and respond to maritime safety and pollution emergencies. Vessel related safety data is registered and exchanged with the rest of the Member States.

Los servicios de búsqueda y rescate, control de tráfico marítimo y prevención y respuesta contra la contaminación son prestados por los 20 Centros de Coordinación de Rescate Marítimo (MRCC) y VTS de la Agencia Española de Seguridad Marítima. Los operadores están certificados para realizar sus tareas de VTS de acuerdo con las recomendaciones de la IALA y la IMO. Realizan un curso de formación en el Centro Jovellanos y «un periodo de trabajo en prácticas» en el MRCC.

Los MRCC están equipados con la última generación de sistemas de control y de tecnologías de comunicación para prestar VTS en Sistemas de Separación de Tráfico y Áreas Particularmente Sensibles en los que es obligatoria la información del buque. Los MRCC también controlan el tráfico en algunos puertos con los que se han establecido acuerdos. Diversas herramientas almacenan esta información necesaria para prevenir y responder a las emergencias de seguridad y contaminación marítima. Los datos de seguridad del buque relacionado se registran e intercambian con el resto de Estados Miembro.

*Les services de recherche et sauvetage, le contrôle du trafic maritime et la prévention et la lutte contre la pollution sont de la responsabilité des 20 centres de coordination du sauvetage maritime et VTS de l'Agence de Sécurité Maritime espagnole. Les opérateurs de VTS sont certifiés aptes à leur tâche suivant les recommandations de l'AISM et de l'OMI. Ils suivent une formation au Centre « Jovellanos » et ont une période de « formation sur le tas » en MRCC.*
*Les MRCC sont dotés de systèmes de surveillance et de technologies de communication haut de gamme pour fournir un service de VTS dans les voies de Séparation de Trafic et les zones particulièrement sensibles, dans lesquelles les comptes rendus de navires sont obligatoires. Les MRCC surveillent aussi le trafic dans certains ports qui ont passé un accord avec eux. Différents outils stockent ces informations, nécessaires pour prévenir et intervenir, en cas de problème de sécurité maritime ou de pollution .Les données concernant la sécurité du navire sont enregistrées et échangées avec les autres Etats membres.*

# The Spanish Maritime Safety Agency

Juan Luis Pedrosa

Spanish Maritime Safety Agency

IALA·2014·AISM

XVIII Conference · A Coruña · Spain

Juan Luis Pedrosa, Spanish Maritime Safety Agency

## INTRODUCTION

The resources are located along the Spanish coastline according to operational criteria in order to minimise the response time, guarantee the best coverage and provide an effective and adequate response.

The resources of the Spanish Maritime Safety and Rescue Agency are the following:

- **Headquarters,** located in Madrid.
- **20 Maritime Rescue Coordination and VTS Centres** (MRCC), 19 along the coast and the Maritime Operations Centre in Madrid. The MRCCs respond to all kind of emergencies at sea; including rescues, searches, towing, pollution response, medical evacuations, navigation and meteorological warnings, and distress calls response. The MRCCs command the airborne and maritime fleet, coordinate the different resources and collaborate with other organisms at a national, regional and local level. The MRCCs have officers on duty 24 hours a day.
- **The Maritime Operations Centre in Madrid,** brand new and equipped with the latest technology, gives support to the MRCCs and coordinates the operations in case of a large incident. At international level the Maritime Operations Centre is the focal point in S&R and pollution emergencies.
- **Jovellanos Training Centre,** located in Gijón, with a team of highly skilled professionals and an area of 143,000 m², carries out training programmes for maritime and land fire fighting, pollution response, rescue operations, VTS, diving operations, SAR and pollution management... Jovellanos Training Centre is the executive instrument of the Maritime Administration's training policy. The pedagogical objectives are continuously revised considering the latest developments in maritime safety technology. The technological facilities are not only used in training activities but also for undertaking applied research in the field of marine safety and pollution prevention and response.
- **Maritime fleet,** permanently on stand-by or on duty.
- **4 multipurpose vessels for rescue and pollution control**, with high towing capacity and pollutants recovery and storage capacity.
- **10 rescue vessels**, with towing capacity,
- **4 patrol boats,**
- **55 fast action lifeboats**, 15 or 21 metres length, highly manoeuvrable, with a rapid-response capability and versatility
- **Red Cross fleet**, under a Cooperation Agreement Framework.
- **Aerial fleet,** permanently on stand-by or on duty.
- **11 helicopters,** especially suited to maritime search and rescue operations, and
- **3 fixed-wing aircraft EADS-CASA CN 235-300**, specifically equipped to fulfil maritime patrol, SAR and pollution combat missions.
- **6 Strategic Recue and Pollution Combat Bases,** located and equipped to enable a quick response in case of emergency. Rescue and pollution combat equipment, such as booms, skimmers, storage tanks, diving equipment and other additional equipment, is stored, maintained and repaired.
- **2 Bases for underwater operations,** with diving equipment and intervention teams.

## VESSEL TRAFFIC SERVICE

The network of MRCCs with the associated Coastal Radio Stations provide the necessary coverage for providing the search and rescue, maritime safety and pollution response services. The MRCCs are equipped with state-of-art technology to ensure permanent operating capacity. MRCCs use an Integrated Management Operations System, especially designed to meet the operational needs involved in coordinating safety and pollution response emergencies. Efficiency and resilience are guaranteed by the interoperation of the MRCCs and Madrid's Maritime Operations Centre.

MRCCs use vessel monitoring tools in order to provide traffic service. SafeSeaNet, LRIT and AIS are systems used to prevent and respond to maritime safety and pollution incidents. Through these systems, ships are tracked in Spanish waters and vessel related safety data is exchanged between member States.

Ports are special areas with port traffic monitoring systems, due to the high shipping density and the navigation risks. According to agreements of the Spanish Maritime Safety Agency with Port

Authorities, VTS in the ports of Bahía de Cádiz, Cartagena, Castellón, Santander, Tarragona and Vigo are managed by the MRCCs.

Spain has the following IMO-adopted Traffic Separation Schemes:

- In the Atlantic Ocean
  - Off Finisterre
  - Banco del Hoyo
  - two in Canary Islands (Eastern TSS between Grand Canary and Fuerteventura and Western TSS between Grand Canary and Tenerife).
- In the Mediterranean Sea
  - In the Strait of Gibraltar
  - Off Cabo de Gata
  - Off Cabo de la Nao
  - Off Cabo de Palos.

Spain has three Traffic Separation Schemes established by the Spanish Government: approaches to Puerto de Vigo, to Castellon and to Barcelona.

In Finisterre and Gibraltar Strait TSS mandatory reporting systems are in place; while in Cabo de Gata reporting is voluntary.

The Traffic Separation Schemes are equipped with monitoring systems to detect and track vessels (VTS radar, radio direction finding systems, AIS), and communication technologies between MRCCs and vessels (digital selective calling system LLSD, VHF and MF/HF).

The MRCCs also monitor the mandatory ship-reporting systems in the particularly sensitive sea areas of Western Europe (WETREP) and Canary Islands (CANREP).

## VTS TRAINING IN SPAIN

Spain is encouraging legal and operational changes to adapt the services offered by the VTS centres to IALA's recommendations

The Maritime Administration (DGMM) is responsible of the training requirements of the maritime professionals in Spain. The DGMM Resolution of the 6 of july of 2011 establishes the legal framework that regulates the training and certification of the professionals working in a VTS centre. The resolution includes the following certificates:

- VTS operator certificate
- VTS supervisor certificate
- VTS instructor certificate

To obtain these certificates, candidates must comply the requirements established in V-103 IALA recommendations and in the model courses associated with this recommendation.

The courses have both a theorical and practical approach. Simulation is crucial in the whole process. Jovellanos training Centre is equipped with a VTS simulator connected to a full mission simulator, in which the students can interact with vessel bridge or GMDSS stations. Jovellanos Centre has instructors with the V-103/4 IALA certificate.

The practical exercises always end up with a debriefing. Once the exercise has been carried out, students and instructor get together. The events that happened during simulation are shown in the screen, the audio recordings are heard and the operations are discussed to analyse routine and difficult situations. From the pedagogic point of view, debriefings are considered crucial in the training process

Once the course is completed and the assesments are passed, the student is awarded with a certificate endorsed by the Maritime Authority. The certificate lasts 5 years once it has been issued. In order to renovate the certificate, the holders must prove the performance of VTS activities during at least two years, under the certificate's validity period. Otherwise, the professionals will need to attend a 20 hours updating course in order to renovate their certificates.

The VTS training modules for operators, supervisors and instructors of Jovellanos Centre consider and implement any modification or updating, established by national law or international recommendations through IALA or IMO.

The Spanish Maritime Safety Agency is establishing for VTS operators a period known as "on the job training". During this period the professionals will get to know the operational requirements and the technical equipment of the centre, before they can start working as a VTS operator. During this "on the job training period" the operator will comply the task book under the supervision of the VTS Centre instructor. Once the instructor considers the operator is prepared to perform VTS duties, and with the VTS manager approval, the professional may work in the VTS Centre. The Spanish Maritime Safety Agency has already received IALA instructors courses and is about to finish the task book of the VTS centres. ■

## 8 A METHODOLOGY TO ALLOW VTS CENTERS TO MONITOR, IN REAL-TIME, THE PERFORMANCE OF THE AIS INFRASTRUCTURE

*Magnus Nyberg, Peter Dolan. Pharos Marine Automatic Power, Inc, United Kingdom*

This paper will present a methodology to continually monitor the AIS system to ensure that the system is performing at as high a level as possible. Such monitoring is particularly important to ensure the integrity of the AIS system is not diminished as new applications to enhance e-navigation are added to the AIS system and users find unique ways to "piggyback" functions on a "free" AIS communications network. And since the AIS system is a completely open architecture with the various standards available in the public domain, it is highly susceptible to exploitation by bad actors. Constant vigilance is required.

Esta ponencia presentará una metodología para controlar constantemente el sistema AIS con el objeto de garantizar que el sistema está funcionando al máximo nivel posible. Este control es especialmente importante para asegurar que la integridad del sistema AIS no disminuye a medida que se añaden al sistema nuevas aplicaciones para mejorar la e-Navegación y los usuarios encuentran vías exclusivas a funciones «combinadas» en una red de comunicaciones AIS «libre». Y como el sistema AIS tiene una arquitectura completamente abierta con varios estándares disponibles en el dominio público, es altamente susceptible a la explotación por parte de personal incompetente, por lo que es necesaria una vigilancia constante.

*Ce rapport présente une méthodologie permettant un contrôle continu du système AIS pour s'assurer qu'il est le plus performant possible. Ce contrôle est particulièrement important pour s'assurer que l'intégrité du système AIS n'est pas amoindrie si de nouvelles applications pour améliorer l'e-Navigation y sont ajoutées et que les utilisateurs bénéficient des fonctions d'un réseau de communications « gratuit ». Et comme le système AIS est une architecture complètement ouverte avec différentes normes disponibles dans le domaine public, il est très exposé à une exploitation malveillante. Une vigilance constante est nécessaire.*

# A Methodology to allow VTS Centers to monitor, in real-time, the performance of the AIS infrastructure consisting of shore-based AIS networks and AIS-equipped vessels, to ensure the optimal performance of the AIS system

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&

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## INTRODUCTION

AIS technology is well-established and is in use world-wide. With governing Directives, Standards, Recommendations and Guidelines established by IMO, ITU, IEC, and IALA that dictate the performance requirements for AIS equipment, AIS protocols and AIS architecture, one may be led to a false sense that their AIS system operating at a higher level of performance than is actually the case.

There are three major areas that an AIS authority should monitor to ascertain the health of their AIS domain.

1. Performance of Equipment
2. Quality of Data Reported by Vessels
3. VDL Operational Performance, i.e. message throughput

The monitoring of these parameters should be automated as much as possible with anomalies reported and logged. In many instances, the ability to alert a vessel to a particular problem should also be automated. For example, advising a vessel that it is reporting incorrect or incomplete data could be done by sending an automated addressed message 12 to the vessel. This would help keep the reliability of reported information at as high a level as possible in a timely manner.

Let's look in more detail at each of the areas where monitoring should be done.

## PERFORMANCE OF EQUIPMENT

Here, one needs to monitor the transmissions of AIS radios to ensure:

Conformance to specified hardware performance standards, and

Conformance to specified operating protocols

Hardware performance parameters that can be readily monitored are shown in *Table 1*. Given the nature of AIS, there will be infrequent instances when a received AIS radio transmission is outside of established specification limits but the radio is, in fact, operating properly. The Authority needs to identify only those radios that are consistently performing outside acceptable parameters. To be able to do this, the Authority needs to set a limit on what percentage of consecutively received transmissions with an error would be needed before a radio was deemed to be out-of-tolerance.

In addition to the performance of the hardware itself, the Authority also needs to monitor the performance of the firmware installed in the radios to ensure the radios conform to AIS protocols, as detailed in *Table 2*.

| Parameter | Alarm | % of Occurrences needed for Alarm | Comment |
|---|---|---|---|
| Frequency Deviation | +/- (user settable) Khz | User settable | Requires enhanced receiver or base station |
| Frequency Offset | +/- (user settable) Hz | User settable | Requires enhanced receiver or base station |
| Synchronization | +/- (user settable) μsec for both UTC Direct and Indirect methods | User settable | Requires implementation of base station VSI sentence and a setting of a minimum received signal strength to be met for alarm to be valid. |
| GPS Position | *(user settable)* reports with No position | User settable | May indicate poor installation |
| GPS Installation | *(user settable)* reports with UTC Indirect | User settable | Indicates internal AIS GPS not working or installed or faulty GPS antenna installation |
| Signal Strength | < (user settable) dB | User settable | Requires implementation of base station VSI sentence. Generally, appropriate for fixed stations only. May indicate poor installation. |

*Table 1: Hardware parameter check*

| Parameter | Alarm | % of Occurrences needed for Alarm | Comment |
|---|---|---|---|
| Channel Alternation | Consecutive messages received on same channel | User settable | Only applicable for scheduled messages. |
| Assigned mode operation | Assigned mode not entered | N/A | |
| Proper access of slot map | Transmits in slot other than advertised slot | User settable | |
| FATDMA Slot Usage | Transmission not received or received in wrong slot | Each occurrence | Applicable for radios operating in FATDMA mode |

*Table 2: Protocol parameter check*

| Parameter | Cause for Alarm Condition | Action |
|---|---|---|
| MMSI | Incorrect ITU MID, Incorrect MMSI for AIS Class, Duplicate MMSI, “default” MMSI’s 000000000, 123456789, etc. | Message to vessel |
| Name | Not reported | Message to vessel |
| Call Sign | Not reported | Message to vessel |
| IMO Number | Not reported | Message to vessel |
| Dimensions | Not reported | Message to vessel |
| Draught | Not reported | Message to vessel |

*Table 3: Static data parameter check*

| Parameter | Cause for Alarm Condition | Comment | Action |
|---|---|---|---|
| Nav Status | Vessel reporting anchored or moored but is actually underway or vice versa. | Set a user configurable minimum speed value that must be exceeded to trigger an alarm | Message to vessel |
| Heading and Course-over-the-Ground (COG) | Heading reported is not same as the reported COG | Set user configurable minimum difference and speed value that must be exceeded to trigger an alarm. Disregard if ROT is above a user configurable value. | Message to vessel |
| GPS Position | No Position Reported | Alarm only if vessel consistently fails to report GPS Position | Message to vessel |

*Table 4: Dynamic data parameter check*

## QUALITY OF DATA REPORTED BY VESSELS

A primary purpose of AIS is to enhance safety at sea by a vessel autonomously transmitting important information about itself over the AIS VDL. An Authority should be interested that each vessel is reporting completely and accurately all the information required by AIS messages.

A check for correct Static Data can be made and a corrective action message sent to vessels as appropriate: (see *Table 3*).

Although not all of the above parameters are critical to the effective operation of the AIS system, certainly a vessel not reporting its NAME, DRAUGHT or DIMENSIONs poses a danger to other vessels that may rely on such information to make passing arrangements or otherwise navigate to ensure the safety of both vessels. Such errors need to be brought to the attention of the offending vessel for corrective action in a timely manner.

Likewise, Dynamic Data needs to be correctly reported (*Table 4*).

Certainly, a vessel that does not report its position or reports an incorrect Nav Status or Heading poses a hazard and needs to be advised of the problem so it can be corrected immediately.

A user-friendly configuration setup should be provided to allow the automatic detection and reporting of both Hardware and Protocol errors.

## VDL OPERATIONAL PERFORMANCE

An Authority should monitor the operational performance of the VDL to ensure the VDL maintains good efficiency for message throughput. The problem is how to best measure efficiency. In an ideal situation, where the number of expected messages to be received is known, one could simply compare this number with the number of actual of messages received as a good measure of efficiency. But such information is not easily determined so other methods must be used. There are several variables that can be considered to develop a satisfactory metric for VDL efficiency.

- Number of Base Station reserved slots, their distribution over the slot map and impact on 120 nm coverage area.
- Base station area coverage
- Distribution of scheduled AIS reports (SOTDMA, ITDMA, FATDMA) versus un-scheduled reports (RATDMA, CSTDMA)
- Number of slots with garbled messages
- Number of slots with bad CRC and un-decoded messages
- Number of slots with collisions (slot reserved but used by another)
- Number of incorrect slot use (reserve one slot, transmit in another)
- Signal strength of received messages (indicator of cell size or extent of coverage)

| **Total Targets: 1225** | | |
|---|---|---|
| **Dynamic and Static Parameters** | | |
| **Alarm Category** | **Number AIS Targets** | **Comment** |
| Course and Heading difference | 19 | Heading and COG differed by 180 deg +/- 10 deg |
| No reported GPS Position | 38 | |
| Improper MMIS | 25 | Wrong AIS Class: 6<br>Incorrect MMSI: 8<br>Incorrect MID: 5<br>Duplicate MMSI: 2 |
| Incorrect NAV Status | 93 | Status Moored/Anchored but with speed above 5 kts |
| No Dims for GPS Antenna | 50 | Total for this category: 95 |
| No Dims for GPS Antenna; No Call Sign; no IMO Number | 3 | |
| No Dims for GPS Antenna; no IMO Number | 42 | |
| No Call Sign | 1 | Total for the category: 32 |
| No Call Sign; No IMO Number | 11 | |
| No Name | 5 | Total for this category: 22 |
| No Name; No Call Sign; No IMO Number | 17 | |
| No IMO Number | 635 | Total for this category: 708 |
| | | |
| **Radio Performance** | | |
| No Channel Alternation for Received Message 1 | 19 | 100% of transmissions received on either Channel A or Channel B |

*Table 5: Example occurrences of detected alarms*

A VDL loading graph provides a good macro look at the VDL load and is useful for determining visually the load make-up by AIS target types.
In the below examples, note that the VDL load for bad CRC/garbled messages is nearly the same as for the VDL loading for all AIS targets. Even though the number of targets is small, this anomaly would normally call for further

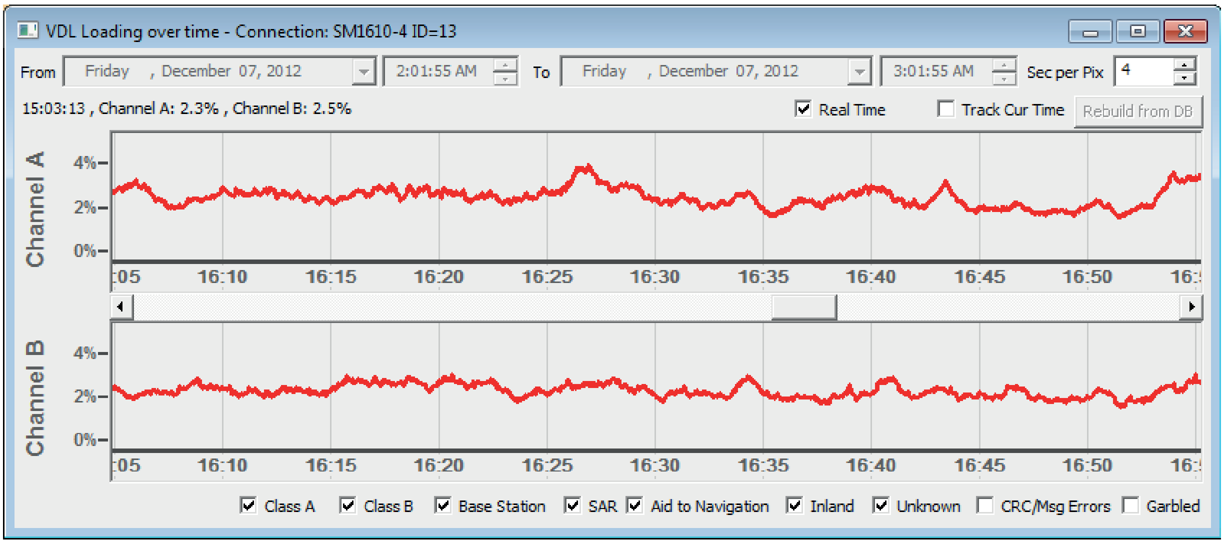


*Figure 1: VDL loading for all target types*


*Figure 2: VDL loading for base stations only*

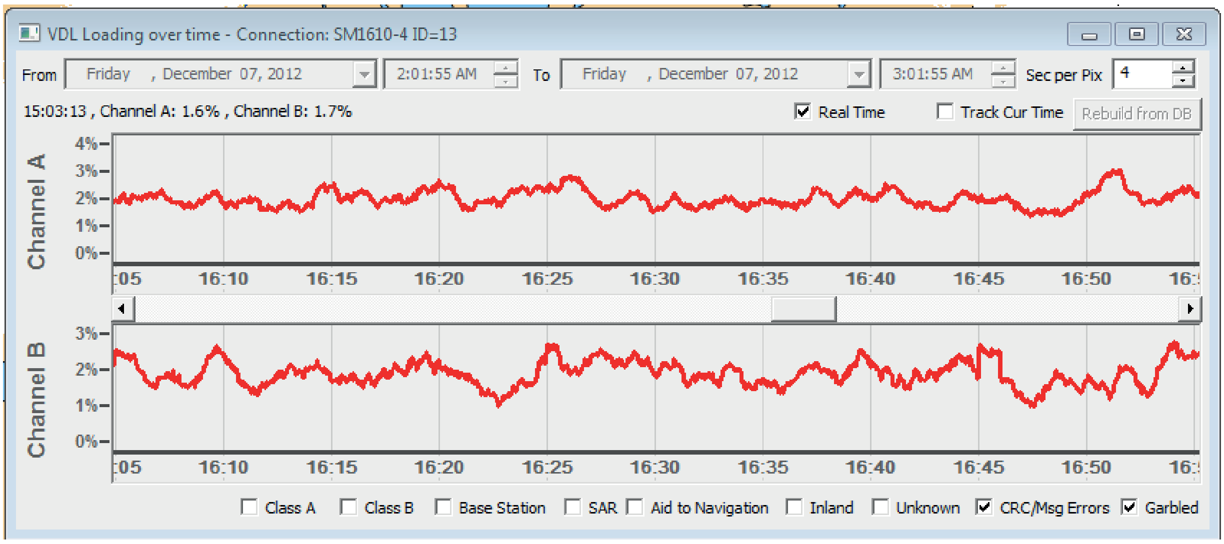


*Figure 3: VDL loading by bad CRC/garbled messages*

investigation.

A graphical depiction of slot usage similar to ***Figure 4*** can indicate bunching of Base Station slot reservations that could decrease slot usage efficiency for that section on the slot frame. Such information can be very useful for slot allocation planning in regions with overlapping base station coverage by different Authorities.

The information panel in ***Figure 5*** provides information on VDL efficiency by classifying messages into various categories. Note that Base Stations are reserving approximately 283 slots (6.2% of the available slots) but are only using 25 slots (0.005%) which is very inefficient.

Similarly, a Slot Map focusing just on the successful reception of messages using the categories shown in ***Figure 6*** can also be useful in determining the efficiency of the VDL.

A plot of slot usage overtime can give an indication if slots are being used in random manner. The plot in ***Figure 7*** shows a slot usage that is not particularly random as several slots are being used more than others.

Looking only at Class A targets in ***Figure 8*** shows that SOTDMA randomization is less than ideal.

Other statistics that might be useful in determining an overall metric for VDL efficiency are FSR Info, PSHI Frame Info, Epoch Info, and Top Users.

Graphical Plots of Received Targets can help to point out problems with Base Station receiver antenna siting. The coverage area plot in ***Figure 11*** is for a base station receiver with the antenna located in a busy port area at a high elevation. Targets to the NW are received at distances of over 300 nm but targets to the SE, in an area of interest to the Authority, are nearly non-existent.

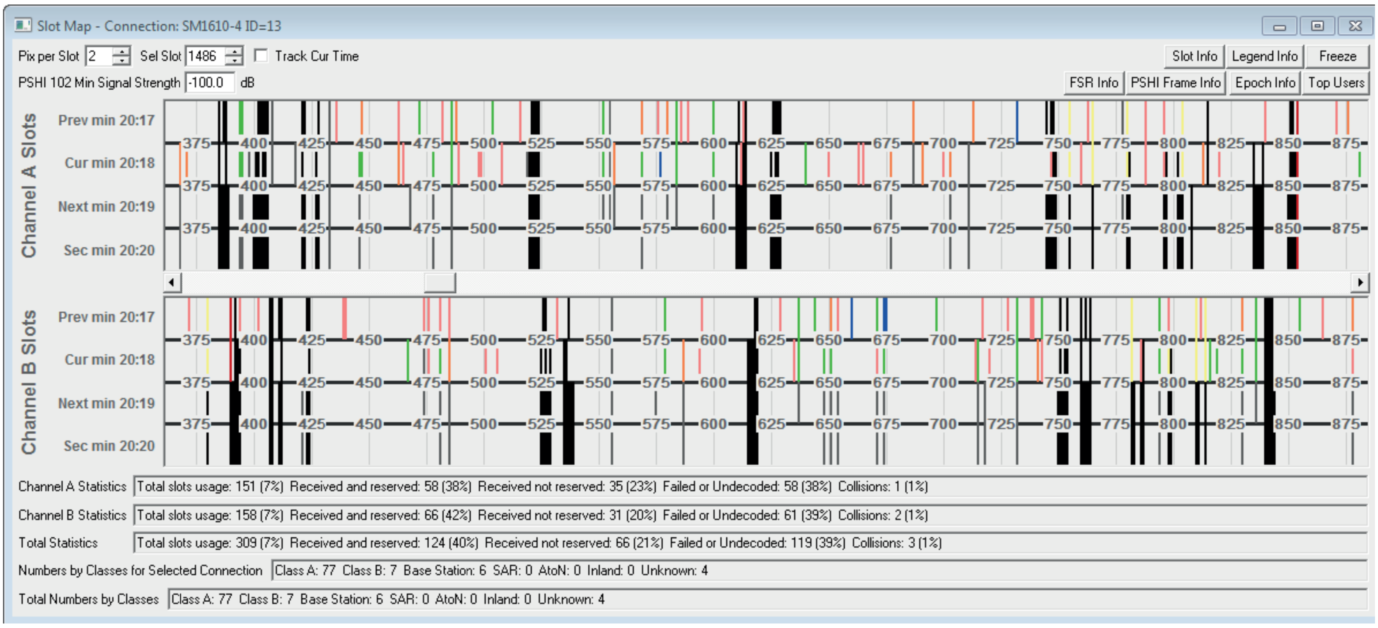


*Figure 4: Slot map*

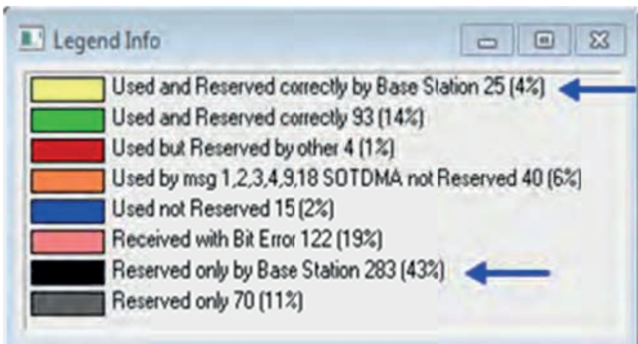


*Figure 5: Slot map legend*

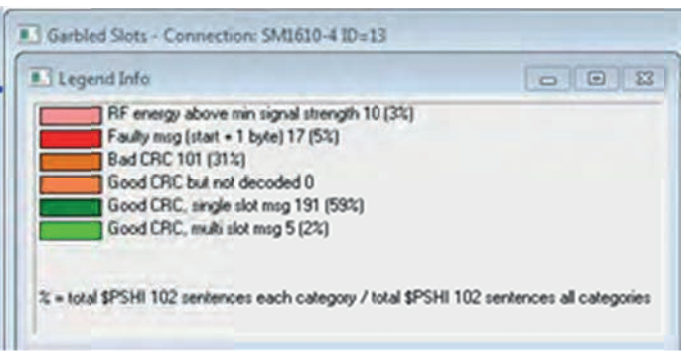


*Figure 6: Garbled lot map legend*

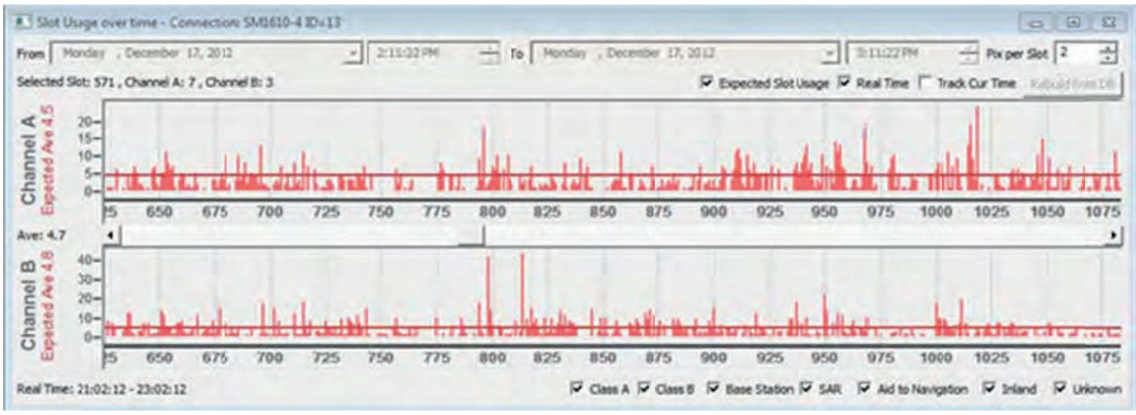


*Figure 7: Slot usage for all target types*


*Figure 8: Class A target slot usage*

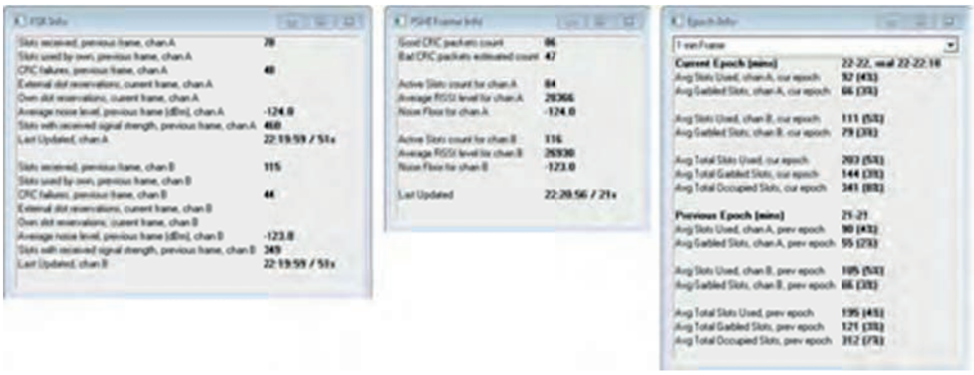

*Figure 9: Additional statistics on message throughput*

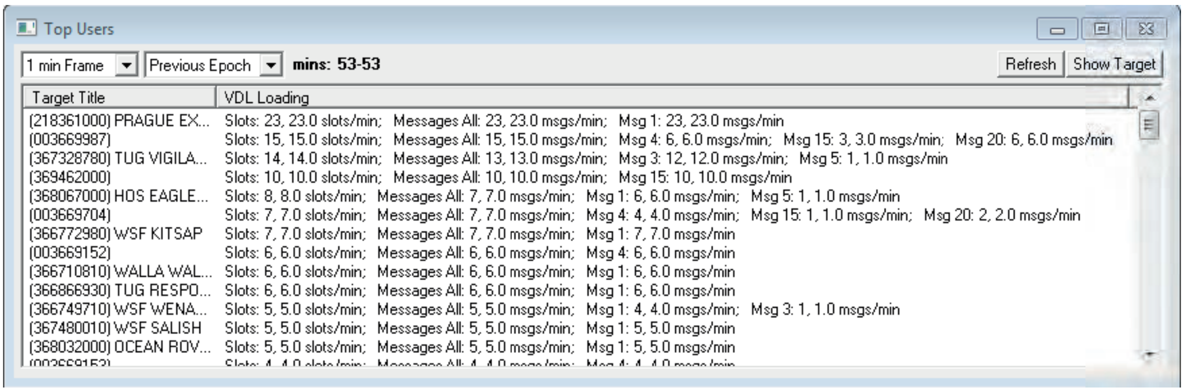


*Figure 10: "Top user" information*

Relocating the receiving site at a lower height provides a coverage area that is better suited for the user, as shown in ***Figure 12***.

## SUMMARY

Continual monitoring of the AIS System is necessary to ensure:

- That vessels participating in the system are providing correct and complete information in their message reports
- That Hardware performs to standards
- That the VDL is as efficient as possible for message throughput.


*Figure 11: Original area coverage plot*


*Figure 12: New area coverage plot at new receiver site*

# 21 ANALOGY BETWEEN THE VTS CENTRES´ HUMAN MACHINE INTERFACE AND THE VESSELS´ INTEGRATED BRIDGE

*Dirk Eckhoff. Federal Waterways and Shipping Administration, Germany*

One prominent aspect of modern vessels is the integrated bridge or integrated bridge design. Like a VTS centre (VTC) a vessel´s bridge has displays for traffic monitoring, met-hydro data, waterways condition and communication facilities. The report compares the state of the art of VTC´s human machine interface (HMI) with a vessel's integrated bridge.

Are there improvements for both, ship- and shore-HMI also with respect to usability and ergonomics?

Can the data be presented in a more comprehensible way or have we reached the limits of integration?

Will the transformation and adoption of a vessel´s integrated navigation system to VTS applications or vice versa support the harmonization between ship and shore?

The paper will discuss if and what the VTC HMI and the vessels´ integrated bridge design can learn from each other.

Un aspecto destacado de los buques modernos es el puente integrado o el diseño de puente integrado. Como centro de un dispositivo de gestión de tráfico de buques VTS (VTC) el puente de un buque tiene pantallas para el control de tráfico, datos meteorológicos e hidrológicos, estado de las vías navegables e instalaciones de comunicación. El informe compara la más moderna tecnología de la interfaz hombre-máquina (HMI) del VTC con el puente integrado de un buque.

¿Es posible realizar mejoras relacionadas con la facilidad de uso y ergonomía en las interfaces HMI de barco y de costa?

¿Pueden presentarse los datos de un modo más comprensible, o hemos alcanzado los límites de la integración?

¿Admitirá la adopción y transformación de un sistema de navegación integrado de un buque a aplicaciones VTS, o viceversa, la armonización entre barco y costa?

La ponencia analizará si la HMI del VTC y el diseño de puente integrado de los buques pueden beneficiarse entre sí y, en ese caso, de qué manera.

*Un aspect important des navires modernes est la passerelle intégrée ou la conception de passerelle intégrée .Comme dans un Centre VTS (VTC), la passerelle intégrée d'un navire a des écrans pour surveiller le trafic, les données météo et hydrographiques, les conditions dans le chenal et les possibilités de communication. Le rapport compare l'interface homme-machine (HMI) de haute technologie du VTC à la passerelle intégrée d'un navire.*

*Y a-t-il des améliorations, à la fois sur le navire et au centre HMI à terre, concernant leur facilité d'utilisation et leur ergonomie ?*

*Pourrait-on présenter les données de façon plus compréhensible ou a-t-on atteint les limites de l'intégration ?*

*Cette transformation et l'adoption de systèmes de navigation intégrés aux applications VTS, ou l'inverse, aideront-elles à une harmonisation entre navire et terre ?*

*Le rapport discute le fait de savoir si le HMI du VTC et la passerelle intégrée du navire peuvent apprendre l'un de l'autre, et quoi?*

# Analogy between the VTS centres “human machine interface and the vessels” integrated bridge

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XVIII Conference · A Coruña · Spain

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## 1. INTRODUCTION

There is a need to take ergonomics into account when presenting additional data at the workstation [1].

The comparison of a human machine interface (HMI) in a Vessel Traffic Centre (VTC) with the ships bridge shows some analogy. Also the aims like a safe voyage and the tasks show some similarity. Modern technology for communication and presentation give the chance to equalize the bridge´s and the VTC´s data level. But will it also help the master on the bridge or the VTS operator to extract the information he needs. Will more or better data make better information? According to the ISO definition "data" is the representation of facts while "information" is the knowledge about facts [2]. Hence, "data" is the technical issue and "information" an issue of the human factors.

The just published IALA Guideline 1105 [3] gives guidance to achieve "a harmonized presentation" of the information ashore and on board. This paper discusses the analogy between the vessel´s bridge and the vessel traffic centre and the possible improvements for the bridge and VTC design when both will grow together in a future e-Navigation world.

Ergonomic design is complex and therefore should follow a procedure. The paper follows the human centred design procedure to compare the vessels bridge with the VTC work environment. Possible improvement for all stages is identified and actions for improvement of the HMIs are concluded.

## 2. HISTORY OF VESSELS BRIDGE AND VTC DEVELOPMENT

In the development to state of the art ship bridges and VTCs was driven by the radar sensor und presentation as the central sensor on board and ashore. With the establishment of the VTS with additional sensors and displays the development became more and more independent from each other.

The vessels bridge equipment was early standardized by IMO. The IMO provides resolutions and guidelines to the detail to prevent diverging and heterogeneous bridge equipment in reaction to the versatile and innovative solutions the industry proposed. For vessel safety reasons not only the equipment was regulated by IMO but also the test of equipment. The development of the VTC work environment was guided by the IALA with more functional instead of detailed recommendations.

The result are numerous standards of the IMO e.g. [4], [5], [6] while the VTC work stations and display are mostly covered by the two IALA recommendation [7], [8]. Although the IALA allowed a much wider frame for development most of the VTC today look very much alike. The reason is that similar tasks require similar tools.

With respect to VTC and bridge harmonisation also the industry did some good job. Instead of separating new development of the bridge and shore systems they copied from each other.

More and more data, graphics, function and presentation tools have been added to the HMI and the work stations extended. A few years ago it was realized on board and ashore that the operator would ´drown´ in information [9], would be stressed by alarms and would watch diverse activities on a wall full of monitors.

## 3. PROCEDURE OF ERGONOMIC DESIGN

The design of the operators´ working environment should follow ergonomic standards. The paper follows the design procedure to compare the vessels bridge with the VTC work environment. The chosen procedure is human centred "onion principle" as applied at the IALA workshop on portrayal [10]. The ***figure1*** below visualizes the "onion principle".

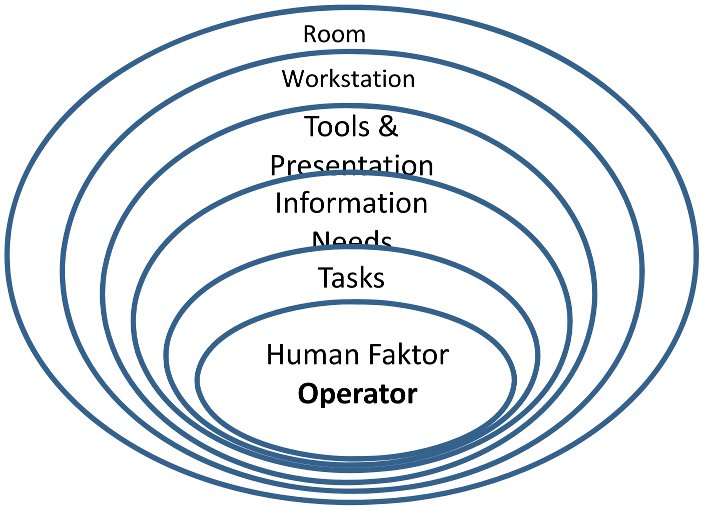


*Figure 1: Onion principle of human centred design*

1) Operator/ Human Factor: the process starts with the human factors as the core element for ergonomics.
2) Tasks: next onion skin or step in the procedure is to determine the operator´s tasks.
3) Information needs: to perform his task the operator needs information. The human machine interface (HMI) design is particularly determined by the information needs to meet the cognitive capabilities the operator.
4) Presentation Tools: The data must to be presented that way the operator can easily derive the information from it. Tools give support by presenting data in charts, graphics, text, symbols and to apply function communication, surveillance, monitoring and planning. The technical equipment is displays, keyboards, headsets, binocular, etc.
5) Workstation: All the tools and functions presentation respectively the equipment should be placed in an ergonomic way at one or more workstations.
6) Room: In the operators room(s) all the workstations should be placed to fulfil the inter-communication needs. But the same time distracting interference should be prevented and the room(s) should provide a comfortable working environment.

## 4. ANALYSIS OF WORKING ENVIRONMENT OF THE VESSEL´S BRIDGE AND THE VTC

### 4.1 The Operator, the Human Factor

The basic characteristics for the job on the bridge or at in VTC are very similar. Both have to watch the screens and scenes permanently, are in frequent decision-making process and interrupted by alarms or communication requests. The operator works day and night shifts. He has low physical challenge but high psychological stress. Both have to cope with mental workload, fatigue, cognitive lock-up, attention loss etc.

Therefore in both cases the same human factors are relevant and the same ergonomic rules should be considered. Ergonomic guidelines do not refer to a specific branch but to specific human factors and operation profiles. For detailed analysis with respect to ergonomics the ISO TC159 should be consulted [11].

The similarity of the required characteristics even more endorses the idea that both sides the vessel´s

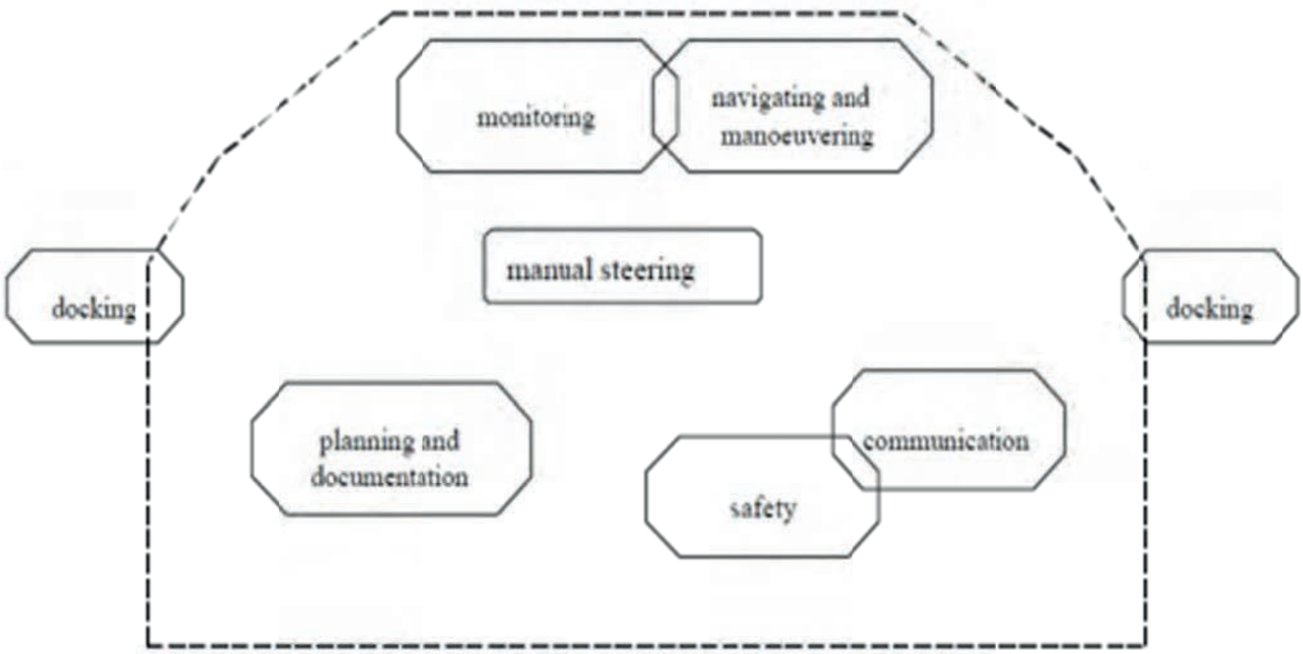


*Figure 2: Example for a vessel's bridge layout. Copy from IMO Res MSC/Circ. 982, Annex Fig.1 [6]*

bridge and the VTC could learn from each other with respect to the ergonomics.

## 4.2 Operators´ Tasks

All tasks of the crew on the bridge are focused on the own ship while the VTC looks after the safety of all vessels in the area.

The vessel´s tasks are standardized by IMO SN.1/Circ.288 [5]. The task is directly linked to the specific workstation on the bridge. For integrated navigation systems the IMO Res. MSC/Circ. 982 [6] calls the task assigned unit "task station". ***Figure 2*** shows the example of function areas – a possible location of workstations given in IMO Res MSC /Circ. 982, Annex Fig. 1[6]

The IMO defined task or workstations as listed below:

- navigating and manoeuvring
- monitoring
- manual steering
- docking
- planning and documentation
- safety
- communication

Of course the core task on the bridge is to manoeuvre the vessel and to care about the own ship safety. For the tasks "manoeuvring", "manual steering" and "docking" there is no analogy to the shore side. The task own ship´s safety may have an overlap with the safety of shipping in general and therefore connection to the VTS.

The task and activity in a VTC are performed to provide the Vessel Traffic Services: Information Service (INS), Navigational Assistance service (NAS) and Traffic Organization Service (TOS). This paper presumes the VTC to provide all three services 24/7. The procedures, tasks and information in a VTC are defined in the IALA Rec. V-127 [8]. The IALA Rec. V-127 differs in internal and external procedures and explains the task and information needs. The ***table 1*** below shows the analogy or relation between the task on the vessel´s bridge and in a VTC.

| Vessel´s Bridge Task | VTS´s Task |
|---|---|
| Manoeuvring | - |
| Navigating | Provide NAS |
| Monitoring | Monitoring |
| Manual steering | - |
| Docking | - |
| Planning | Provide TOS<br>Internal Planning |
| Documentation | Documentation |
| Safety (own ship) | Emergency |
| Communication | Provide INS, NAS, TOS |

*Table 1: Vessel's bridge tasks and VTS's tasks*

### Monitoring

The monitoring task is an internal task for both sides. The information needed for the monitoring task and the data presentation should not differ too much to prevent a different performance and result of the task. The next chapters deal with the analogy of the information needs and the presentation.

### Navigation

The wording of the task "navigation" on board and "navigational assistance service" ashore indicates, that they complement each other. Hence it is one task or business use case.

The business use case for save and efficient navigation should not be examined separately for the VTC and the vessel´s bridge. The business use case includes both vessel´s and VTS´s part (and allied services and maybe other stakeholders) to achieve the aim of save and efficient movement of the vessel. To improve the ergonomics the business use case with the link between the workflow on board and in a VTC should be considered.

### Communication

The verbal communication (VHF) is not only an exchange of data but gives the VTS operator an additional information - the impression of current problems and performance (human factor) on the bridge. The bridge should get the impression that there is an helping hand out there. To reduce communication errors only data transport should be done by electronic means where ever feasible.

### Planning

The IMO Res. A.893 (21) [12] defines the planning as an internal task for the vessel but there is no reference to the Traffic Organization Service (TOS). However, the business use case should include the planning task on board, the TOS, the information exchange via the VTS´s Information Service (INS) and internal planning task in the VTC.

The use case analysis should result in a clear definition of the beginning and the end of the use case on the bridge and in the VTC and should state the required results of the process. The use case should run smoothly without breaks or information losses and the roles on board and ashore and the workflow should be determined.

Thus an overall efficient and ergonomic planning process could be implemented.

### Documentation

The documentation is an internal process. But some documents are used ashore (not only in VTC) and on board. To ease the task on board and ashore, there is a need to unify the templates, forms etc. and the communication link, to be able to reuse the same data in different documents [13]. But not the entire document may be relevant for the other side or only parts of the contents may be needed in other tasks like planning and in decision making for navigation. The data in the documents should be computable. Therefore generic documents are recommended. Also the document / data exchange between bridge and ashore could be automated.

### Safety

If there is a case of safety or emergency on a ship, this is originally internal, but some support might be required from the VTC-operator and the data exchange could be electronic.

The bridge has to cope with many ship own but also operational alarms. The IMO react to this by implementing a resolution about navigational alarms [14] and alert management [15]. To support the monitoring task the VTC will probably need more automated operational alarms in future.

The IMO Res. [14] and [15] may be considered to improve the ergonomics in the VTC.

## 4.3 Information Needs

The IMO Res. MSC 191(79) [4] defines the arrangement for the information presentation (colours, readability), the information needs plus the required display and there physical requirements. The IACS Rec. 95 [20] sets the relation between tasks, equipment and the data that it provides. Referring to the IMO standards the information needs are:

- Ship own information
- Charted Information
- Radar information (Radar Echo only)
- Target information (Radar + AIS incl. CPA, TCPA)
- Target data (Track data)
- Operational alarms
- Fairway and environmental information

Also the respective forecast and prediction information should be available on the bridge.

The VTC information needs can be derived from the IALA Rec. V-127 [8] and the V-125 [7] and the IALA Guideline 1105 [3]. The summary of the information needs is listed below.

- Traffic information
- Vessel static and voyage related information
- Fairway and environmental conditions
- Pilotage and allied services status
- Berth, anchorage and adjacent VTS Informations
- VTS own information
- Legislation information

In addition the VTS has the need for forecast and prediction information.

The comparison of both list show a broad overlapping. While the information scope of VTS includes all the vessels and the entire VTS-area the vessel needs a subset of the information – timely, spatial and own vessel specific information. The information need on board is like an information window moving with the vessel - a moving information window.

The VTS´s required information is not just a simple addition of all windows but composed of all the vessels information windows by considering all the relation between the vessels.

In respect to its "own" situation the VTS and the bridge only needs information about the other's internal situation, if it has an effect on traffic.

The bridge generates the information only from the vessel´s own sensors. Information from external sources are imported, e.g. from VTS, met /hydro services or external sources like agents or ports. But in most cases the information is not provided in electronic format and therefore it is not integrated to the ships data base. If the information or parts of it are needed at more than one task station it can neither be forwarded, nor integrated into the presentation if not electronic data.

The VTCs also mainly rely on their own sensors. But VTS-systems today can have an architecture which allows to integrate additional sensors and sources and makes the data available for every application and presentations interface [16].

But the vessel has one sensor most VTCs do not have. According to [5] the most important information on the vessel´s bridge is the look out of the bridge windows. In this respect the VTS has a lack of information.

In addition the VTC and bridges may have electro-optical sensors (EOS). Whether there is need to exchange the live streams between board and ashore should be investigated.

The voice communication via VHF on board and at a VTC complement each other. The information given by voice can only made available to others if they are listening to the same VHF channel or if the operator types the key-data into the database. With future digital VHF channels the technology should enable the vessel´s identification and the extraction of the key-data from the voice stream.

Other modes of voice and data communication like mobile phone, fax, e-mail, internet are not really harmonized for communication between VTC and the vessel´s bridge. Also the other stakeholders use this modes of communication. They should be implied in the harmonization process, with the aim of an equal information level and to prevent unambiguity due to parallel communication.

According to [12] the planning is solely a vessel´s task but shall consider external information for the planning. Therefore the VTS information about the traffic and fairway conditions and forecast is needed on board. But the information important for planning is not provided electronically and therefore not integrated and assessable in planning tools on board.

Also in the VTCs there are currently very few planning tools used that integrate traffic, fairway, environmental and legal parameters for planning.

Considering the growing multiple use of the navigable waters and the requirements for vessel traffic management [17] the traffic planning und the TOS will be enhanced in the future. The aim of the harmonization should facilitate a combined planning.

Currently there is a difference between the information position of the vessel and the VTC. The VTS information bases often on many sensors plus information from the VTS-operator's communication plus numerous external data – networks.

The vessel´s information rely on the own human sensor (optical or acoustical) and ship own technical sensor data. Due to each one's use of his own sensors (human and technical sensors) the information and decision derived may be different on board and ashore. Therefore this differences and / or gaps should be minimized. The same level of relevant information should be achieved on board and in the VTC.

The progress in information technology allows the VTC to have access to the broad information for situation awareness in the VTS area and prediction data from beyond the own area. The moving information window of the vessel should be cut out of the VTS´s full scope and be transferred to the vessel to prevent lack of information or different interpretation. This goal can be achieved, when the information is derived from electronic data, with meaning of data as described in [3]. Data picked up by the operator´s "human sensors" remains in his brain as long as he not converts into machine readable data. In addition the information flow between the separate task or workstations on the bridge and among the VTCs could be improved.

### 4.4 Presentation & Tools

The bridge HMI looks complex at first sight. But the closer look shows that about half of the presentation equipment is doubled as active redundancy and on each wing of the bridge. The vessel's presentation and communication equipment for operation can be derived from IMO Res. MSC. Circ. 982 [6]. The IMO Res. MSC 191(79) [4] defines in detail the arrangement of the information (colours, readability), the information needs plus required display and their technical specifications. The IMO regulates also the test and test procedure for the sensors on board and the presentation equipment on the bridge with reference to the IEC standard [18]. The IMO Res. MSC.252(83) [19] gives a summary for presentation tools, tasks and alarm for integrated navigation systems.

The presentation equipment that have an equivalent in the VTC is listed below, not including the tools which are used for internal tasks only like manoeuvring or docking:

- Radar display
- AIS-Display
- Communication Interface
- Charts Display
- Environmental and fairway data display
- Displays for files and documents

For the VTC´s presentation interface the IALA published the Rec. V-125 [7] and the guideline [3] just a few month ago. The basic applications for the presentation are listed below.

- Traffic chart
- Met / hydro data
- Ship Data
- Traffic planning
- Communications
- Documentation
- Replay

For ergonomic reasons it may be recommended not to use different physical screens or logical window for each application. Better to integrate for example geo-referenced data like water level, wave height at a certain position etc. on a chart display in combination with the traffic. Due to the foreseeable restrictions for some vessel particularly the conjunction with vessels´ position with environmental data will occur in the future. The alert should not show up on separate screen. Also the function to switch the mode for current situation display to prediction for all presented data may be useful in some cases.

The equivalent to the radar, AIS and Chart display on board is the VTS-Display with the traffic image of the relevant VTS area. On modern bridges all position, track and some vessel data is integrated into one combined chart/ AIS/ radar track presentation. On the bridge radar echo presentation requires a separate screen. In the VTC the radar echo is either displayed together with the track data or different sources or radar echoes are not presented at all. To achieve the same information level a further improvement would be that track data from the same track source would be displayed ashore and on board.

While on a bridge ECDIS and ENC are mandatory the VTS is recommended to use ENC to allow the access to the same chart as used on board. Harmonization is recommended that both sides will use the same chart update cycle and version. This becomes particularly important when future electronic charts may include also dynamic data like actual tide, water depth, weather and / or the respective frequently updated forecasts.

The presentation at the safety workstation displays the vessel´s internal safety signals like fire alarms etc. It is comparable with the presentation of internal technical system failures as described in IALA Rec. V-127 [8] on emergency procedures. The own systems status should be managed internally as well as the presentation. But when the internal situation results in external effect, it may be considered that the other side and involved parties are informed automatically. The technical status on board is recorded on the voyage data recorded anyhow and therefore available as electronic data.

On board the met/hydro and fairway conditions and forecast are presented at sensor or source specific display. The same layout can be found in many VTCs. An integration to the data base and ergonomic presentation is recommended on the bridge as ashore. Better to integrate geo-referenced data like water level, wave height at a certain position etc. to the traffic chart display. Due to the foreseeable restrictions for some vessel particularly the conjunction with vessels´ position with environmental data will occur in the future. The alert should not show up on separate screen.

The use the same data on both sides would allow the presentation of the restrictions and alerts on both sides.

The presentation at the workstation for planning and documentation on board does not have a counterpart in the VTC. On board the planning is partly made on a paper chart. Some electronic chart devices at the workstation for navigation and / or monitoring allow the input of the planning results like way-points, routes and can calculate and display the distance between the planned route and the current position. In addition meteorological and hydrologic conditions and forecast is received on board and displayed on various displays [20] and used for planning.

The presentation for documentation on board and ashore differs from electronic data files to paper hard copies /fax. Only electronic data can be distributed to several receivers in a time. Therefore electronic data is recommended. In most cases the electronic documentation is done on separate office computers. The integration to the operational bridge system or to the VTS system may be useful to reuse data and to prevent time-consuming transfer between systems. But the integrity of the operational system should be considered.

To achieve the same level of relevant information on board and ashore it is not necessarily the need for the same presentation. But a computer can only present data but in many different ways. The operator gets the information from the presented data. To prevent that the data is interpreted differently on board and ashore the same presentation should be considered for data used on both sides.

For situation awareness and tactical decision making on board the presentation should cover the information window moving with the vessel. The VTC needs the presentation of the entire scope of the VTS-Area and beyond. For planning purposes the bridge needs a prediction window for her vessel only, while the VTC need a prediction presentation composed of the expected movements of vessels in the area. In the future the entire information is needed on board and ashore may available in a cloud. Each vessel and each workstation in the VTCs could be provides with his specific presentation window.

## 4.5 Workstation(s)

The Paragraph 4.2, ***figure 2*** shows the typical bridge design. There is no equivalent IALA standard for the layout of a VTC. Other than on the bridge where the IMO has standardized details the IALA Rec. V-127 [8] is far more functional. No task is allocated to a specific workstation, no layout for an operator´s room is made.

Nothing at all around the world the VTC workstation design looks very much the same. Mostly there are workstations for the supervisor and for each assistant. All workstations are equipped with same HMI- function for data sampling, monitoring, communication, planning. While the workstation of the assistant mostly covers a part of the VTS area, the supervisor´s workstation has the feature to overview the entire VTS area and maybe the function of overwriting the other workstations. The workstation layout to support local, regional or national tasks is not considered in this paper.

Usually one operator at one workstation in the VTC has the link to the vessel in his VTS sector. On the vessel ´s bridge the received information may be needed at more than one workstation or for more than one task. The split up of communication/interaction links may have an impact on the human factor and may result in information failures and losses or additional intercommunication on the bridge. This could be prevented if the needed data is directly forwarded by electronic means to the respective workstations.

On the other hand in the VTC one operator has multitasking functions like monitor, verify, decide and provide information. That could lead to a cognitive lock-up of the operator particularly when many vessel have to be served. The load of the operator is increasing slowly. The VTS-management should implement preventive measures in time.

Today most VTC´s are organized that way, that one workstation respectively one operator serves one VTS area or sector – VTC workstation layout is area-oriented. That may have technical reasons, because in the past the sensors did not have the wide coverage, track data from different sources could not be integrated and the sensor data could not be transported longer distances. With technology of today is it feasible to provide one operator with all the data to serve the vessel from berth to berth via many VTS areas and sectors - the voyage-oriented workstation layout. The voyage-oriented layout of the VTC may not fit for the INS, which provides area / sector specific information. But the NAS and TOS out of one operator´s hand for vessels which need attention may be recommended. The vessel handover among workstations or VTCs can be omitted and the repeated reporting when entering another VTS area may be reduced.

The voyage oriented VTC-workstation could also improve the TOS and enable overarching vessel traffic management.

## Operators´ Room

A proposed design of the vessel´s bridge is shown in figure 2 in paragraph 4.2. In addition to this the IMO defines in [6] the workstations position and the space between them.

There are no recommendations or guidelines for the room design of a VTC, but the guidance on ergonomics in the VTS centre is planned for the work program 2014-18 [21].

It is quite obvious that a VTC–operator room is not identical to a vessel´s bridge. The core tasks are different. The bridge´s design supports the task to manoeuvre the own vessel, while the VTC shall serve all vessels in respect to a safe and efficient journey. For manoeuvring and docking the look out of the window is a core element for the bridge “room” design, while the direct view is not relevant for most of the VTCs. Where the VTC have task specific work stations instead of VTS area specific the bridge´s task station design should be considered for the VTC. However, the bridge room design should not be copied to a VTC or vice versa. But the methodology and standards for ergonomic design can be applied for both, the vessels´ bridge and VTCs.

# CONCLUSION

The comparison of the operator´s work place on the vessel´s bridge with the one in the VTC shows some analogy. Benefits can be expected when learning from each other are listed below.

1) The job profile like watch, monitoring and immediate decision making is similar on the bridge an in the VTC. The same criteria, methodologies and standards for ergonomics can be referred to.
2) Some tasks on board and ashore are overlapping or complementary and both have the same aim a save and efficient voyage of the vessel. There may be improvements, if the interaction of the vessel´s bridge and VTC is considered in a use case analysis as one workflow, like navigating and NAS, voyage planning and TOS, communication and VTS Information Service (INS).
3) To improve the safety and efficiency in the maritime world the harmonization should not only cover the technical link but all links as shown in figure 4 in IALA Rec. e-Nav 140 [16] and particularly the operational link which are according the services. The examination should include the entire workflow on board and ashore including the operation link and the adjacent procedures to prepare for service provision and to process the received service information.
4) The vessel and the VTC should achieve the same information level. While the VTC needs the full scope of information, the vessel bridge needs a window of that information moving with the vessel.
5) The information provided by INS, ship reporting and data form other sources meteorological and hydrologic data and fairway situation and forecasts should be available electronically to be integrated to the different workstations and be computed in the systems on board and ashore.
6) The internal distribution of data on the bridge and in the VTC could be improved if INS and ship reporting is electronically.
7) To achieve the same information level, the presentation of the data should be similar to prevent misinterpretation, while on board only presentation of the vessel specific information window is needed.
8) For ergonomic reasons the use of dynamic electronic chart including met, hydro and fairway data plus forecasts and the processes for continuous update should be examined.
9) Due to the different core tasks performed on the bridge and in the VTC there is little analogy. For vessels which need particular attention it should be considered if the VTC workstation should have a vessel voyage oriented layout rather that a VTS area oriented layout. A single VTS operator at one workstation serves the vessel from berth to berth.
10) The intercommunication between the task specific workstation on the bridge and vessel handover in the VTC could be improved by electronics means.

The IMO defines the bridge layout in more than ten standards, while the IALA the VTC layout in has less the five recommendations. The harmonization process should start in IALA and IMO in finding the counterparts on both sides. ■

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## 32 THE IMPROVEMENT OF VTS OPERATION CAPABILITY WITH THE INTRODUCTION OF KU-BAND SOLID-STATE RADAR

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The Japan Coast Guard (JCG) has been used high resolution Ku-band radars as a VTS sensor since 1977. While conventional radar uses magnetron as an oscillation source, recently there has been remarkable progress in the semiconductor technology. Thus, new Ku-band radars using solid state devices are able to develop. The JCG started to install the Ku-band solid-state radar as a VTS sensor in 2013.

The digital signal processing technology has improved detection performance and rain/sea clutter suppression performance. Furthermore, as a result, costs and workload for maintenance, and spurious emission has been reduced through the solid-state technology.

La Guardia Costera Japonesa (JCG) ha estado utilizando radares de banda Ku de alta resolución como sensor VTS desde 1977. El radar convencional utiliza un magnetrón como generador de oscilaciones, pero recientemente se han realizado destacados progresos en la tecnología de los semiconductores. Por ello, ha llegado el momento de desarrollar nuevos radares de banda Ku utilizando dispositivos de estado sólido. La JCG comenzó a instalar radares de estado sólido de banda Ku como sensor VTS en 2013.

La tecnología de procesamiento de señal digital tiene mejores resultados de detección y de supresión de señales parásitas por lluvia/mar. Además, como resultado, los costes y la carga de trabajo de mantenimiento y las emisiones falsas se han reducido gracias a la tecnología de estado sólido.

*La Garde-côtière japonaise (JCC) a utilisé des radars haute résolution de la bande Ku comme capteurs pour les VTS depuis 1977. Tandis qu'un radar conventionnel utilise le magnétron comme source d'oscillation, il y a eu un progrès récent et remarquable dans la technologie des semi-conducteurs. De nouveaux radars utilisant des appareils « solid-state » sont capables de se développer. La JCC a commencé à installer le radar « solid-state » de la bande Ku comme capteur VTS en 2013.*

*La technologie du traitement du signal digital a amélioré les performances de détection et de suppression des retours de pluie ou de mer. De plus, elle a permis une réduction des coûts et du travail de maintenance, et la technologie « solid-state » a réduit les rayonnements non essentiels.*

# The improvement of VTS operation capability with the introduction of Ku-band solid-sate radar

Hiroaki Tanaka & Kazuyuki Tanaka

Japan Coast Guard

IALA·2014·AISM
XVIII Conference · A Coruña · Spain

## 1. INTRODUCTION

The Japan Coast Guard (JCG) is operating seven VTS Centers to ensure safe navigation in congested waters such as Tokyo-Wan, Ise-Wan, Seto Inland Sea and Kanmon-Kaikyo strait. The VTS Centers monitor the movement of maritime traffic within the area covered by VTS Centers through the means of visual monitoring, radar, AIS and so on, provide necessary information for safe navigation and coordinate the entry time of navigational route for large vessels.

In particular, the radar is a crucial way to monitor the maritime traffic in the water areas which are congested with various kinds of small and large vessels. Currently, total of 21 radar stations are operational under the control of VTS in Japan. The JCG has installed the Ku-band solid-state radar in Umihotaru radar station of Tokyo-Wan VTS Center since March, 2013.


*Figure 1: Location of VTS centers in Japan*

## 2. VTS RADAR PERFORMANCE

The JCG has been installed the Ku-band (13.3 - 14.0GHz) radar for VTS centers in Japan since 1977, the year which Tokyo-Wan VTS Center had started its operation.

Since the harbor radar stations in the Osaka Port and the Kushiro Port were built from 1962 to 1964, various frequency bands such as 6GHz, 24GHz and 32GHz had been used. However, the

*Figure 2: Ku-band radar antenna*

performance greatly degrades due to rainfall in the use of 24GHz or more, and the antenna length to maintain necessary azimuth resolution is too long in the use of 9GHz or less. To this end, the Ku-band radar has been used, which has relatively small rainfall attenuation and length of the antenna is adequate to install.

The radar antenna consists of a slot array antenna

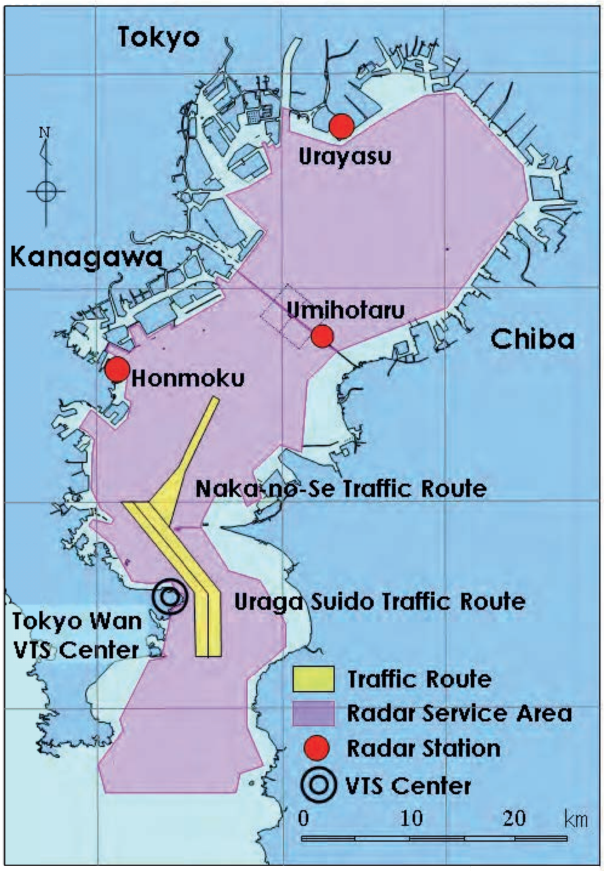



*Figure 3: Radar coverage area of Tokyo Wan VTS center*

for both transmitting and receiving, and the overall length is 5,750mm. It rotates once per 6 seconds (10rpm ± 10% or less).

The water areas monitored by VTS in Japan have characteristics that they are as narrow and long as Tokyo Wan shown in Figure 3 (the width of the entrance of bay: about 20km, the length from entrance to inner part of the bay: about 60km), so that the coverage area by a single radar station limits to about 20km and we have installed multiple stations to cover whole area. In addition, high resolution detecting performance is required because a lot of large container, tanker and passenger vessels and small ships such as fishing and pleasure boats sailing in the water areas.

For this reason, while we have installed the radar which has a high power of 40kW by using a magnetron to ensure a detecting distance of 20km, and also has the transmission pulse width of 0.1μs to ensure the high distance resolution of 15m. In this case, the distance resolution 15m is a theoretical value and a magnetron specifically causes the distortion of pulse, so that actual distance resolution falls to about 30-40m.

As for the azimuth resolution, assuming the width of antenna beam is 0.25°, it is defined to be about 40m at a point 10km distant from the antenna.

In addition, in coastal waters of Japan, 26 typhoons occur each year and 11 of them approach or hit the mainland of Japan. Taking such natural conditions into account, the antenna has a structure enabling it to rotate without any difficulty for average wind velocity of 40m/s and is impervious to instantaneous wind velocity of 60m/s.

As described above, the VTS radar in Japan, using Ku-band frequency, achieves high detecting performance with a short transmission pulse and a narrow width of antenna beam and has high wind resistance with a strong structure. Thus, they satisfy the performance which we require.

## 3. CHARACTERISTICS OF SOLID–STATE RADAR EQUIPMENT

A conventional radar uses a magnetron as a source of oscillation in order to transmit high frequency electromagnetic waves (microwaves). However it does not conform to the Spurious Regulation in ITU-R recommendation M.1177-3 (International Telecommunication Union, Radiocommunication Sector) in 2003, so we have been studied to install the solid-state radar which has a stable oscillation frequency for the VTS in Japan.

With the evolution of recent semiconductor technology, the high power (350W) solid-state radar has been developed through the using gallium nitride (GaN) semiconductor devices for an oscillation source and for a high power source of 350W. The specifications of solid-state radar are shown in ***Table 1***.

*Table 1: Major specifications of solid-state radar*

| | Items | Specifications |
|---|---|---|
| 1 | Transmitting power | 350W |
| 2 | Tansmisson frequency | 13.64GHz/13.66GHz<br>13.74GHz/13.76GHz<br>13.84GHz/13.86GHz<br>13.94GHz/13.96GHz |
| 3 | Pulse width | No modulation : 0.15μs<br>Chirped : 12.2μs<br>Non-linear method |
| 4 | Pulse Repetition Frequency | average 3kHz (2.7～3.3kHz) |
| 5 | The beam width of a principal radiation from antenna | Azimuth : 0.25°<br>Vertical : 15.0° |
| 6 | Pulse Compression Gain | 19dB |
| 7 | Minimum Reception Power | -96.0dBm |
| 8 | Antenna Gain | 36dBi |

The characteristics of solid-state radar include Pulse Compression Technology which gains the distance detection performance equivalent to the existing one and Pulse Doppler Processing which suppresses rain/sea clutter.

### (1) Pulse Compression Technology

A solid-state radar uses a frequency modulated (FM) long pulse of 12.2μs pulse width for transmission in order to gain the transmission energy equivalent to that of existing radar. Such a frequency modulated pulse is called a "chirped pulse". The pulse is converted into a compressed waveform through the compressing filter with delay time characteristic when it is received and a distance resolution equivalent to one of 0.1μs pulse width can be obtained.

A side lobe, however, exists in the compressed waveform and it forms false image along distance direction. In order to reduce the side lobe, the modulated frequency is varied non-linearly. This method is called "non-linear chirp".

In general, a radar cannot receive the reflected microwave while it is transmitting pulses, so that it cannot detect targets in short range areas if it uses pulse compressing method which transmits a long width chirped pulse. For this reason, it transmits a short pulse of 0.15μs (non-chirped pulse) to detect targets in short range areas and covers the monitoring area of radar by alternately transmitting a chirped pulse (shown as ***Figure 5***).

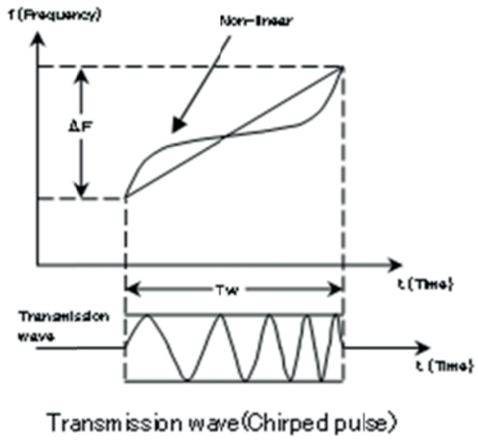
### (2) Pulse Doppler Processing

The Pulse Doppler Processing detects the Doppler frequency of a radar reflected microwave using the Doppler Effect and separates it into each velocity component to suppress unnecessary reflected echoes such as rain clutter and sea clutter.

Conventional rain clutter suppression methods have not been able to detect a target when the target level is weak compared to unnecessary reflected echoes.

The Pulse Doppler Processing utilizes the fact that unnecessary echoes consist of various kinds of components of velocity and a target has a definite velocity component. The method separates radar echoes into each velocity component, distributes the receiving levels of unnecessary reflected echoes to enlarge at a glance the signal level of a target and thus suppresses rain clutter and sea clutter, etc.

The Doppler frequency ranges from dozens to



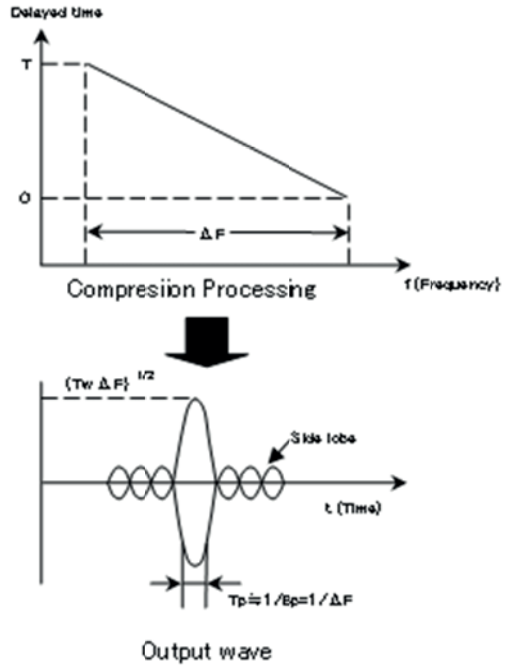




*Figure 4: Pulse compression processing and output characteristics*

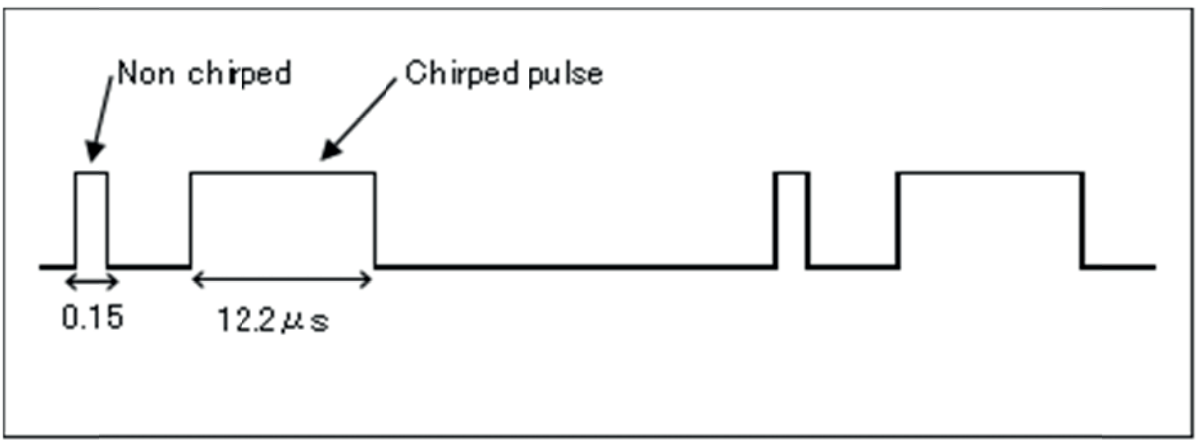



*Figure 5: Transmission cycle of chirped pulse and non-chirp pulse*

several thousand Hz. A stabilized level of transmission frequency is required in order to make it precisely reappear accordingly. A stabilized oscillation frequency by semiconductor technology of solid state radar has enabled the Pulse Doppler Processing.

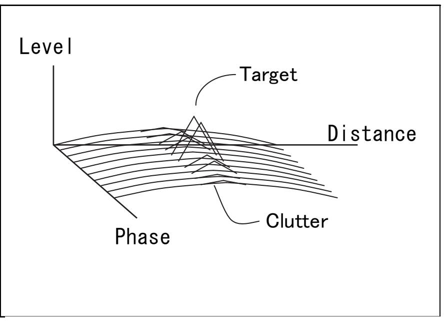



*Figure 6: Transmission cycle of chirped pulse and non-chirp pulse*

## 4. IMPROVEMENT OF VTS OPERATION CAPABILITY

The first-ever solid-state radar started its operation at Umihotaru radar station of Tokyo-Wan VTS Center in March, 2013. The installation of solid-state radar provided the following effects which have improved the VTS operation.

### (1) Improvement of Detection Performance

According to the image of Umihotaru radar station, the light beacon at the point about 10km distant from the station is clearly detected. The improvement of detection performance was confirmed.

A conventional radar, as its transmission power is as large as 40KW, has used an electron tube of TR limiter to protect itself from the reflected waves produced within short distances. However, as a solid-state radar made a TR limiter unnecessary, reception loss has been mitigated and minimum reception power has been improved. Because of this, detection of small scale targets which could not be sensed by conventional radar has become possible.

### (2) Improvement of Suppression Performance for Rain/Sea Clutter

***Figure 7*** shows the radar images of Tokyo Wan in the case of rainfall (precipitation: about 15mm/h) on March 19, 2013.

The left image shows that it is hard to monitor the navigational route due to the rain clutter (green portion) by a magnetron radar. The right image shows that rain clutter is removed by a solid-state radar through the Pulse Doppler Processing. That is to say, a solid-state radar improves rain clutter suppression performance compared with a conventional magnetron radar.

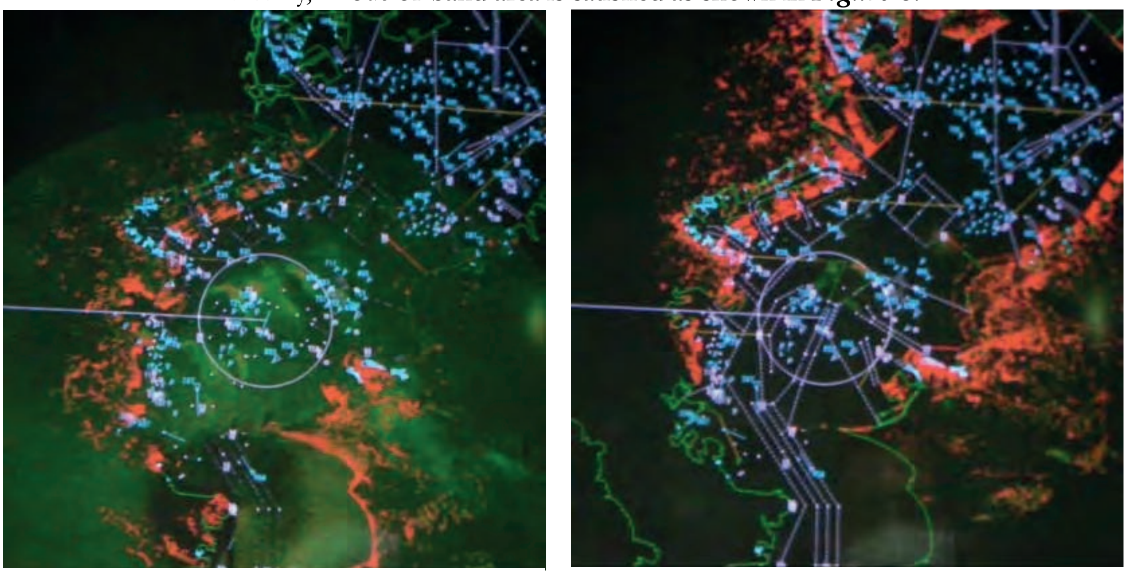
### (3) Reduction of Cost and Workload for Maintenance

A conventional radar can gain a great deal of transmission power with a magnetron as an oscillation source. However a magnetron is required to be replaced every year. On the other hand, solid-state radar does not need regular replacement of that, leading to the reduction of cost and workload for maintenance.

Furthermore electric power was reduced by 32% compared to a conventional radar.

### (4) Reduction Effect of Spurious

According to the ITU spurious regulations, radars need to satisfy the permissible value of -60dB in spurious area and -20dB in out-of-band area. As for a magnetron radar, second harmonic has exceeded the permissible value in spurious area. In the case of solid-state radar, not only the permissible value in spurious area but also -20dB in out-of-band area is satisfied as shown in ***Figure 8***.



*(a) Magnetron radar* *(b) Solid-state radar*

*Figure 7: Radar images of Tokyo Wan in the case of rainfall*

## 5. CONCLUSION

With the introduction of solid-state radar utilizing semiconductor technology, the detection performance of radar is improved because receiving loss is reduced. A TR limiter which has been used to protect the circuit of magnetron radar is no longer necessary. In addition, we have enabled to detect the target suppressed by sea/rain clutter with the introduction of digital signal processing. Moreover cost and workload for maintenance are reduced as a magnetron is no longer required. As a result of the improvement of these radar performances, VTS operation capability has been enhanced.

By 2022, the JCG has a plan to upgrade 21 VTS radars to solid-state radars conforming to the spurious standard during the migration term of the Radio Act, a Japanese law (Act No. 131 of 1950).

### *Acknowledgements*

The measurement of the spectrum of the solid-state radar (shown as Figure 8) was carried out by the National Institute of Information and Communication Technology (NICT).

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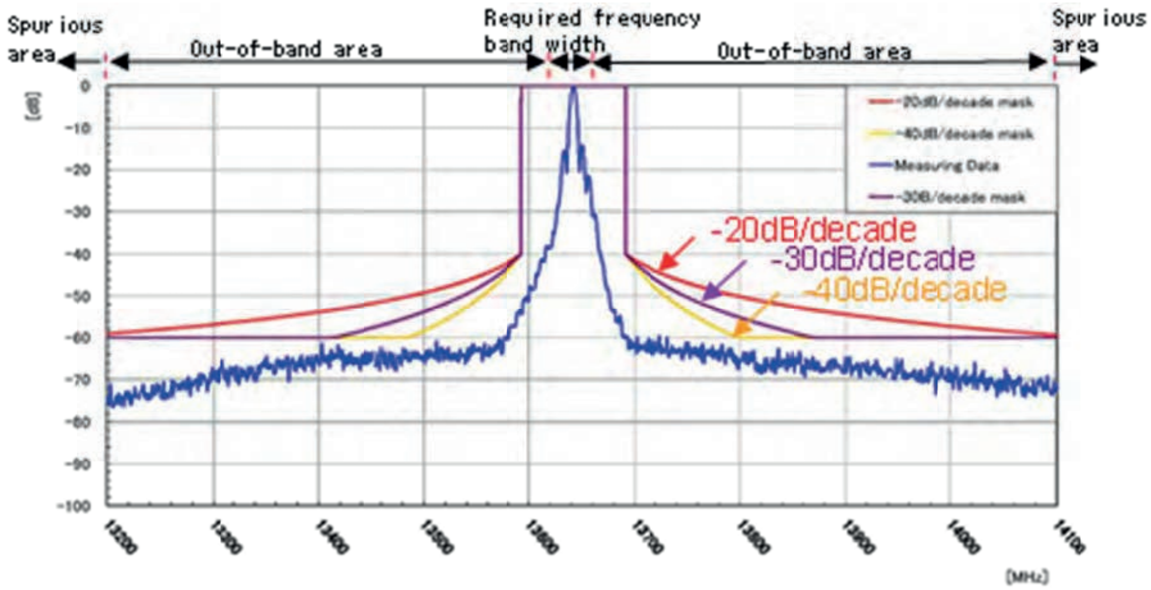


*Figure 8: Solid-state radar measurement spectrum*

## 52 HOW HUMAN FACTOR CAN HELP ON IMPROVING CONTROL ROOM PERFOMANCE

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To optimize the performance within safety critical control rooms two aspects have to be looked at in more detail. On one side, there is the symbiosis between the human and the machine while on the other side there is the overall "production" process within the control room. The human-machine-symbiosis requires a good understanding of human capabilities and human needs. This results in the ability to establish a dedicated human machine interface (HMI) design and a system matching those needs. Similar to this a good understanding of the production process is necessary. Within the SESAR project ZeFMaP (Zero Failure at Maximum Productivity in safety critical control rooms) analysis has shown that tools, well established for example in the mass production industry such as in the automotive industry, could also be applied for safety critical control rooms to optimize the production process. When these two aspects are taken into account and appropriate measures to optimize those two aspects are undertaken, the combination of them will help in improving the control room performance.

Para optimizar el rendimiento en las salas de control crítico de la seguridad se deben estudiar con más detalle dos aspectos. Por un lado, la simbiosis entre el hombre y la máquina y, por otro lado, el proceso de «producción» general en la sala de control. La simbiosis entre el hombre y la máquina requiere una buena comprensión de las capacidades y necesidades humanas. Esto tiene como resultado la capacidad para establecer un diseño de interfaz hombre-máquina (HMI) especializado y un sistema que satisfaga estas necesidades. También se necesita una buena comprensión del proceso de producción. Dentro del proyecto SESAR ZeFMaP (Cero Fallos con Máxima Productividad en las salas de control crítico de la seguridad) los análisis han mostrado que herramientas muy consolidadas, por ejemplo, en industrias de producción en masa como la industria del automóvil, también podrían aplicarse en las salas de control crítico de la seguridad para optimizar el proceso de producción. Si se tienen en cuenta estos dos aspectos y se adoptan medidas apropiadas para optimizarlos, su combinación ayudará a mejorar el rendimiento de las salas de control.

*Pour optimiser leurs performances en termes de sécurité, les salles de contrôle ont deux aspects à examiner en détail. D'une part, on a la symbiose entre l'humain et la machine, et d'autre part, le processus de « production » de la salle de contrôle. La symbiose homme-machine demande une bonne compréhension des possibilités et des besoins humains. D'où la possibilité d'imaginer une interface homme-machine (HMI) dédiée et un système capable de répondre à ces besoins. De même, une bonne compréhension du processus de production est nécessaire. Dans le projet SESAR, l'analyse ZeFMaP (Zero Failure at Maximum Productivity) des salles de contrôle, a montré que des outils, bien établis par exemple dans l'industrie de production de masse comme celle des automobiles, peut aussi s'appliquer dans les salles de contrôle pour optimiser le processus de production. Lorsque ces deux aspects sont pris en compte et que des mesures appropriées à leur optimisation sont prises, la combinaison de ces deux aspects permettra une amélioration des performances de la salle de contrôle.*

# How human factors can help on improving control room performance

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## INTRODUCTION

A control room in general could be defined as a collaboration of people, performing tasks to achieve a common goal, supported by machines, within a defined environment. Out of this definition, the three major aspects to look at when thinking about performance optimization are:

1) The people meaning the actual users working with the system
2) The work represented by the tasks required to achieve the intended goal
3) The environment in which the work is done which does not only relate to physical aspects but also includes interactions with other users in the control room.

In this regard, Human Factors is more than just ergonomics. It is getting an understanding of all these three aspects and putting them into symbiosis. A good definition of human factors is as follows:

> *"The discipline of applying the knowledge of human capabilities and limitations to the design of technical systems to help ensure that human performance within a system is optimised [1]."*

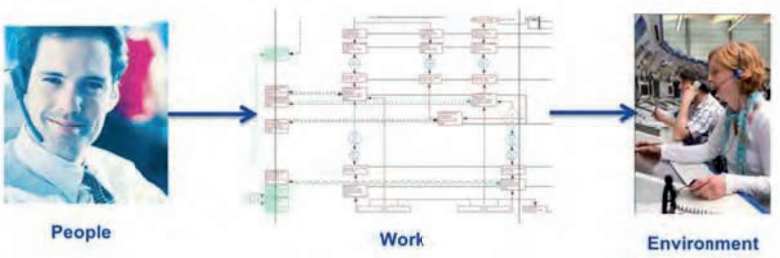


*Figure 1: The three aspects in a control room*

Hereby as already implied in term Human Factors the human plays the most important role, meaning the system should be designed in a way that it optimally supports the human, the user, in performing his tasks. It also means that it is required to involve the user when introducing or changing a system. Additionally an understanding of his work, his tasks is needed to achieve the optimal support. For safety critical control rooms one additional pre-requisite is that the safety remains at a high level and that measures undertaken to improve the performance have no negative impact on the level of safety.

In the following sections, this document goes into more detail on how to gain knowledge about the control room process, how to involve the user and how to combine those aspects to achieve a symbiosis between the human and the machine.

## GAINING KNOWLEDGE ABOUT THE CONTROL ROOM PROCESSES

### A common tool: Task Analysis

A common tool and a tool, already used in safety critical control rooms to gain knowledge about a process is a task analysis. A task analysis is used to identify:

- Human actors answering the questions:
  - Which actors are involved in the task?
  - How do they interact with each other?
  - What are the operational needs?
- Systems
  A task analysis allows identification of tasks performed by humans and machines
- Information flow
  A task analysis enables to identify the information flow necessary to complete a specific task

By the identification of those three aspects, a task analysis allows the elicitation of operational needs through the study of operational tasks, their context and the related interaction with the system. Considering the operational task, the context of the tasks and the related interactions is necessary to ensure an effective information presentation. In regard to performance an effective information presentation is a pre-requisite when intending to improve the control room performance as the user needs to easily identify the information necessary to fulfil his tasks. An effective information presentation minimizes or even eliminates search processes and thus saves time to complete the tasks.

In this regard, a task analysis represents a basis in a user centred design process and represents a starting point to achieve a good human-machine symbiosis. Human Factor aspects can be pointed out and taken care of during the following design process of the HMI as well as the during the system development itself. Still when thinking about improving the control room performance the outcome of the task analysis is limited as the process itself is not challenged.

## One step further: Value stream analysis/value stream design

To achieve improvements also in the process itself other tools than a task analysis are necessary. In other industries and especially in the automotive industry additional tools to optimize a production process are already well established [3]. One of these tools is the value stream analysis combined with an additional value stream mapping. Value stream analysis is a method to create a representation of the current status of a "production" including the material and information flow with the idea to visualize the flow of it throughout the whole process. It enables a holistic view on the processes in a control room with a focus on the produced value.

These tools could, with slight adaptations, also be used for safety critical control rooms. Although to apply these tools a different way of thinking than usually existing in safety critical control rooms today has to be introduced. Instead of just looking at safety and the avoidance of errors, the control room has to be seen similar to a production facility. The processes within the control room represent the target for the optimization.

This means also a safety critical control room is producing something. What the product is might be different for the various control rooms or even be different between actors in the same control room. Still with the intention of improving the performance of the control room the definition of the product suddenly adds a value to what is done in the control room. As this definition should also include key performance indicators to measure the "quality" of a product and the performance of the control room it makes control rooms and the work performed within a control room comparable.

The above-mentioned definition of the product already represents the first step the value stream analysis is based on [2]:

- The definition of the product and the customer

The customer is the other important aspect in this first step as the work is done for a specific goal requested by a customer. In the end the customer is the one paying for the service. So becoming clear of who the customers are and what their intentions are directly relates to the product definition and the following step in the value stream analysis. In this regard the other three major steps in a value stream analysis/mapping are:

- Definition of KPIs
- Performing the analysis
- Designing the new process based on the outcome of the analysis

So while the first step is about answering the question why am I doing this work by defining the customer and the product, the second step, the KPI definition represents the pre/requisite to be able to give a quality to the work done. A KPI definition with the customer's intention in mind makes the performance of the control room

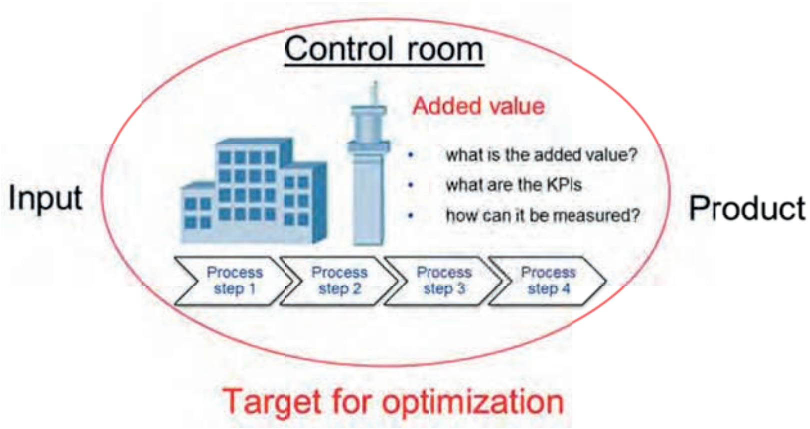


*Figure2: Value stream in safety critical control rooms*

measurable and comparable. Statements on how well the customer needs have been satisfied can be made. In addition measurable and comparable criteria are the basis to make statements about any kind of improvement. Defining KPIs answer questions like:

- How well am I doing it? What is the performance?

As with the product and the customer, the KPIs can vary between control rooms.

The analysis itself, the 3rd step in a value stream analysis/mapping covers aspects answering the question what exactly needs to be done and how am I doing it. The important point in this analysis is to break down the overall production process into sub-processes or tasks and to identify the tasks of the process that directly influence the defined product or in other words bring the added value. Value adding tasks herby are any tasks that have a positive effect on the defined product. Again the customer's perspective needs to be taken into account. He is the one who has ordered some kind of service. So the value adding sub-processes are the ones that are required to fulfil his request.

These process tasks need to be clearly separated from the business process, which is of course necessary, but does not change or enhance the product in any way. Typical tasks in this regard are for example tasks related to reporting. They are necessary for the control room but do not change the product in any way.

The separation of value adding and non-value adding processes and tasks opens the possibility to improve and concentrate on the tasks that are connected with the product. It opens up the possibility for increased automation of the non-value adding processes which might relieve the user so he may better perform on the value adding tasks, directly influencing the overall control room performance.

The last step in the value stream analysis/mapping is using this differentiation of value adding and non-value adding processes/tasks to optimize the overall process. The measurement of the defined KPIs after the design of the new process shows the achieved improvement, gives feedback on the effectiveness of the made changes and thus is a new starting point for the next cycle. So a continuous improvement process is established.

Now coming back to a user-centred design process performing these two types of analysis cover the first two key design activities of a user centred design process as defined in the ISO 9241-210 [4], which are:

1. **Understand and specify the context of use** (including users, tasks, environments). Identify the people who will use the product, what they will use it for, and under which conditions they will use it.

2. **Specify the user requirements in sufficient detail to drive the design**
Identify any business requirements or user goals that have to be met for the product to be successful. Especially the outcome of the value stream methods allows much more specific statements in this regard and thus enables specifying requirements much more focused to the goals of a successful product.

So in addition to the improvement of the performance that can be achieved also the user-centred design process, a pre-requisite for a good human-machine symbiosis is covered. The other two key design activities in a user centred process are:

3. **Produce design solutions that meet these requirements**
This part of the process may be done in stages, building from a rough concept to a complete design.

4. **Conduct user-centred evaluations of these design solutions and modify the design taking account of the results**
The most important part of this process is that evaluation - ideally through usability testing with actual users - is as integral as quality testing is to good software development.

These two key elements are more related to the human machine symbiosis, which represents the other side to be looked at when thinking about control room performance.

## THE HUMAN–MACHINE SYMBIOSIS

As already stated in the beginning the human plays the most important role in this symbiosis. The system is just a support tool for the user to perform his work efficiently. This means it has to be adapted to the needs of the user. So as shown in the following picture the user stands in the centre in this approach. This means the tools intended to support him/her in is work have to be adapted to the needs of the user. The supporting tools in a control room can be summarized in the working position, which consists of a variety of functionalities. The working position is what the controller works with every day. Therefore, when the human represents the one side of the symbiosis the working position represents the other, the technical, side.


*Figure 3: The human in the centre of the human-machine symbiosis*

This already shows that the user has to be involved in the design of new systems. He is the one who has to work with it on a daily basis and the one who knows best about the tasks that need to be done. He has probably also identified the most efficient and possible way with the available support given by the system. It also means that any changes in the system affect the user in some way. This in the end can lead to resistance towards the introduction of new functionalities, another reason why involving the user in the design process is required.

During the design of the solution, which would be the third key activity in a user centred design as stated in the ISO 9241-210, a way to come to good solution and to involve the user is the production of several kinds of prototypes. With prototypes, the potential improvement measures coming from the performed analysis can be easily tested and discussed with end users. It allows further optimization by integrating additional inputs from end users. Dependent on what needs to be discussed different levels of prototypes can be built. Those levels reach from simple paper prototypes to highly sophisticated ones close to the real product. While paper prototypes might be used for early discussions of a concept, the highly sophisticated ones enable the testing of the HMI interfaces to other systems and workflows within the intended environment.

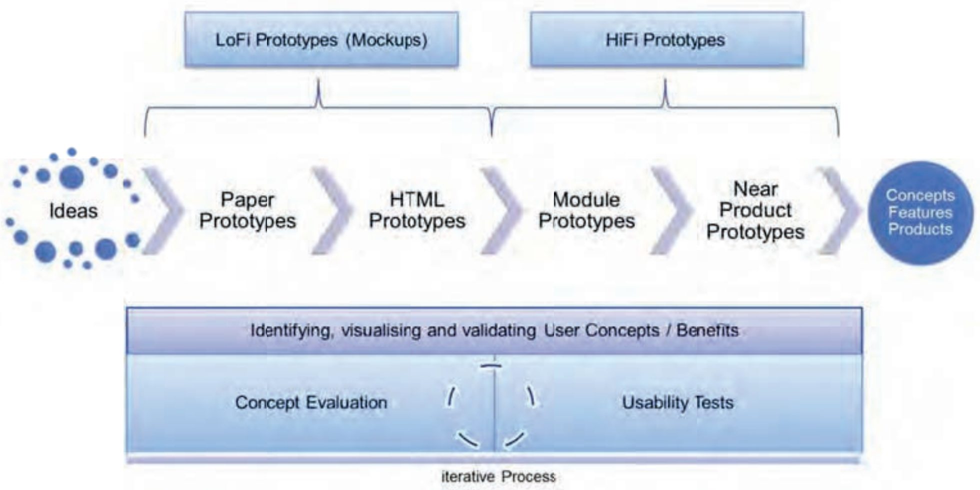


*Figure 4: Different levels of prototypes during a design process*

As shown in **figure 4** the prototyping is already part of the concept evaluation, marking the fourth key element from the ISO 9210-210. It goes hand in hand with usability test and user experience evaluations.

As previously mentioned the system should be adapted for optimal support of the user in his daily work. Usability test or user experience evaluations are a good way to identify weak points and get direct feedback from the user. Usability testing aims at the following topics:

- Help discover the real needs and tasks of the user early in the design process
- Balance graphic design with functionality
- Provide tangible evidence for design recommendations
- Reduce costs by anticipating and eliminating potential user roadblocks
- Show significant cost savings through user productivity
- Decrease user acclimation time and errors
- Increased user productivity

Apart from this, it also keeps the user in the loop, involves him in the change process or the introduction of new system and thus is a way to lower possible resistance towards the change or the new system as the user is directly involved and his feedback is taken into account.

User experience evaluation goes even one step further [8]. In contrast to usability, the term user experience refers to aspects beyond pragmatic quality. User experience evaluation is a research technique to assess the user experience of a product using reliable questionnaires filled by real users after a usability test.

During a user experience evaluation not only the usability of a product, based on fulfilment of tasks is important, but also the whole experience of the user expressed in:

- Feelings and needs
- Personal experience of the interaction
- Perception of our products

The following **figure 5** from the nnGroup Conference Amsterdam, User Experience 2008 [5] shows the additional topics that are added when thinking about the user experience.

While usability stops at people being able to use it, user experience also adds the desirability to the product, bringing in design aspects to the look and feel. In terms of the well-being of the user, these are important aspects. Especially in today's world where everyone is used to graphical interfaces from mobile devices and computer programs the users do expect their working position to also have a modern look. Comparisons to the known user interfaces are made. You can expect that when people like the interface look and feel also the performance will be affected as the work with something you like is more enjoyable. Thus in this sense the desirability and the design of the HMI play their part in the human-machine symbiosis.

- ➢ Will orientation guidance be seen?
- ➢ Are there any disturbing elements

The advantage hereby is that statements to these aspects can be made based on objective data measured during a usability test or user experience evaluation. **Table 1** on the next page shows the data that could be measured and explains for what kind of statements it can be used [6].

In addition to this eye tracking can also easily be used to identify differences between various groups. So while usability testing and user

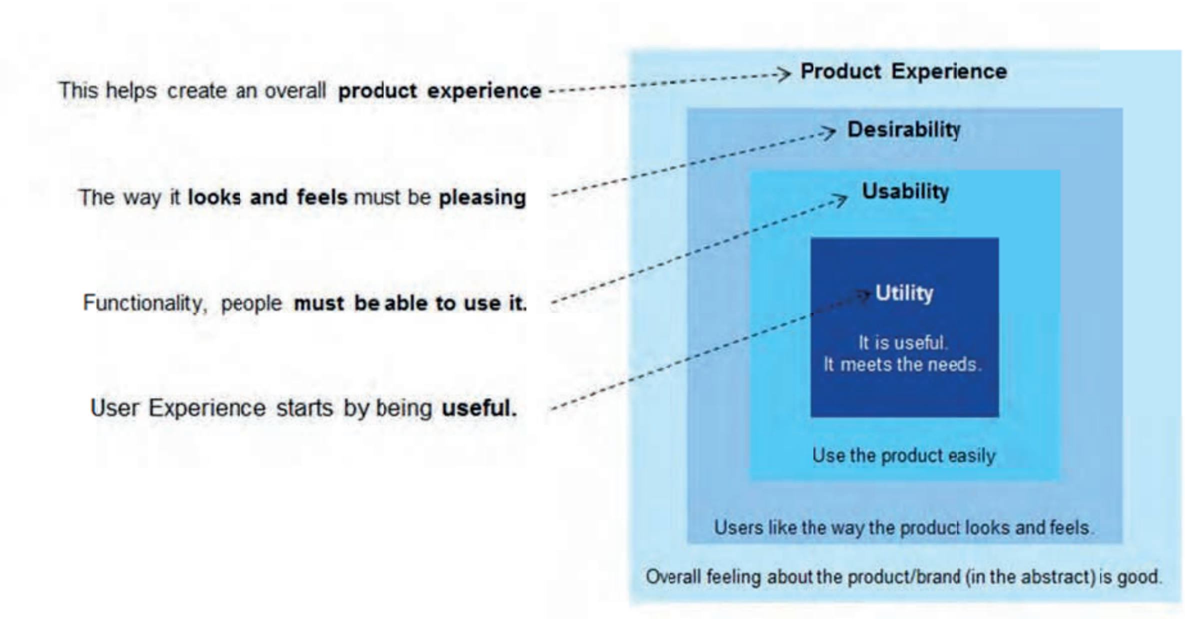


*Figure5: Different aspects of user experience (Source: User Experience 2008, nnGroup Conference Amsterdam)*

While usability tests or user experience evaluations done via observations and/or questionnaires bring mainly subjective results the additional use of systems like an eye tracking system also enables gathering objective data about the system under test. Typical aspects that can be covered with the usage of an eye tracking system are:

- Which elements immediately attract the user‘s attention?
- Do elements exist that deviate from important elements?
- Which elements call the user‘s interest during the process?
- How does the user orient himself on the application?
- Which elements are seen when completing a task?
  - ➢ Are important elements seen?

experience evaluations reveal mostly the outcome of the interaction and answer practical question the usage of eye tracking systems reveals factors that contribute to that outcome by providing a more detailed analysis. In this sense the tests provide the context and the eye tracking enables to gather information for a better understanding and illustration. So when both tools are combined the improvement of the human machine symbiosis is based on objective and subjective inputs.

Summarized it can be said that with the mentioned aspects taken into account, the two main topics to achieve a good performance are already covered. The process is stream-lined and the human-machine symbiosis is optimized. Additional optimization potential for the future is based in decision support tools aiming at supporting the user to optimize decisions.

| ***Quantitive Measures*** | ***Meaning*** |
|---|---|
| # of fixations on area | Informativeness of an area / user interest in the area |
| Fixation length | Info clarity / info density / info processing demands |
| Time to 1st target fixation | Layout effectiveness / search demands |
| Scanpath complexity | Layout effectiveness / search demands |
| % users fixating on an area | Prominence / perceived importance of an area |

*Table 1: Eye tracking measurements*

## THE NEXT STEP: ANALYSING DECISION POINTS

Decisions influence the overall performance. Often decisions are made without knowing the influence on the overall production process. This although is not intended but due to the limited knowledge of the user on the overall process. Usually the user only sees the parts production of the process he is responsible for with only little or none information about the requirements of the following process steps. So the user has no or only little information if a decision has negative or positive impacts on future process steps. Building a tool to support the user in making decisions by considering the whole process would be the next step.

This also requires a different understanding of the decision making process. Instead of being right or wrong, each decision will be assigned with a certain value. This value represents the quality of the decision in regard to the overall control room performance. A tool simulating this process before a decision is made would be very helpful for the controller. An optimal tool could learn from previous situations so the quality of a decision is enhanced in similar situations in the future. Currently decisions could only be analysed afterwards. Although this could also have learning effects for similar situations and can be integrated into training programs it does not represent a support tool for decisions made within the daily work.

## SUMMARY

The SESAR long-term research project ZeFMaP, Zero Failure Management at maximum productivity for safety critical control rooms

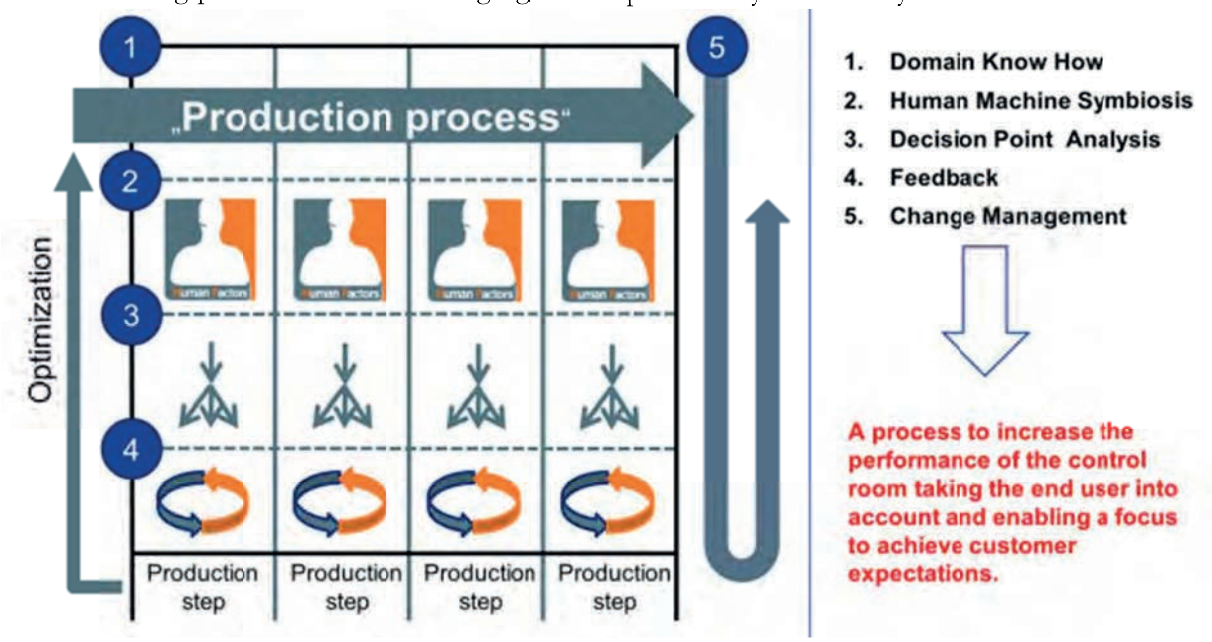


*Figure 6: ZeFMaP process*

combined the aspects described in this document into a process consisting of four steps that cover the production process, the human machine symbiosis plus the analysis of decisions [7].

Although the project environment was set up in another area of safety critical control rooms the project goal was similar. It was investigated if and how process improvement methods and tools coming from other domains can be used in the context of safety critical control rooms. So the results could certainly be transferred to the maritime sector. For the selected environment of the project, a tower control room, the results indicate that the four step productivity improvement process as shown in **figure 6** with associated methods and tools coming from other domains can help improve productivity in the context of tower control rooms. In two experiments and by using a holistic approach for the decision point analysis an increase in the performance was observed. For the defined KPIs average taxi time and punctuality the improvement has been:

- Decrease in average taxi time is between 33% and 36%
- Punctuality improves with 57% to 67%.

This proves that the approach is of value for safety critical control rooms. It now has to be applied to maritime control rooms by selecting KPIs to measure the performance and follow the described steps.

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## 72 REDUCING OPERATOR WORKLOAD AND STRESS THROUGH CO-OPERATIVE HUMAN-MACHINE SYSTEMS

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This paper about operator stress explores the relationship of stress to workload, stress management strategies, and how cooperative human-machine systems can reduce stress. The solutions offered in this paper are the result of work conducted by the maritime group of "Designing Dynamic Distributed Cooperative Human-Machine Systems" (D3CoS), a research project funded by ARTEMIS Joint Undertaking. This paper describes the VTS Trials, which are experiments conducted as part of the D3CoS project that sought to establish a relationship between workload and stress level. The paper concludes with a description of a prototype cooperative human-machine system developed by the maritime group that shares data between shore-based and ship-based systems. The goal of the system is to reduce operator task load and thus operator stress.

This paper addresses operator workload and stress, and the possibility of reducing both through the use of cooperative human-machine systems. The topic alone might raise several questions, such as "Why reduce operator workload?", "Why reduce stress?", "Is operator workload and stress connected, and if so, how?" and "What exactly is a cooperative human-machine system?" I will address the last question first.

Esta ponencia sobre el estrés del operador examina la relación entre el estrés y la carga de trabajo, las estrategias de gestión del estrés y cómo pueden reducir el estrés los sistemas cooperativos hombre-máquina. Las soluciones ofrecidas en esta ponencia son el resultado del trabajo realizado por el grupo marítimo de «Designing Dynamic Distributed Cooperative Human-Machine Systems» (D3CoS), un proyecto de investigación financiado por ARTEMIS Joint Undertaking. Esta ponencia describe los ensayos VTS, que son experimentos realizados como parte del proyecto D3CoS que busca establecer una relación entre la carga de trabajo y el nivel de estrés. La ponencia concluye con la descripción de un prototipo de sistema cooperativo hombre-máquina desarrollado por el grupo marítimo que comparte datos entre sistemas basados en tierra y basados en barco. El objetivo del sistema es reducir la carga de trabajo del operador y, por lo tanto, su estrés.

Esta ponencia analiza la carga de trabajo y el estrés del operador, y la posibilidad de reducir ambos mediante el uso de sistemas cooperativos hombre-máquina. El tema en sí mismo puede suscitar algunas preguntas como: «¿Por qué reducir la carga de trabajo del operador?», «¿Por qué reducir el estrés? », «¿Está relacionada la carga de trabajo del operador y el estrés, y si es así, cómo? » y «¿Qué es exactamente un sistema cooperativo hombre-máquina? ». En primer lugar abordaré la última pregunta.

*Ce rapport, sur le stress des opérateurs, explore la relation entre stress et charge de travail, les stratégies de gestion du stress, et comment des systèmes homme-machine coopérants peuvent réduire le stress. Les solutions proposées ici sont le résultat d'un groupe de travail maritime « Designing Dynamic Distributed Cooperative Human-Machine Systems » - D3CoS – projet de recherche financé par « ARTEMIS Joint Undertaking ». Le rapport décrit les essais en VTS, prévus par le projet D3CoS, qui tendent à établir une relation entre charge de travail et niveau de stress. Il conclut par la description d'un prototype de système homme-machine développé par le groupe maritime, qui partage les données entre systèmes à terre et systèmes à bord. Le but du système est de réduire la charge de travail de l'opérateur, et donc son stress.*

*Ce rapport traite de la charge de travail et du stress de l'opérateur et des possibilités de les réduire en utilisant des systèmes home-machine coopérants. Ce seul sujet pourrait poser plusieurs questions comme : « Pourquoi réduire la charge de travail de l'opérateur ? », « Pourquoi réduire le stress ? », « Y a-t-il un lien entre charge de travail et stress , et si oui, lequel ? » et « Qu'est-ce exactement qu'un système homme-machine coopérant ? » . Je traiterai en premier la dernière question.*

# Reducing operator workload and stress through co-operative human-machine systems

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This paper addresses operator workload and stress, and the possibility of reducing both through the use of cooperative human-machine systems. The topic alone might raise several questions, such as "Why reduce operator workload?", "Why reduce stress?", "Is operator workload and stress connected, and if so, how?" and "What exactly is a cooperative human-machine system?" I will address the last question first.

## WHAT IS A COOPERATIVE HUMAN–MACHINE SYSTEM?

This topic came to my attention through participation in an Artemis/EU-funded research project called Designing Dynamic Distributed Cooperative Human-Machine Systems or D3CoS. The D3CoS project concludes at the end of 2013 and will go through final review in March 2014. The goal of the project was to create methods, tools, and techniques for developing distributed, cooperative, human-machine systems that will reduce development cost and time. The project asked questions like "How can machines cooperate with users during stressful and high workload situations that will result in higher safety?" and "What tasks can a system take on to ease the burden on operators?"

The D3CoS project included three transportation groups: Aviation, Automotive, and Maritime. Cooperative human-machine demonstrators were developed in each group. The automotive group, for example, developed a lane change demonstrator, with systems onboard two vehicles cooperating to facilitate safe and smooth traffic merging. The maritime group developed a means of sharing data between a shore-based VTS system and a ship-based system – a portable pilot unit (PPU). All demonstrators have a certain degree of automation. The maritime demonstrator, for example, sends vessel conflict data and weather data from the VTS to the PPU without VTS operator involvement.

What is a cooperative human-machine system? A cooperative human-machine system is a technology solution that facilitates communication between two or more separate systems and involves some level of automation.

## WHY REDUCE OPERATOR WORKLOAD?

In some VTS areas, operators experience what is called "underload" in their work, meaning there are periods of inactivity that can lead to boredom and distraction. In these areas, perhaps organizations are not looking for ways to reduce workload but rather to increase it. Other VTS areas, however, are remarkably busy. Singapore, Rotterdam, Hong Kong, Dover Straits are examples of remarkably busy areas. Still other VTS centres are expanding their area of responsibility, which will increase operator workload, while not increasing staffing levels. The issue of reducing operator workload. But for those individuals who work in or whose organization is responsible for either a very busy area or a very large area, managing operator workload is important. Operators need to be alert in order to identify and respond to critical situations. If they are overloaded with tasks – no matter how appropriate to their responsibilities – they might not be alerted to critical situations that require their attention.

## WHY REDUCE STRESS?

Not all stress is bad. If one is stress-free, after all, one is dead. In the short term, being stressed can make one more alert and trigger a fight-or-flight response. Stress in an emergency situation, therefore, can be a positive thing. Too much stress, however, both in the short term and in the long term, can potentially lead to several negative consequences. In the short term, when stress has accumulated over a period, it can lead to headaches, bursts of anger, physical pain or discomfort, poor judgment, fuzzy thinking, and loss of precise motor skills. In the long term, stress can lead to a number of illnesses, including depression, anxiety, heart attack and stroke. The well-understood consensus is that experiencing stress in appropriately engaging situations is necessary and good, but if stress persists over a long period, the effects are overwhelmingly negative. Stress levels, therefore, should be managed and relieved in VTS operators.

The need to reduce stress and the effects of stress in operators are well-known. It is why operators rotate positions in the Dover Channel Navigation Information Service. It is why the Maritime Port Authority of Singapore hands over operations to another operator every 45 minutes for their busiest VTS areas. It is why V-103/1 Module 7 teaches VTS operators about the causes of stress and how to manage it.

## IS OPERATOR WORKLOAD AND STRESS CONNECTED, AND IF SO, HOW?

The final question concerning the connection between operator workload and stress is the most difficult to answer. When I started researching and discussing this topic, I discovered some skepticism about the role workload plays in stress. Some people pointed to the composition of traffic as a stressing factor. The berthing of a supertanker is more stressful than the berthing of a small container vessel, one harbor master noted. Others pointed to task type, not task load. A collision in one's area of responsibility creates more stress than multiple VHF requests for weather data, for example. Is workload an important factor to consider when looking at operator stress?

The D3CoS project asked this question, too. The project sought to understand the role workload plays in an operator's stress. One of the project members, the University of Modena and Reggio Emilia in Italy, provided a method to measure this. We used this method in the VTS Trials.

## WHAT ARE THE VTS TRIALS?

The VTS Trials were part of the D3CoS project. These trials consisted of a simulated VTS control task. In the first round of trials, two experienced maritime operators acted as the VTS operators. They were instructed to control a specific area and execute realistic tasks. Relevant information about the situation was given prior to the simulation. Specific physical responses were measured by connecting the operators to monitoring equipment. Operators also finished a post-testing questionnaire and were debriefed. In order to analyze the trial results, it was also necessary to use both video and audio recording of the simulation.

Operators completed four scenarios for the VTS Trials, each scenario increasing in workload, from an under load scenario, progressing to an overload scenario. Operators were asked to take ship reports by VHF while managing a traffic separation scheme with crossing ferry traffic as well as a precautionary area. Each scenario lasted 10 minutes.

In the trial, three types of measures were recorded that are linked to the workload that a person experiences while performing a task. The goal was to discover what are the best indicators of workload level. These measures were examined:

- The performance outcomes (e.g., goals achievement, errors, response times, accuracy, etc.),
- The effort and load experienced by the operator by means of some self-rated questionnaires and a brief interview,
- Psycho-physiological parameters that are related to effort and workload, such as heart rate, blood pressure, transpiration (assessed by the changes in the electrical conductivity of the skin), eye blinks and pupil diameter. Previous research has shown that these processes changes when a person is required to exert more effort or has to perform a task of elevated difficulty.

For the VTS Trials, the following procedure was followed for each operator:

- Prior to testing, the researcher connected test equipment to the subject (eye-tracker, electrocardiogram sensors, plethysmograph, electrodermal activity recorders images),
- The researcher gave instructions relative to the questionnaires that the subjects would complete after the mission to rate the workload and the mental effort experienced (NASA_Taskload Index and RSME-Rating Scale of Mental Effort),
- The subjects were briefed on the control task,
- The simulation trial lasted about 40 min. (divided into four 10-minute segments)

The conclusion by Sergio Fonda and other the researchers at the University of Modena and Reggio Emilia was that these first experiments were useful to assess and test the instrumentation hardware, the software algorithms and the experimental protocol. The trials also demonstrated promise that stress levels, as indicated by physiological parameters and confirmed by self-assessment questionnaires, can be linked to workload.

The **figures 1 & 2** below show the analyzed data for one of the operators as a preliminary result.

In layman's terms, when task load increased, so did the measurements that indicate stress.

Also noteworthy is an observation of the simulations. As workload increased, the area of the operator's attention became increasingly narrow. This resulted in each operator missing dangerous situations, and in one case, a collision.

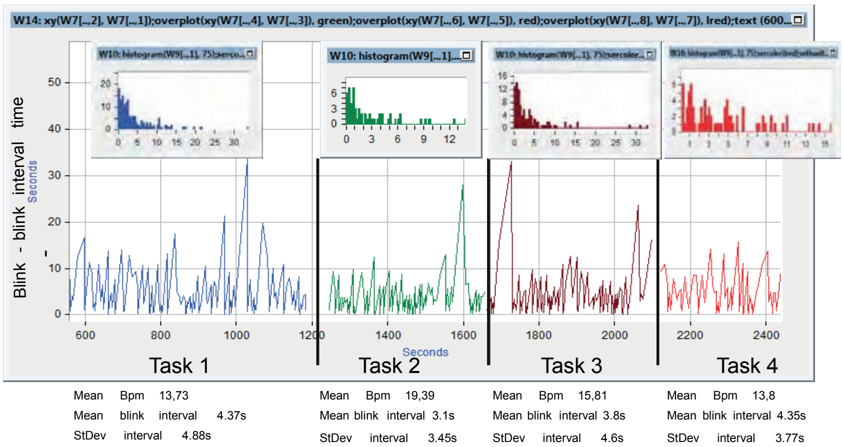


*Figure: 1 Blinking activity into the 4 taskload phases – Blink per minute and Blink-blink interval*

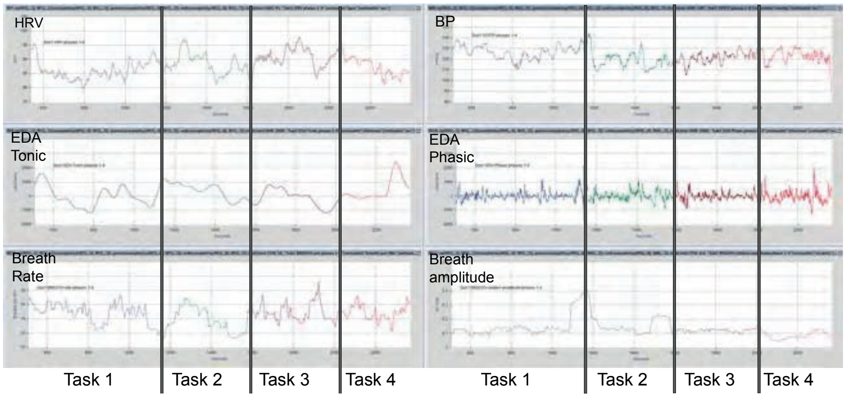


*Figure: 2 HRV - Blood Pressure – EDA – BREATH, during the 4 taskload phases*

A second round of VTS Trials with operators from the Norwegian Coastal Administration is scheduled for December 2013. The results of these trials will be included in the presentation at the 18th IALA Conference.

## REDUCING STRESS IN OPERATORS

In V-103 training, operators are taught several techniques to reduce operator stress. Depending on the V-103 instructor, stress management theory might include relaxation techniques (meditation, breathing deeply, massage, laughing, and listening to music, as well as physical exercise), reflection on the sources of stress, examining how one currently copes, and adopting healthy coping strategies. Then there are stress avoidance techniques, such as altering the stressful situation and accepting the things you can't change.

Since I work for a VTS technology provider, my interest and contribution to stress management is in how technology can help reduce operator stress. Technology already offers several possibilities to help operators manage and reduce stress. Some are better than others.

## RELAXATION

If we consider only relaxation techniques as the way to reduce stress, the technology solution for VTS operator stress reduction might look like **figure 3**.

The VTS Operator Massage Chair is fantasy, of course, but we should note that ergonomics DOES have a role to play in managing operator stress. A considerable amount of research has been done over the past decades showing a strong link between ergonomics and stress, and that proper ergonomic design can reduce stress.

Consider the design in the operations center in **figure 4**.

Now consider that many operators sit in a chair like the one shown in **figure 5**.

If we consider only the chair that an operator sits in, I can't help but wonder if we VTS technology solution providers are offering VTS service providers the best possible options.

Whether it's a massage chair or the most ergonomically advanced office chair, both can help to relieve operator stress. However, neither chair does anything to change the stressful situation.

*Figure: 3 VTS Operator Massage Chair with RADAR display and touchscreen communications suite*

*Figure. 4 VTS Operations Center concept*

*Figure 5: Office chair*

understood and addressed, and a human solution is employed. But what about the VTS centres where only one or two operators are on duty at a time? How can technology assist both small and large centres to reduce operator stress?

## THE STRESSFUL SITUATION

Many operators are responsible for areas with high traffic volume, and many operators are required to be responsible for increasingly larger areas, often without an increase in staff. The types of tasks operators are asked to perform is likely to increase as well. With integrated databases and port community systems, operators may, and in some cases already are taking on responsibilities that were once allocated to office staff, such as booking port services, scheduling resources, and even invoicing.

Managing stress and stressful situations might actually be easier in a place like Dover CNIS or the Singapore Port Operations Control Centre, where a large number of operators are on duty, and they can rotate sectors and responsibilities in order to spread out the workload and stress. In such busy centres, the need to manage stress is already

## HOW COOPERATIVE HUMAN-MACHINE SYSTEMS CAN HELP

The D3CoS project explored how, during stressful times, the machine can cooperate with the human operator and assume specific, appropriate functions in order to allow the operator to focus on the most critical situation. In keeping with this theory, the maritime group in D3CoS, composed of British Maritime Technologies (BMT), Marimatech, and Kongsberg Norcontrol IT, developed a vessel path planner.

The vessel path planner is composed of an Active VTS system (supplied by Kongsberg), a path planning server (developed by BMT), and a Marimatech portable pilot unit (PPU). These three systems/machines work together in the following way:


*Figure 6: D3CoS Path Planner*

- The pilot onboard a vessel requests a path from the VTS centre
- The VTSO draws a path for the vessel on the VTS system chart.
- The path planner receives the path and validates it based on chart data
- If valid, the path planner sends it to the PPU
- The PPU displays the path and continuously sends the position of the PPU to the VTS.
- The VTS fetches forecast and current weather data for the path, which the pilot can access at any time directly from the PPU by tapping on that part of the path.
- Any warnings or conflicts detected by the VTS along the path, such as potential collisions, are immediately sent to the PPU.

Once the path is established and validated, the rest is automated. The VTS operator isn't required to find and report weather data to the pilot, and should the VTS operator become engaged in a critical situation, any warnings relevant to the pilot are automatically communicated. Workload is reduced, and with a reduction in workload, stress is likely reduced.

One might question whether or not the machine should communicate warnings, especially about something as critical as a collision. In an ideal situation, the operator would of course detect and notify a vessel of a probable impending collision. Not all situations are ideal, however. In some areas, monitoring for collision is problematic due to high traffic density and/or complexity. At certain times or situations, the operator could be overwhelmed with warnings from the VTS system. In these cases, an automated notification to the PPU is preferable to none at all.

This cooperative human-machine system is a beginning. It is a prototype, and more research and development is needed to understand precisely what situations or criteria create high levels of operator stress. When we better understand the complete picture, we can design human-machine systems that will detect those stressful situations and/or criteria and then assume specific, appropriate operations. By relieving the operator of specific routine tasks, while ensuring critical information is shared with ship-borne systems, operators can focus on critical situations as they arise. We believe that this sort of cooperative human-machine system is a step forward in reducing some of the stress operators experience.

## 93 ENHANCING VTMIS DATA MANAGEMENT WITH SERVICE ORIENTED ARCHITECTURE (SOA) - CASE STUDY: FTA'S VESSEL TRAFFIC MANAGEMENT SYSTEMS

*Kaisu Heikonen. Finnish Transport Agency, Finland*

Turning navigational and other maritime information into machine-readable digital form will open up new possibilities for using information both on board and ashore. The exchange of digital information is expected to increase not only between ship and shore but also between different shore-based actors. In the future it will be necessary to effectively connect a large number of shore-based information providers and consumers representing different areas of responsibilities and originating from an expanding geographical area. What has widely been seen and recognized as a suitable way to create an efficient environment for the required information exchange is the use of service-oriented architecture (SOA). The Finnish Transport Agency also sees this as the most effective way to meet the future demands for information exchange. However, we also expect to face some challenges before the technical systems can be expected to fully support the visions in practice.

La conversión de la información de navegación y marítima a un formato digital legible por máquina abrirá nuevas posibilidades de uso de la información tanto en tierra como a bordo. Se espera un aumento del intercambio de información digital no solo entre el barco y tierra sino también entre los diferentes actores con base en tierra. En el futuro será necesario conectar de manera efectiva un gran número de proveedores de información en tierra y consumidores representantes de diferentes zonas de responsabilidad que procederán de distintas zonas geográficas que irán en aumento. Lo que se ha visto y reconocido ampliamente como una forma adecuada de crear un entorno eficiente para el intercambio necesario de información es el uso de una arquitectura orientada al servicio (SOA). La Agencia del Transporte Finlandesa también ve esto como la forma más eficaz de satisfacer las demandas futuras de intercambio de información. No obstante, también esperamos afrontar algunos desafíos antes de que los sistemas técnicos den soporte total a las visiones en la práctica.

*Donner à l'information de navigation et aux autres informations maritimes une forme numérique lisible à la machine ouvrira de nouvelles possibilités à l'utilisation de l'information à la fois à bord et à terre. On attend un accroissement de l'échange d'information numérique, non seulement entre le navire et la terre mais aussi entre différents acteurs terrestres. Dans l'avenir, il sera nécessaire de connecter efficacement un grand nombre de fournisseurs et de consommateurs terrestres d'information, représentant divers domaines de responsabilités et originaires de zones géographiques allant en s'élargissant. Ce qui a été largement identifié et reconnu comme un moyen approprié de créer l'environnement idéal pour l'échange d'information requis, est l'utilisation d'une architecture orientée service (SOA). L'Agence des transports finlandaise la voit également comme moyen le plus efficace de répondre aux exigences futures en matière d'échange d'information. Cependant, nous nous attendons aussi à devoir relever quelques défis avant que les systèmes techniques puissent, dans la pratique, apporter leur pleine contribution à ces projections.*

# Enhancing VTMIS data management with Service-oriented architecture (SOA) – Case study: FTA's Vessel Traffic Management Systems

Kaisu Heikonen

Finnish Transport Agency

IALA·2014·AISM

XVIII Conference · A Coruña · Spain

## BACKGROUND

The coastal states worldwide have the responsibility and interest to secure and enhance the safety of navigation in their waters. They are putting every effort into preventing maritime accidents that would cause pollution, loss of life and/or structural damage in their responsibility area. For this purpose, coastal states provide aids to navigation and information services which directly support the safe and efficient navigation of individual vessels, and also monitor the vessel traffic in coastal, congested and harbour areas. In Finland it is the responsibility of the Finnish Transport Agency (FTA) to control and develop aids to navigation and traffic management in the waterways, to ensure winter navigation as well as a well-functioning transport system also under abnormal conditions and in exceptional situations under normal conditions.

## CHANGES IN OUR OPERATIONAL ENVIRONMENT AND OUR FUTURE OPERATIONAL GOALS

The development of e-Navigation is gradually bringing traditional navigation based on visual observation and vocal communication into the digital age. New communication and sensor systems produce increasing amounts of accurate real-time information in digital format for both ship borne and shore-based users. When all available data is turned into series of zeroes and ones in digital form, this opens up endless possibilities to exchange, enhance, integrate, process, analyse and portray information with the help of computers. But this also requires a tremendous amount of preparatory work. Unlike in communication between humans where there is always some room for inaccuracy and interpretations, the direct machine-to-machine communication requires unambiguous definitions and rules. The IMO has taken the leading role in this huge effort to harmonise and standardise the maritime information exchange and it has already given us some concrete issues to work with (such as the Maritime Service Portfolios, MSP [1]). IMO's e-Navigation work is expected to provide some new globally harmonized information services and some upgrading of the already existing ones will probably be required. The implementation of MSP's will be one of the main factors enhancing our future system development.

IMO's e-Navigation work is mainly focused on communication between ships and between ship and shore. There is however an equally strong demand for harmonised information exchanges between shore-based actors. Increased shore-to-shore information exchange is also expected to have many positive effects on the safety of navigation and the efficiency of maritime transport. Some of these will be explained in the following sections.

### Reducing the administrative burden

It is known that the majority of maritime accidents are caused by the so called human factor. One efficient way to support the navigator and mitigate the risk of human errors is to reduce the mandatory reporting required during the voyage. In practice this would for example mean that the vessel only contacts one authority or coastal state during the planned voyage to make all the required mandatory reporting. Information would then be distributed automatically to all other relevant authorities along the route of the vessel. This single window concept would enable the navigator to shift his/her attention from administrative duties to tasks more related to the safety of navigation. It would also benefit authorities who could access extensive vessel data from one source and at the same time reduce and share the administrative costs related to receiving the reports. However, this requires increased shore-based ability to seamlessly exchange information between all the authorities involved both nationally (cross-sector) and between different countries (cross-border).

In Europe, the single window concept will in fact become mandatory under Directive 2010/65/EU (on reporting formalities for ships arriving in and/or departing from ports of the Member states) [2]. This Directive requires that during 2015 all European Union Member States shall set up a national single window system, which will be linked to SafeSeaNet, e-Customs and other existing European wide electronic reporting and information exchange systems enabling the vessels to make all different required notifications and reports in one place and only once. The reporting formalities (and data) referred to in the Directive are:

- Reporting formalities resulting from legal acts of the European Union:

- Notification for ships arriving in and departing from ports of the Member States (Directive 2002/59/EC, Article 4)
- Border checks on persons (Regulation (EC) No 562/2006, Article 7)
- Notification of dangerous or polluting goods carried on board (Directive 2002/59/EC, Article 13)
- Notification of waste and residues (Directive 2002/59/EC, Article 6)
- Notification of security information (Regulation (EC) No 725/2004, Article 6)
- Entry summary declaration, customs code (Council Regulation (EEC) No 2913/92, Article 36a and Regulation (EC) No 450/2008, Article 87)

- FAL forms and formalities resulting from international legal instruments
  - FAL form 1, General Declaration
  - FAL form 2, Cargo Declaration
  - FAL form 3, Ship's Stores Declaration
  - FAL form 4, Crew's Effects Declaration
  - FAL form 5, Crew List
  - FAL form 6, Passenger List
  - FAL form 7, Dangerous Goods
  - Maritime Declaration of Health
- Any relevant national legislation

The development of supporting EU-level technical standards and data models is currently under way. It is expected that a European standard and related data models for exchanging the above mentioned information and data will be available in due time.

## Implementing proactive traffic monitoring

Our long-term goal is to change the observer role of vessel traffic monitoring toward more active participation. In the future we envision focusing more and more on identifying developing risk situations in advance. We hope to be able to intervene at a very early stage when there is still time to make corrective actions and hopefully in that way prevent accidents. At the same time we are facing the challenges with reduced availability of human resources due to the general need to cut down the administrative costs of the government. Developing automatic risk identification functions would help us to reach both of these goals. The shore-based proactive traffic monitoring and supporting automatic risk identification requires enhanced situational awareness where data from various information sources is continuously integrated and analysed. To be able to timely identify developing risk situations it is not enough just to monitor the real-time traffic picture. The current situation has to be dynamically monitored against the past and the simulated future traffic flows and patterns to find anomalies. Individual vessels can also be assigned with risk levels based on the characteristics of the vessel, prevailing environmental conditions, cargo and other factors listed in **figure 1** [3]. This would help the operators monitoring the traffic to focus their attention on those vessels which are most likely to be involved in accidents with most severe consequences.

Automatic proactive risk identification requires information from various real-time and historical

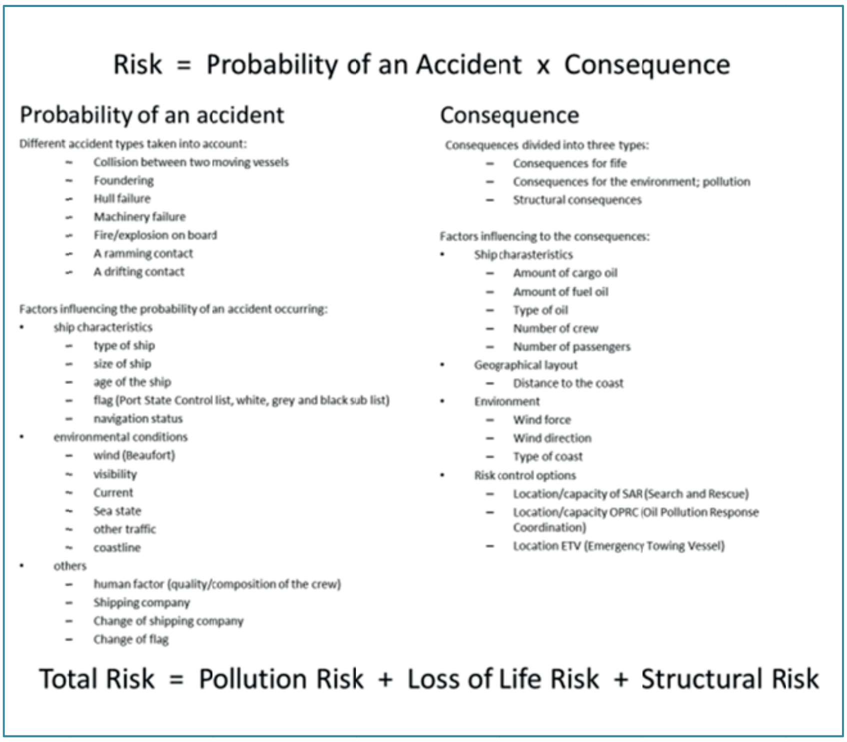


*Figure 1. Factors affecting the risk level of individual vessel (source: MarNIS project [3])*

data sources and registers that at least in our case are maintained by many different authorities. Thus, also in this case increased exchange of information related to vessels, cargo, crew, environmental observations etc. is needed between authorities both nationally (cross-sector) and internationally (cross-border).

### Increasing efficiency of transportation

In most cases maritime transport is only one (although very important) part of the total transport chain. The cargo is transported by wheels (either by road or railway) before and after it is carried by ship. The transfer of the cargo between different transport modes in terminals should be made as smooth as possible since the waiting time for any means of transportation (vessel, lorry or train) is expensive. Information related to the cargo of the vessel and its movements should be effectively exchanged between the different actors involved in the journey of the cargo to enable optimal logistics planning and to avoid unnecessary waiting time.

This goal is very important for FTA because we are responsible not only for maritime transportation, but also for providing efficient road and railway connections for the citizens and industry in our country.

### Sharing surveillance information

At least in Europe there are strong initiatives towards securing the efficient and sustainable use of our seas by increased co-operation between maritime authorities. The sea is seen as a valuable source of energy, food and chemicals as well as an important transport lane and recreational area. There are also a large number of authorities outside the maritime safety sector, which monitor and secure the different activities in sea areas. These include the customs, border control, fisheries, environmental agencies, and the general law enforcement and defence community. All of these will be taking part in the envisioned future maritime cross-sector and cross-border information exchange. The initiative for creating a platform for efficient exchange of maritime surveillance information between European authorities is called Common Information Sharing Environment (CISE) [4]. Its two main goals are to increase the cost-effectiveness of maritime surveillance operations and to support sustainable growth. There are about 400 authorities that would be either providing or receiving information to/from CISE or doing both. The work to define the information services and the related data models that would be used in this European information exchange environment is currently under way and it is expected that in few years a set of standards will be available. The first services defined are called entity services and they are meant to carry very basic information related to vessels, cargo, people and their locations and movements (**figure 2** [5]).

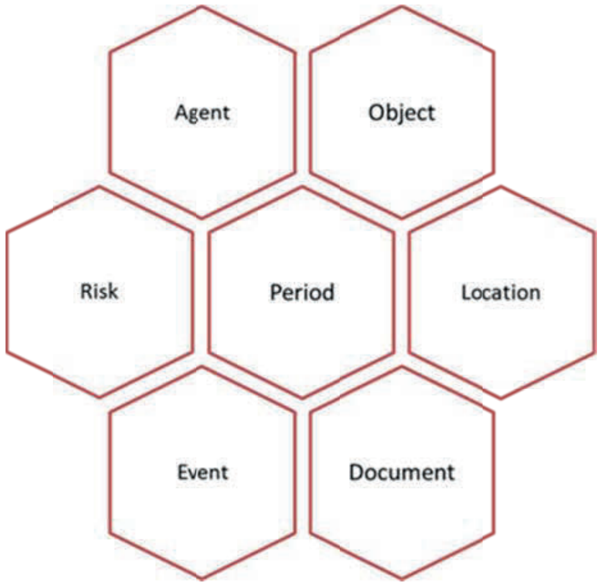


*Figure 2. Seven basic CISE entity services (source: CoopP project [5])*

In Europe there is also strong pressure to make public data available to citizens and private companies enabling the creation of new added value services and thus helping to create new business opportunities. This "open data" initiative will require all European authorities to carefully go through all the data they possess and prepare to gradually open all data that is not classified. This will be one of FTA's major challenges in the coming years.

## EFFECTS ON THE DEVELOPMENT OF OUR TECHNICAL SYSTEMS AND SOLUTIONS

Some information exchange with other organizations has already for a long time been required for us to be able to carry out our basic responsibilities. We are monitoring traffic separation schemes (TSS) and operating mandatory ship reporting systems (SRS) in international waters jointly with neighboring countries (Sweden, Estonia and Russia). Winter navigation is also ensured in co-operation with neighboring countries, whereas securing the transport system in all conditions requires close co-operation and information exchange with other national authorities.

At the national level the maritime surveillance, monitoring and communication systems supporting FTA's VTS services has been interoperable with the respective technical systems used by the Finnish Navy and the Finnish Border Guard already from the mid-1990's. This national cross-sector information sharing environment (called FIMAC) was formed mainly to avoid duplicate investment and maintenance costs related to sensor systems (like radars, cameras and AIS) and communication networks. Maritime surveillance and ship reporting data is also exchanged continuously with neighboring countries to support joint operations related to icebreaking services, monitoring of traffic separation schemes and mandatory ship reporting systems. Data is also provided continuously to various mandatory regional and EU systems. (e.g. HelCom AIS and SafeSeaNet). Since the early 2000's, FTA and the Finnish Customs have been responsible for running a single window system for accepting mandatory ship reports at the national level. As described above, FTA has been actively involved in various data exchange arrangements for a long time. So far, however, the data exchange has always been created to meet a specific operational need and is not necessarily capable of serving any other purpose.

On the basis of the general technical development and needs described in the earlier sections, it will probably become necessary in the future to effectively connect a large number of shore-based information providers and consumers representing different areas of responsibilities and originating from an expanding geographical area. It will no longer be an option to agree upon case-specific data exchange mechanisms between shore-based information providers and consumers. A set of standardized data models and data exchange procedures common to all actors will be required. A joint effort much like the way communication interfaces between ship and shore are being harmonized related to IMO's e-Navigation initiative will also be needed for shore-based communications. What has widely been seen and recognized as a suitable way to create an efficient environment for the required information exchange is the use of service-oriented architecture (SOA) and service buses.

The Finnish Transport Agency is currently preparing the renewal and update of all the technical systems supporting Vessel Traffic Management. During the planning process we have tried to identify all the possible future demands and challenges that we have to meet. After this work it seemed very clear to us that a new profound approach is required. We obviously cannot envision all the possible future operational needs or potential consumers and uses of data and information, but we know for certain that there is an increasing demand for access to digital information in machine-readable format. In response to this, we need to make a clearer distinction between data sources and consumers in our systems and ensure that all the information that we handle and process will be also be available to any other authorized user via standard interface (e.g. as a web service).

The data and information that we collect via sensors and other sources and use to support our current and planned operations must be treated as a valuable resource in itself. By doing so, we ensure that in the future the data sources will still be available for our own internal use but also to other authorities across sectors and borders and also for such purposes and uses which are not even recognized today. The goal is that all our renewed and updated systems would be built to support Service-oriented architecture. We have started the time-consuming work of identifying and classifying the data in our systems and which we plan to be able to provide as data services in our renewed VTMIS system. As a European country we are even obliged to do this sooner or later.

We have also understood the vital importance of national, regional and international co-operation related to this work. In future visions where information is exchanged via information-sharing environments or clouds, it is no longer realistic to create and define own provider-specific information services and data models. Instead a set of global ones have to be adopted also for the information exchange between shore-based actors.

## FORESEEN PROBLEM AREAS

We have a quite clear understanding of the basic principles that we need to follow while updating our technical systems supporting the vessel traffic management. We need to

- distinguish between information sources and consumers
- provide all relevant data as services equally to all authorized users

However, there are also some challenges related to the process. At this point there is still a lack of clearly defined and internationally agreed data models and standards for shore-to-shore information exchange. There are some on-going initiatives at least in Europe and the US and some work is also done by IALA (e.g. IVEF) to tackle this problem. It can be foreseen that eventually the required data models and ontologies will be standardized internationally, but because this is not the case at the moment, further updates to our systems will be required later on.

Although SOA seems to be the best and widely supported solution for the majority of the information exchange needs in the future, we are still not convinced that this is the best solution to support all the basic VTS operations. We are a bit concerned about the fact that if the surveillance data (e.g. vessels position) is provided as a service via our general service bus, it might not be sufficiently accurate and timely for monitoring traffic in our narrow and shallow waterways. It is possible that in some cases we need to keep the close direct connection between data source and consumer also in the future.

We have also experienced that there in some cases might be a conflict between commercial interests and the principals of service-oriented architecture. In case of old monolithic systems the transfer to SOA will cut the close connection between data source(s) and consumer application and thus enable the separate tendering processes. However this change is luckily mainly seen as a positive consequence which creates new business opportunities. .■

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## 100 THE SHIPPING INDUSTRY AND MARINE SPATIAL PLANNING. A PROFESSIONAL APPROACH

*David Patraiko. NI, Master Mariner. The Nautical Institute, United Kingdom*
*Paul Holthus. World Ocean Council, United Kingdom*

This paper outlines the issues raised in a recent publication (November 2013) published by The Nautical Institute and co-written by The Nautical Institute (NI) and the World Ocean Council (WOC), and produced in association with IALA. The full publication can be ordered (or downloaded for free in pdf version) from www.nautinst.org.

This guide has been produced to enable professionals with knowledge of the maritime industry to participate more effectively in Marine Spatial Planning exercises, not to defend the status quo, but to work in cooperation with other water space users to maximise benefits to society.

Esta ponencia resume los temas puestos de relieve en una reciente publicación (noviembre de 2013) realizada por The Nautical Institute y escrita en colaboración entre The Nautical Institute (NI) y el World Ocean Council (WOC), y producida en asociación con la IALA. La publicación completa puede solicitarse (o descargarse gratuitamente en versión pdf) en www.nautinst.org.

Esta guía se ha elaborado para permitir a los profesionales con conocimientos del sector marítimo participar más eficazmente en ejercicios de planificación del espacio marino, no para defender la situación actual sino para trabajar cooperando con otros usuarios del espacio acuático para maximizar los beneficios para la sociedad.

*Ce rapport souligne les problèmes exposés dans une récente publication (Novembre 2013) du « Nautical Institute, (NI)» écrite en collaboration avec le Conseil Mondial de l'Océan (WOC) et en association avec l'AISM. Cette publication peut être commandée (ou téléchargée gratuitement en version pdf) sur le site www.nautinst.org.*

*Ce guide a été fait pour permettre aux professionnels ayant une connaissance de l'industrie maritime de participer plus efficacement aux essais de planification de l'espace maritime, non pour défendre le statu quo, mais pour oeuvrer en coopération avec d'autres utilisateurs de cet espace marin pour optimiser les bénéfices pour la société.*

# The shipping industry and marine spatial planning – A professional approach

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&

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# The shipping industry and marine spatial planning – A professional approach

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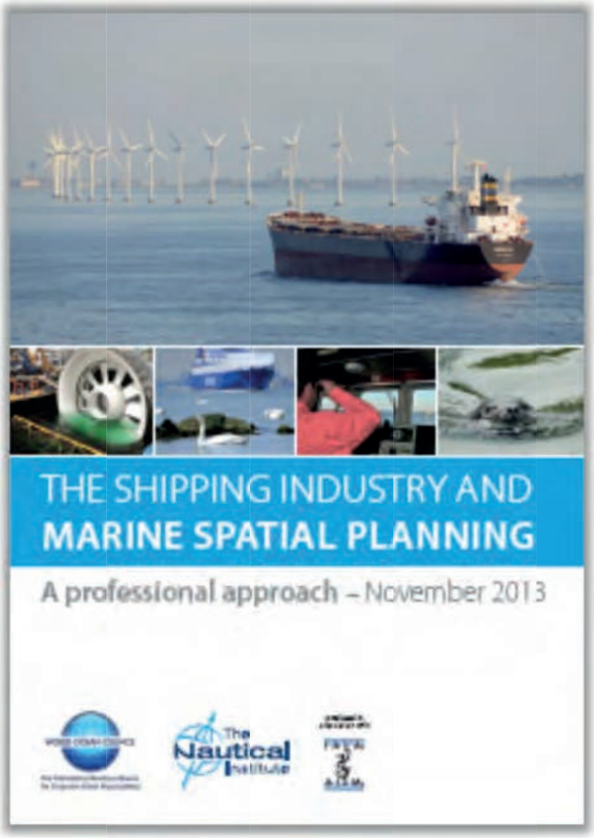



## BACKGROUND

Marine Spatial Planning (MSP) will become an increasingly important issue for the shipping sector over the next few years. Maritime professionals need to engage with other users of waterways space, from both a sea and shore perspective, and to take part in international, regional, national and local MSP debates, to ensure that the needs of the shipping sector are taken into full consideration and that the sector understands the needs of other marine users and resources.

The Nautical Institute, together with the World Ocean Council, has put together this operational guide to the risks and benefits connected with the shipping industry that should be considered during the MSP process. This guidance seeks to outline just some of the many opportunities for engagement and issues to consider. It should be noted that this guidance only summarises some of the main issues, but does however provide reference to other industry documents for further technical and procedural details.

This guide has been specifically produced to aid maritime professionals to participate in MSP developments. For the purpose of brevity the guide assumes a certain level of maritime expertise and has not sought to clarify a number of maritime terms and definitions. Should this guide be used by non mariners (and we hope it is) it may be useful to seek further explanation of some issues by those familiar with maritime operations.

## WHAT IS MARINE SPATIAL PLANNING (MSP)?

MSP is defined by UNESCO as a public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that are typically specified through the political process. MSP is an element of sea use management.

Essential characteristics of MSP include that it is ecosystem-based, integrated, place-based or area-based, adaptive, strategic, anticipatory and participatory. It should be based on sound science and be an iterative process.

MSP has the potential to address the impacts of all activities in a specific place, so that marine ecosystems can be productive, resilient to change, and accommodate appropriate, responsible economic activities. Several countries are developing MSP approaches to address fragmented management schemes that do not adequately tackle the complex interactions of the myriad activities that occur simultaneously on and in waterways.

It needs to be recognised that there is a temporal aspect to MSP, such that the same water can be used for different purposes at different times / seasons. It also needs to be recognised that each instance of MSP will be on a case by case basis.

## THE MSP PROCESS

Marine Spatial Planning is a process that brings together multiple users of marine areas, including shipping, offshore energy, aquaculture, fishing, government, conservation and recreation, to make informed, co-ordinated decisions about how to use marine resources sustainably and reduce conflict between users.

More detail about this generic approach to MSP, its planning steps and management processes can be found in the UNESCO document *Marine Spatial Planning - a step by- step approach* at http://www.unescoioc-marinesp.be/msp_guide. Examples of regional and national application of MSP are contained in the document. Although this approach may not be used by all authorities, the essence should be adhered to.

The table on page 5 [of the publication] outlines some of the major steps in MSP and indicates how the shipping community might participate to support the planning process.

## THE CHANGING OCEANS

Growth in the world economy is expected to result in an increase in ship traffic in certain areas, all in decreasingly available sea space.

In addition, there will be challenges for such waters from industries such as oil and gas, offshore renewable energy, commercial fishing, recreational craft, aggregate dredging, mining, fish farms and government imposed restricted areas.

MSP discussions are taking place at international, regional and national levels.

However the finer details of where to place such activities as a fish farm, offshore wind farm, environmental protection zone or shipping lane will ultimately depend on local debate. This debate is likely to be both emotive and controversial. It is also important to note that MSP is the 'planning' stage and, although hugely important, will need to be integrated with the full management process including monitoring, enforcement and re-evaluation.

It is all too easy for non-mariners to assume that shipping operations and shipping lanes can be altered without consequence to accommodate new demands such as offshore energy or environmental protection. It is up to maritime professionals to engage in these debates at all levels to ensure that these changes and their consequences are fully understood and are taken into account when finding a solution, as unanticipated consequences may lead to accidents, environmental damage or commercial losses. In some cases the rerouteing of a shipping lane may be justified in order to provide energy and food to a local community. In other cases, a proposal for altering shipping operations may increase the risk of collision or grounding to an unacceptable level, increase shipping costs or change the commercial dynamics of a regional area so that ports or shipping services become uncompetitive.

Developing a common vision for the use of sea space in a particular location is essential to the successful outcome of the MSP process and any and all debates and decisions about use allocation should be based on this common goal. An approach, when conducting training for those participating in MSP, could be scenario development, in which stakeholders are challenged to provide their own vision and then invited, as a group, to find a common starting point for the MSP process.

Maritime professionals, including Nautical Institute members, will need to participate in the discussion and determination of this common vision and the subsequent debates on allocation of uses at international, national and local levels. The aim is to explain the current situation and to ensure that the marine space and resources are used to best support society, they are used sustainably and marine risks are understood and addressed.

While there are many industries competing for the use of waterways and resources, some of them have issues in common that provide the basis for engaging and addressing them in a co-ordinated, cost effective manner, such as ship strikes on marine mammals or ocean noise. Within companies, there is a need to co-ordinate across business unit 'silos' relevant to operations or policy roles for waterways, in order to improve the efficiency of marine operations and increase co-ordination of waterway related work.

It is also important to recognise that MSP is not just a one-off activity, and that it must be adoptive, flexible and iterative, to take into account changes in the environment, commercial activities, social demands and even changes in government policies. The marine spatial plan should specify achievable goals that can be monitored, evaluated, enforced and, when necessary, improved.

## WHY SHIPPING MUST GET INVOLVED

Without shipping industry involvement there is a significant risk that MSP will not include full consideration of the existing and potential economic activities in the area under consideration, bearing in mind that the shipping footprint in the waters under consideration may not be as large as other maritime interests.

In addition, the maritime industry often has scientific information and data on resources and ecological processes that may not otherwise be available to planners. Constructive maritime industry involvement in the MSP process requires sustained, systematic efforts to build relationships with the relevant stakeholders. This could take place at the local, national or regional level, e.g. within the Baltic Sea. In addition, MSP is now being adapted for consideration in international waters, with significant implications for international shipping.

As a major user of waterways and resources, the shipping industry must constructively engage with MSP discussions and stakeholders to ensure that the process is well informed and balanced. Unfortunately, those currently involved in MSP are often not involved in key shipping sector planning developments and so are not engaged in a constructive, co-ordinated manner that brings together the full range of industries operating in the marine environment. Maritime professionals, including Nautical Institute members, will need to participate in these debates at international, national and local levels. The aim is not to defend the status quo, but to ensure that the seas are used to best support society, that they are used sustainably, and that risks are understood and addressed.

Shipping industry involvement in MSP could be constrained by a number of factors, including:

1. Lack of understanding of the MSP process and momentum behind the input to MSP from others.
2. Limited engagement in the governmental and multi-stakeholder processes where MSP is being developed.
3. Lack of means for engaging the broader maritime business community on marine management and sustainability issues.

It is vital that any form of MSP requiring change to regulations affecting shipping is made in full collaboration with the shipping industry. Speaking at *The Economist* World Ocean Summit in 2012, Spyros Polemis, Chairman of the International Chamber of Shipping (ICS) emphasised that "Politicians should always consult with the industry when considering new regulation for shipping in order to avoid inefficient outcome." It should be emphasised that the International Maritime Organization (IMO) is recognised as the only international body for developing guidelines, criteria and regulations on an international level for ships' routeing systems.

## LEGAL FRAMEWORK

There is a substantial legal and policy framework relevant to the development of MSP for the global ocean 'commons'. The key international legal regime that needs to be taken into account is the United Nations Convention on the Law of the Sea (UNCLOS), which sets out a State's rights and responsibilities, both in zones subject to coastal State sovereignty (internal waters; archipelagic waters and territorial seas up to 12 miles offshore) and jurisdiction (the Exclusive Economic Zone up to 200 miles offshore and the continental shelf ) and in Areas Beyond National Jurisdiction (ABNJ - the high seas and the seabed beyond the continental shelf ).

UNCLOS is a treaty among countries that have become party to this international legal instrument. The UN Division of Ocean Affairs and the Law of the Sea (DOALOS) administers the UNCLOS processes, which includes regular meetings of the parties to the convention. The International Maritime Organization (IMO), and other UN agencies addressing issues related to the ocean, all operate within the legal context that UNCLOS has created.

UNCLOS provides that all States are free to use the high seas with due regard for other States' interests. These freedoms include navigation, fishing, marine scientific research, the laying of undersea cables and pipelines, and the construction of artificial islands.

High seas freedoms must be exercised under conditions laid down by UNCLOS, including general obligations to protect and preserve the marine environment and to conserve and manage high seas living resources.

UNCLOS also contains a general obligation for States to protect and preserve the marine environment, which applies both within and beyond national jurisdiction. States must take, individually or jointly, all necessary measures to prevent, reduce and control pollution from any source, including land-based sources, pollution of the atmosphere, pollution from vessels, pollution by dumping, pollution from installations and devices used in exploration or exploitation of the natural resources of the seabed, and the intentional or accidental introduction of alien species.

While UNCLOS does not explicitly provide for MSP, States are required to take measures necessary to protect and preserve rare or fragile ecosystems, as well as the habitat of depleted, threatened, or endangered species. It also covers responsibility and liability for damage caused by pollution of the marine environment, including in the ABNJ (areas beyond national jurisdiction). In addition, UNCLOS provides for monitoring and environmental assessment, especially regarding the risks or effects of marine pollution and to assess the potential effects of planned activities under their jurisdiction or control that may cause substantial pollution or significant and harmful changes to the marine environment.

Governments are currently negotiating the possibility of an 'implementing agreement' on UNCLOS that is likely to include the means for MSP to be developed for international waters. The World Ocean Council has been the only presence of maritime industry in these UN discussions.

The regional, national and local basis for MSP, or other forms of sea space allocation, is being developed at these various geographic scales in many parts of the world.

## ISSUES TO CONSIDER

After making the decision to participate in the MSP process, maritime industries should bring forward the items that are most vital to their continued operation, business success and efficiency while also being prepared to better understand the points of views and needs of other industries, the environment community, the natural resources and government. The result of a good MSP process is the better understanding and accommodation for the needs of others for sea space.

Below are some suggestions for the shipping industry when engaging in MSP, including suggested input for the planning process.

## MANOEUVRING CHARACTERISTICS

When considering the rerouteing of shipping lanes or the placement of MSP limitations on sea space i.e. aquaculture, off shore energy installations, the manoeuvring characteristics of vessels must be considered both for normal and abnormal conditions. The following issues should be considered, for the most difficult to manoeuvre ships anticipated in the area:

- Adequate sea room to avoid collision and comply with COLREGS. Route planners should take into consideration anticipated traffic densities, reduced visibility and the presence of leisure craft and increased traffic from craft supporting the offshore installations;
- Ship characteristics such as transfer and squat will also need to be taken into account when addressing sea room and under keel clearances (UKC).
- Adequate sea room for large vessels to make a round turn or hove to;
- Heavy weather: ships may need to find shelter from a lee shore or need access to a safe anchorage;
- Heavy weather also reduces visibility making navigation and the ability to spot other vessels or navigation aids either visually or with radar more difficult.
- Interference on radar displays created by wind farms;
- Deviation from course: ships can also be expected to make unplanned deviations from course or track due to unforeseen circumstances, in addition to weather, these might include malfunctions, emergencies, search and rescue operations or evacuations;
- Allowance must be made for vessels constrained by their draft, vessels limited in their ability to manoeuvre, manoeuvring to pick up or drop off a pilot, or vessels involved in ship to ship (STS) transfer.

Non mariners often consider that offshore sea lanes do not need much more 'corridor width' than in-port channels, which may be measured in hundreds of metres. They fail to take into account that service and support levels in port differ to those offshore, as do navigational accuracy and visual references.

A very good guide is published by the UK's Maritime and Coastguard Agency, titled *Offshore Renewable Energy Installations Guidance on UK Navigational Practice, Safety and Emergency Response Issues (MGN 371)*, which is available from http://www.dft.gov.uk/mca/mgn371-2.pdf.

Further technical guidance can be found from other organisations.

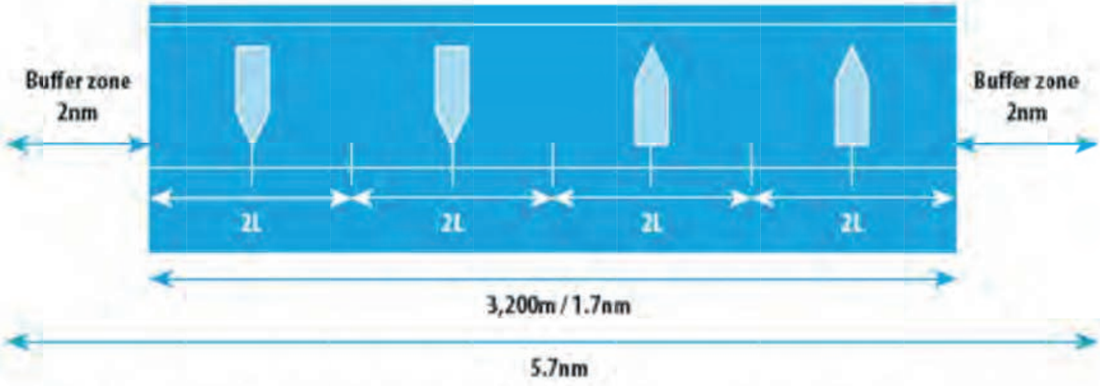
Additional guidance can be found in the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) *Recommendation O-139 on the Marking of Offshore Structures*, which is available from www.IALA-AISM.org.

## WIDTH OF SHIPPING LANES

Standard turning circles for vessels are six times the ship's length. This is a particularly good assumption for vessels on ocean or deep sea passage, which will not have the same manoeuvrability as when engines and systems are prepared for port approach.

Requirements for stopping in an emergency must be considered, for example in case of a steering gear failure. The crash stop distance for a large tanker may be up to 3km.

One study has made an assessment of sea room required, using data supported by the PIANC assessment for channel design. In general it strives for an obstacle free, or buffer zone of 2nm between hazards and shipping lanes (see diagram on the next page).




An example of recommended minimum shipping lane width between two adjacent windfarms considering vessels of 400m in length (UK NOREL Committee). In every instance a case by case assessment must determine actual requirements

The possibility of ships overtaking cannot be excluded and should be taken into consideration. Consequently the assumption should be that fours ships should safely be able to pass each other in a shipping lane.

A distance between overtaking and meeting vessels of two ship's lengths is normally maintained as a minimum passing distance; this is based on experience gained from ships' masters and deep sea pilots operating in the North Sea and has been verified by simulation trials carried out in the Netherlands [(see annex A, p11) of the full publication].

## NAVIGATION ISSUES

Any information from other marine users that could impact on the navigation of vessels must be produced on nautical charts and publications with the full participation of the hydrographic community, using international standards and symbology that will be recognised by mariners. It is vital that this information is provided in a timely and safe manner.

Further, in assessing the impact on shipping by other marine users under an MSP plan, anything that might interfere with visibility or radar conspicuity must be taken into account. Such interference might include a physical object, electronic interference or even light pollution, either at sea or on the shoreline.

In the future, greater demands for ships to navigate closer to navigational hazards while ensuring high levels of safety may require new services and technology, in which case serious consideration will need to be given to issues of authority and liability.

Evolving navigation technology may provide greater reliability and accuracy of automated electronic position fixing systems. Cheaper communication with greater bandwidth may lead to better provision of critical information and decision support tools for the navigator. Increased traffic density in increasingly constricted water space may require isolation zones for different ocean users such as commercial shipping, fishing and leisure craft. For many years, improved technology has lead to the development of Vessel Traffic Service (VTS) in port areas.

However, as technology facilitates the global tracking of ships by using the Automatic

Identification System (AIS) and satellite observations; the provision of coastal traffic management may provide for improved safety and commercial efficiencies, for instance by such means as slot management and monitoring distance separation.

## ENVIRONMENTAL AND COMMERCIAL IMPACT

In the MSP process, solutions for the management of sea space may entail proposals for the rerouteing of commercial traffic to achieve other benefits for society.

In addition to navigational safety risks, it is also essential to understand the impact rerouteing may have on the environment and commercial operations.

Some sort of risk assessment, combining both qualitative and quantitative measures, will need to be carried out during any MSP developments. There are many formal tools to choose from including the IALA Waterways Risk Assessment Program (IWRAP Mk2), which is used in conjunction with the Ports and Waterways Safety Assessment (PAWSA) and simulation [(see box) in the full publication]. Risk assessment should also take into account the increased workboat traffic during construction and maintenance of coastal and offshore projects, and risks posed by broken parts in energy generation, such as underwater turbine blades or wave generator floats coming adrift.

Although ships remain the most environmentally efficient form of commercial transportation, ships are large and do consume a significant amount of fuel. They also, as with any carbon fuel user, emit certain toxins such as sulphur oxides (SOx) and nitrogen oxides (NOx); and although the shipping industry is currently reducing these emissions (in compliance with MARPOL Annex VI), any increase in miles will have a resultant increase on fuel consumption, and therefore the related environmental impact. Other environmental impacts include marine sound, the scouring effect on the seabed in shallow areas and the potential environmental impact from an accident or grounding. Changes to shipping patterns have also had a knock-on effect for other transport chains such as an increase of road traffic and associated environmental impact associated with less efficient modes of transport.

Increased route distances will increase the costs of shipping and goods due not only to the extra cost of fuel, but also due to the significant ship operation costs such as wages, insurance, maintenance and consumables. It may also be that the balance of risk of a major pollution incident and consequential damage to the environment can outweigh the value of a renewable energy installation.

Consideration also needs to be given to any change to the competitive advantage of local ports. Should shipping routes need to be changed; commercial competition between local ports can be fierce and emotive. Shipping is a critical link in most logistics (supply) chains that are based on Just In Time (JIT) delivery, therefore changing shipping routes may have an impact on either the JIT logistics chain or the intermodal transport links it is tied into such as road, rail or feeder vessels.

## THE NEED FOR COOPERATION

As the world presses for greater use of the world's waterways, within a framework of sustainability and economic growth, it is inevitable that established commercial shipping operations will be challenged.

Society will need to manage the demands of the multitude of stakeholders all wishing/demanding to use inland waters, coastal and ocean space. Within the embryonic process of MSP, the many stakeholders involved won't always understand the needs and operational requirements of other stakeholders and the impact changes will have upon them and the society that they support.

It is essential however that each and every MSP development be taken on its own merits and care is needed that high profile issues are not allowed to obscure potential dangers to shipping. The Case Studies and Annexes included in [the full publication of - this guidance document] are for example only.

Each new development will be unique both in terms of physical properties and political emphasis.

The Nautical Institute firmly believes that our members must engage in MSP debates on an international, regional and national and, most importantly, local basis. Maritime professionals from all disciplines need to be involved, not to be negative with regards to change but explain and support the reasons for the existing situation. It is vital to ensure that all other MSP stakeholders understand the issues critical to shipping and that the full impact of shipping operations are assessed prior to the management of change in the use of our coastal and ocean spaces to best effect. Care must be taken however that disproportionate emphasis of high profile current issues does not cloud real dangers posed to shipping and the marine transport community which could have a long term negative impact on the environment and trade.

The Nautical Institute will maintain a MSP forum on its website, www.nautinst.org to track any further resources that it identifies as being useful.

The Nautical Institute (NI) is an international representative body for maritime professionals involved in the control of sea-going ships. It provides a wide range of services to enhance the professional standing and knowledge of its members, who are drawn from all sectors of the maritime world.
www.nautinst.org

The World Ocean Council (WOC) is a cross-sector industry leadership alliance on Corporate Ocean Responsibility. The WOC is working with a wide range of ocean stakeholders, including commercial shipping, to create an intelligent and professional debate on how to best manage ocean resources and space to serve society in a sustainable manner and maintain a healthy ocean ecosystem.
www.oceancouncil.org

## 103 HOLISTIC MARINE SPATIAL PLANNING. SAFETY BEYOND THE ENVIRONMENT

*Nick Lemon, Alec Millet. Australian Maritime Safety Authority, Australia*

The world's oceans and coastal waters are increasingly being used for growing range of human activities, including: shipping, recreational boating, commercial and recreational fishing, oil and gas exploration and extraction, research and, more recently, renewable energy.

Modern technologies, such as web-based GIS tools and near real-time tracking of ships now make it possible for maritime authorities to be more aware of such activities off their coasts.

Maritime jurisdictional arrangements can be complex, with coastal states having a variety of rights and obligations within their territorial waters and EEZs.

Marine Spatial Planning (MSP) is coming of age. When combined with the related activity of Water Space Management, it offers some solutions to the challenge of multiple sectors making increasing demands on the world's coastal waters and high seas. It is clear that in an e-navigation era, MSP and Water Space Management will be becoming increasingly important activities.

It will not be long before all coastal States will need national policies for the improved stewardship of their waters. Comprehensive maritime information will need to underpin MSP governance structures.

This paper discusses some of the tools, techniques, management and cooperation methods that can underpin MSP – and the important role that shore based navigation services and aids to navigation can play. The paper will also discuss developments in Australia, links between MSP and e-navigation and some of the common challenges faced.

Las aguas oceánicas y costeras del mundo se usan cada vez más para actividades humanas en aumento, como son: transporte marítimo, navegación de recreo, pesca comercial y de recreo, exploración y extracción petrolífera y de gas, investigación y, más recientemente, energía renovable. Las tecnologías modernas, como las herramientas GIS basadas en web y el seguimiento de barcos casi en tiempo real hacen posible hoy en día que las autoridades marítimas estén más al tanto de tales actividades lejos de la costa.

Los acuerdos marítimos jurisdiccionales pueden ser complejos con estados costeros que tienen diversos derechos y obligaciones dentro de sus aguas territoriales y EEZ.

La Planificación del Espacio Marítimo (MSP) está madurando. Al combinarla con la actividad relacionada de Gestión del Espacio Acuático, ofrece algunas soluciones al desafío de múltiples sectores aumentando las demandas de aguas costeras mundiales y alta mar. Está claro que en una era de e-navegación, la MSP y la Gestión del Espacio Acuático se convertirán en actividades cada vez más importantes.

No pasará mucho tiempo antes de que los estados costeros precisen de políticas nacionales para la administración mejorada de sus aguas. La información marítima global tendrá que apoyar las estructuras de gobierno MSP.

Esta ponencia trata algunas de las herramientas, técnicas y métodos de gestión y cooperación que pueden apoyar el MSP, además del papel importante que pueden desempeñar los servicios de navegación en tierra y ayudas a la navegación. La ponencia tratará también los desarrollos en Australia, los enlaces entre la MSP y la e-navegación y algunos de los desafíos comunes afrontados.

*Les océans et les eaux côtières du monde sont de plus en plus utilisées par une palette grandissante d'activités humaines, dont la navigation, la plaisance, la pêche – industrielle ou de loisir – l'exploration et l'exploitation pétrolière et gazière, la recherche et, plus récemment, les énergies renouvelables.*

*Les technologies modernes, telles que les outils GIS basés sur le Web et le suivi des navires en temps presque réel permettent maintenant aux autorités maritimes d'être plus au fait des activités menées au large de leurs côtes.*

*Les dispositions juridiques maritimes peuvent être complexes, les états côtiers ayant tout une variété de droits et obligations prévalant dans leurs eaux territoriales et leurs zones économiques exclusives (EEZ).*

*La planification de l'espace maritime (MSP) est un signe des temps. Combiné à la gestion de l'espace aquatique, il offre quelques réponses au défi représenté par les vues qu'ont de multiples secteurs sur les eaux côtières et les hautes mers du monde. Il est clair qu'à l'ère de l'e-Navigation la MSP et la gestion de l'espace aquatique deviendront des activités de plus en plus importantes.*

*Il ne faudra pas longtemps avant que les états côtiers n'aient besoin de politiques nationales pour améliorer la gestion de leurs eaux. Une information maritime exhaustive devra soutenir les structures de gouvernance de la planification de la MSP.*

*Ce rapport fait état de quelques-uns des outils, techniques, méthodes de gestion et de collaboration qui peuvent appuyer la MSP – et du rôle important que les services de navigation basés à terre et les aides à la navigation peuvent jouer. Le rapport présentera aussi les développements en Australie, les liens entre MSP et e-Navigation et quelques-uns des défis communs à relever.*

# Holistic Marine Spatial Planning

## Safety beyond the environment

Nick Lemon
&
Alec Millett

Australian Maritime Authority

IALA·2014·AISM
XVIII Conference · A Coruña · Spain

## 1. THE IMPORTANCE OF MARINE SPATIAL PLANNING

Australia's marine areas are becoming more crowded with competing demands on common water space for marine activities. Water space is particularly in demand in the increasingly crowded, shallower coastal waters where significant volumes of commercial shipping traffic with high net worth cargoes can be found.

In the United States, United Kingdom and in a number of north-west European countries, Marine Spatial Planning (MSP) is relatively mature and is carried out relatively holistically, reflecting multiple-use objectives and patterns, albeit with a bias towards ecology and the environment – both important aspects in their own right but this can relegate some aspects of commercial shipping and navigational safety to a lessor importance.

Yet in Australia, fragmented planning and decision making places constraints on other legitimate marine activities or makes them less efficient and it can reduce their potential for growth. A disjointed methodology also weakens the capacity and efficiency for agencies to protect the marine environment through regulation and management. This can lead to sub-optimal maritime and navigation safety outcomes.

A well-designed and appropriately led MSP process can help manage competing scenarios and future directions for any given common water space. Rather than reacting separately to each individual request, project or activity, or looking in isolation at sectoral developments, MSP, that involves appropriate consultation, can facilitate strategic decision making over common water-space both in two and three dimensions. This enables activities to be proposed, assessed and undertaken according to a clearly set out vision, policy and objectives from a number of perspectives. In so doing, MSP can contribute to conserving and enhancing the value of the marine environment whilst also contributing to strategic decisions involving environmental and commercial decisions.

## 2. BENEFITS OF MSP

The following list of enduring benefits[1] reflects the potential holistic outcomes of such a system. It can be seen that the benefits contribute to greater waterway management with added benefits to allied environments and applications.

An appropriately mandated, planned, resourced and implemented system of MSP should:

- Deliver a coordinated and integrated approach to the planning, use and management of the common water space;
- Involve the participation of all stakeholders (private and public sector) at a level that conveys accountability;
- Replace the largely sectoral and reactive regulatory systems that are characterised by potentially insufficient cross-agency planning, coordination, integration, information sharing and monitoring;
- Improve the consistency and compatibility of regulatory and other management decisions;
- Improve the understanding and consideration of cumulative and combined effects and interactions between differing users and developments;
- Enable government and agencies to more effectively deliver their commitments to sustainable development;
- Provide greater clarity in decision-making with more certainty about what activities and changes may be acceptable in different areas of the marine environment;
- Improve information collection, storage, retrieval, data processing and sharing of marine spatial information;
- Provide the context for improved management of sensitive areas that require special protection and environmental conservation;
- Reduce conflict between marine users and regulators;
- Create new working partnerships and communities with a common purpose;
- Improve public participation;
- Help to avoid unnecessary trade-off and compromise and build on consensus;
- Change the approach to management of the marine environment from one dominated by regulation and control to an approach that is based on planning;

- Share the beneficial results of monitoring and reduce the uncertainty of decision making, resulting in a reduced reliance on precautionary measures that may be unnecessary; and
- Help to reverse the decline in biodiversity and act as a catalyst to restoration of marine ecosystems.

## 2.1 Expanding beyond traditional MSP

Whilst the high level mandate of MSP is well acknowledged and indeed there are some successful attempts at creating wide-ranging software applications, it is very useful to see that a number of expansive efforts were made at IALA's March 2013 Workshop on MSP (Working Group 2 (Geographic Information System (GIS) considerations). Specifically, the notion of minimum criteria of what information to consider, including in spatial tools:

- description areas;
- traffic;
- actual situation manoeuvrable space;
- identification of:
  - present risk areas;
  - service provision;
  - traffic developments;
  - utilisation of space; and
  - future risk areas.

Of interest in this context is the *integrated* inclusion of vessel traffic information. Many competing interests, either inadvertently or deliberately, may overlook this particular input and hence decisions, either perceived or real, can be made effectively ignoring a real and present danger to the water space in question.

## 3. MSP AND 'TRAFFIC'

Within the Australian context there is significant activity taking place in the area of offshore oil and gas exploration and potentially in the future for renewable energy solutions and also for carbon sequestration. Oil and gas exploration releases are issued every year in a regular grid pattern for interested proponents. As part of this process, there is a legislative requirement, as with other nations, to consult other organisations that 'may' have an interest in the area of the release. However, although trying to help facilitate the release of independently held data about areas where there are concentrations of commercial shipping, it is apparent that some decisions are being made with little or no understanding about existing uses being made of marine areas, including shipping.

The scenario shown in **Figure 1**is a case in point. In this case, a release was issued to a proponent that covered not only busy shipping routes but also an IMO adopted traffic separation scheme involving thousands of ship movements each year. Proponents can be later disappointed when provided with advice about the volume of shipping activity and its implications when carrying out seismic surveys involving towing lengthy seismic arrays, let alone risks to mobile offshore drilling units or other infrastructure.

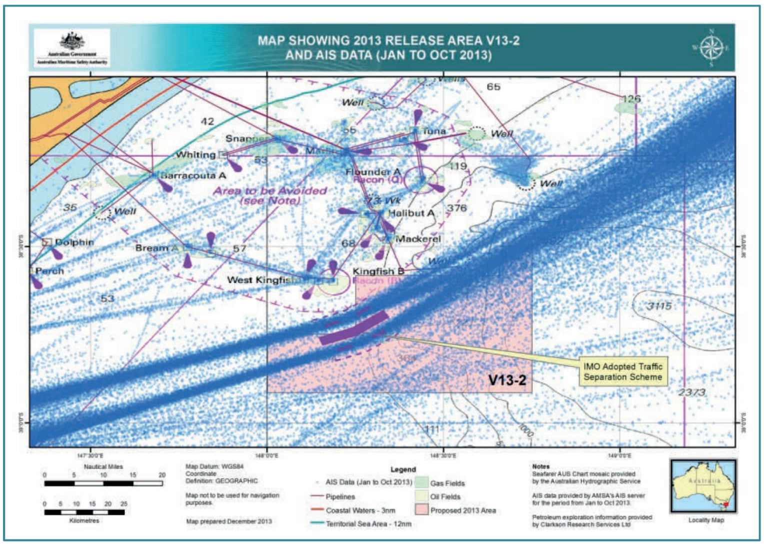



*Figure 1: Common waterspace conflict*

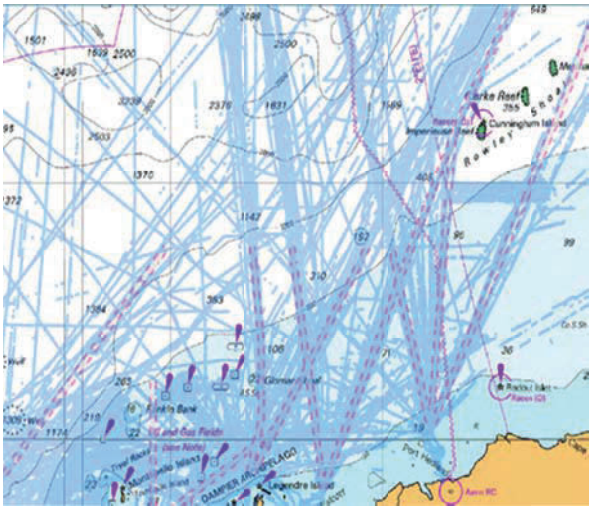
## 3.1 Traffic Density

Within the context of GIS tools that support MSP the temporal nature of selecting the right amount of integrated spatial data to assist in making the right decisions is vitally important. Whilst a traffic density plot made using received Automatic Identification System (AIS) data may look impressive if it covers a period of 12 months, this may only represent two vessels each day passing through an area. This pragmatic assessment of shipping data may disproportionately affect decisions on such things as associated protective measures and placement of aids to navigation. Trying to facilitate and then project this display of integrated shipping information is a challenge to be addressed for MSP. It is important that accurate and realistic information is provided to assist all those involved in MSP, taking into account their experience and understanding of spatial information and the ways it can be presented.

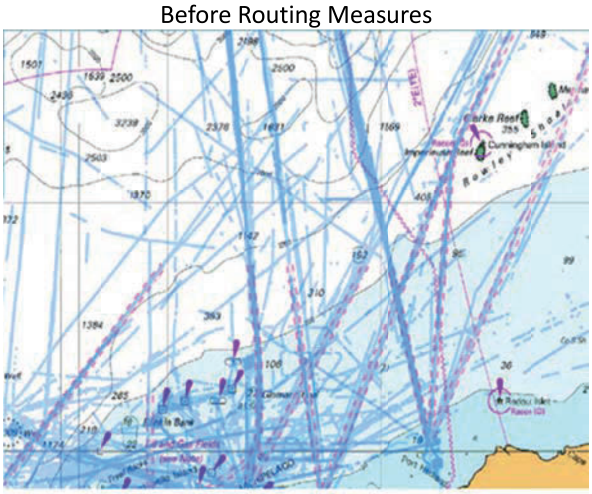
### 3.2 Aids to navigation and routing measures

MSP can provide an integrated approach to determining navigational safety measures within areas of high conflicting water space use.

**Figure 2** illustrates the results of an assessment, which at the time was a manual process, of establishing routing measures to promote safety within a heavily used area of exploration, offshore infrastructure and competing demands within the same water space. It can be clearly seen that the provision of routing measures has minimised the spatial distribution of ships tracks to within safety fairways.



Before Routing Measures



After Routing Measures

***Figure 2: Routeing measures and the before and after effects on traffic patters***

In this example, the lack of current integration of this shipping traffic information within a common application or easily accessible interface, makes MSP decisions difficult, exposed to latency and possible misinterpretation.

It can clearly be seen that the navigational safety aspects, which can include the deployment of aids to navigation as well as routing measures, can benefit from the incorporation of this information. This is not a new concept, however integrating near real-time or more to the point, *operational*, information will assist the MSP decision process greatly for both regulators and end users.

### 3.3 Support Structures

At this point in international MSP developments, it is worth considering the importance of:

- proper and effective training;
- Standard Operating Procedures (SOPs);
- government sponsorship & support; and
- marketing.

These four aspects are not uncommon to the successful implementation of any system - the concept of a distributed MSP process is no different.

To ensure the overall success of an *effective* and holistic MSP process, all four aspects should support, interrelate and work together with equal importance. Should any one item be ignored or be deficient in any way, sub-optimal results may be the result. Such an outcome may potentially lead to an inadvertent and unnecessary redrafting of a particular proposal or possibly contribute to a perceived lack of confidence in the overall marine and common water-space planning processes.

## 4. AUSTRALIAN MSP PERSPECTIVE

The Australian federal government agency responsible for geoscience research, Geoscience Australia (GA), deployed the Australian Maritime Spatial Information System (AMSIS) in 2006 as an integrated cross-agency project to facilitate access to regulatory information in the marine domain. AMSIS, reflecting many MSP principles and outcomes, is a web based interactive mapping and decision support system that improves access to integrated government and non-government information. AMSIS contains layers of information displayed in themes of maritime boundaries including petroleum, fisheries, regulatory, environment, native title and offshore minerals. Information within AMSIS can be interrogated for further details and deeper understanding of the various information themes. Most importantly, by integrating information from many different agencies, AMSIS has the unique ability in government of visually representing all the regulatory interests in a given area, bringing into focus the requirement for cross-sectoral management of the marine space.

The current AMSIS user interface can be seen in **Figure 3**.

GA is currently developing a set of requirements for the third iteration of AMSIS (AMSIS3) which will provide improved functionality suitable for Australia's particular needs by drawing from developments taking place in other international MSP platforms. AMSIS3 will differ from the current version by being designed more logically consistent with the legislative instruments active in the marine space, as well as adopting technologies to provide an improved visual and information gathering experience via a smaller bandwidth (an important consideration for offshore users).

## 4.1 Maritime Spatial Data Infrastructure

AMSIS3 will involve the adoption of the emergent and adaptive GIS framework which has been termed a Maritime Spatial Data Infrastructure (MSDI). To create the MSDI, GA has begun discussions with Australian state and Commonwealth organisations that hold maritime regulatory information to identify relevant sources of geospatial information including commercial shipping traffic. GA has a strong relationship with Australia's Hydrographic Service and is seeking to work collaboratively on developments being progressed by the International Hydrographic Organisation's MSDI Working Group.

GA has a vision to make the MSDI a single shop-front for national maritime geospatial regulatory information. GA is seeking to facilitate other agency's capacity to distribute their own regulatory information by delivering an aggregation service, technical advice on rigorous spatial data and facilitating the delivery of this information. In the future it is envisaged that this capacity will develop into a register of georegulation (spatially defined marine regulatory legislation). Such a registry will be seen to deliver a similar role to Australia's Federal Register of Legislative Instruments. Essentially, providing a central point of discovery and legal certainty in the information obtained. This will provide the opportunity for improved information management and should better inform the MSP activities being carried out.

The MSDI and associated information delivery can be enabled using 'web services' technology. Web services allow a custodian of spatial information to exercise full control and configuration of their information without the need for any third party warehousing whilst making it available to applications, such as AMSIS, for display and integration with other relevant information provided by different organisations.

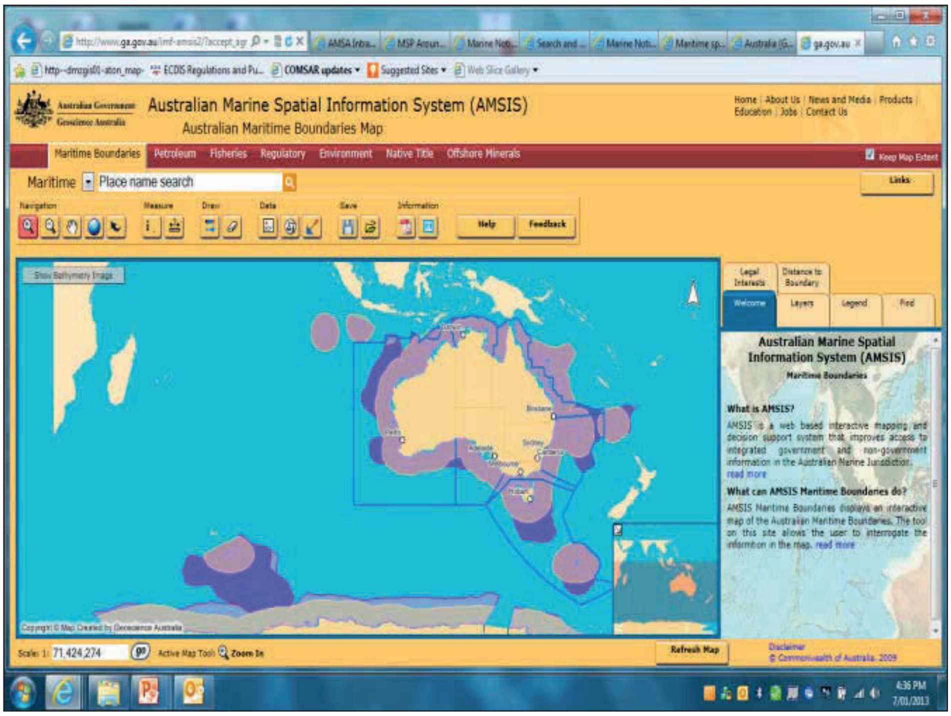



*Figure 3: AMSIS User Interface*

### 4.2 Stakeholder Engagement

To assist in developing practical solutions that could lead to a more complete and mature approach to MSP in Australia and in so doing, enhancing maritime safety, AMSA is engaging with a broad range of related stakeholders. Such engagement includes those representing the different sectors at sea through several national and regional forums (e.g. a national Navigation Safety Advisory Group and another group that deals with Water Space Management issues off Australia's North East coast). This is in addition to working closely with GA to determine what types and themes of information can be supplied that is collectively useful to the MSP process and identified customers.

In expanding GA's spatial data set to include such themes of information as traffic density, IMO adopted protective measures and other navigationally significant areas and/or routing measures, holistic decisions can be supported that promote navigational safety yet help facilitate trade and other combined water space uses.

GA has also prototyped rapid-deployment web technologies for stakeholder engagement, for example by providing a consultation platform for gathering feedback to proposed changes to ship routeing measures. Such web technologies have the following advantages in that they are:

- dynamic;
- can be created quickly and more cheaply than paper products;
- allow user editing and interaction if required;
- provide excellent version and access control;
- portable; and
- easily accessible.

### 4.3 MSP Advancements

GA has achieved a number of recent advances in the development of AMSIS and hence contributing to the development of true, inter-agency/inter-customer MSP in Australia. These developments reflect a concerted effort to address the unique Australian, yet in many cases common, waterspace usage issues in a way that outcomes will be broadly usable within many instrumentalities, including AMSA, and have wide customer acceptance.

GA has made progress in:

- Internal testing of an updated visualisation platform. This testing has begun and is looking promising;
- The majority of nationally significant maritime datasets are either completed or nearing completion;
- Programming for two of GA's software applications has passed final testing which will enable GA to dramatically decrease the effort needed to create and maintain MSP related information;
- Understanding the changes in management and infrastructure that are necessary to support MSP and other related activities;
- Resolving a number of legal, disclaimer and copyright concerns related to providing MSP related data;
- Developing a plan to deploy the necessary "back end" to support the programme which includes skill sets, procedures and infrastructure; and
- Capitalising on 'web service' technology to access proprietary spatial datasets as input into MSP applications.

## CONCLUSION

The flexibility of MSP to be used beyond typical ecological and environmental management using initiatives such as intuitive user interfaces together with enhanced GIS toolsets and additional complimentary spatial datasets can be achieved relatively seamlessly and easily using current technology. Such adaptiveness can be expanded to include management assessments for navigational aids and other protective and management measures.

Software applications used to manage the data required for a robust MSP process should have real time access to an up to date snapshot of the maritime domain and also be the unambiguous source of marine operational and regulatory information. By using such distributive technologies as web services, owners of data can both provide the most up to date information whilst maintaining full custodianship, configuration and management control of their digital material.

When in place, a mature MSP process will enable a national, holistic approach to the regulation and management of coastal, offshore and ocean waters – including the management of practical decision making for navigational safety, resource exploration and many other activities. This in turn will optimise the use of the finite amount of available two and three dimensional water space whilst ensuring MSP becomes an integral part of any marine-based spatial decision making process.

MSP is relatively advanced where protecting ecology or the environment is the main objective. Until recently however mature MSP processes have not often been present when the objective has been to manage operational shipping concerns or to assess maritime safety.

AMSA's interest will be to ensure that shipping is able to continue to operate safely and efficiently. AMSA is promoting a national approach to MSP in Australia by actively participating in related activities including allied conferences and symposia and supporting other government agencies develop appropriate spatial datasets, tools and schemas that can complement the greater MSP process. ■

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[1] Based on *Making the Case for Marine Spatial Planning in Scotland* ; David Tyldesley and Associates May 2004.

## 104 CAPACITY BUILDING INITIATIVES IN THE SOUTH WEST PACIFIC TO ENHANCE THE SAFETY OF NAVIGATION

*Brad Groves. Australian Maritime Safety Authority, Australia*

The south west Pacific region, being remote from many major world suppliers and markets, relies heavily on sea-borne trade. Shipping is therefore extremely important to the region with a vast majority of its trade carried by sea. Adequate shipping services are critical to growth and development in the Pacific region and Australia recognises the importance of enhancing cooperation with its neighbouring maritime counterparts to promote a safe, secure and efficient international shipping sector.

The Australian Maritime Safety Authority's (AMSA) international engagement is conducted primarily through technical cooperation with many of its neighbouring countries. AMSA's technical cooperation program relies strongly on collectively sharing expertise, resources and information to improve the capacity of individuals and institutions engaged in the maritime industry.

While AMSA's technical cooperation program extends across the globe and offers assistance with functions such as port State control, marine pollution prevention and response and maritime and aviation search and rescue, this paper focuses solely on AMSA's capacity building work in the field of navigational safety with countries in the south west Pacific region.

La región del Pacífico Sudeste, lejos de muchos de los grandes proveedores y mercados mundiales, depende totalmente del comercio de transporte marítimo. Por ello, el transporte marítimo es extremadamente importante para la región con una amplia mayoría de su comercio transportado por mar. Los servicios adecuados de transporte marítimo son fundamentales para el crecimiento y el desarrollo de la región del Pacífico, y Australia reconoce la importancia de aumentar la cooperación con sus homólogos marítimos vecinos para fomentar un sector de transporte marítimo internacional seguro, fiable y eficiente.

El compromiso internacional de la Autoridad de Seguridad Marítima Australiana (AMSA) está dirigido principalmente por la cooperación técnica con muchos de sus países vecinos. El programa de cooperación técnica AMSA depende enormemente de compartir experiencia, recursos e información para mejorar la capacidad de las personas e instituciones involucradas en la industria marítima.

Mientras que el programa de cooperación técnica de AMSA se extiende por todo el mundo y ofrece asistencia con funciones como el control estatal de puerto, la prevención y respuesta de la contaminación marina y la búsqueda y rescate marítima y aérea, esta ponencia se centra exclusivamente en el trabajo de desarrollo de capacidad de AMSA en el campo de seguridad en la navegación en países de la región del Pacífico Sudeste.

*La région sud-ouest du Pacifique, isolée des grands fournisseurs et marchés du monde, est extrêmement dépendante du commerce maritime. La navigation est donc vitale pour la région, dont la majorité du commerce s'effectue par la mer. Des services de navigation adéquats sont essentiels à la croissance et au développement de la région pacifique et l'Australie reconnaît l'importance de renforcer la coopération avec ses homologues maritimes pour promouvoir la sécurité, la sûreté et l'efficacité du secteur maritime international.*

*L'engagement international de l'Autorité de sécurité maritime australienne (AMSA) est principalement assuré par la coopération technique avec beaucoup de ses pays voisins. Le programme de coopération technique d'AMSA dépend fortement du partage collectif de l'expertise, des ressources et de l'information pour améliorer la capacité des individus et des institutions impliqués dans l'industrie maritime.*

*Alors que le programme de coopération technique d'AMSA s'étend sur toute la planète et offre son aide dans des domaines tels que le contrôle par l'état du port, la prévention et la lutte contre la pollution marine, et la recherche et le sauvetage maritimes et aériens, le rapport portera uniquement sur les travaux de renforcement des capacités dans le domaine de la sécurité maritime pour les pays de la région sud-ouest du Pacifique.*

# Capacity building initiatives in the South West Pacific Region to enhance the safety of navigation

Brad Groves
Australian Maritime Authority

IALA·2014·AISM
XVIII Conference · A Coruña · Spain

# Capacity building initiatives in the South West Pacific Region to enhance the safety of navigation

Brad Groves– Australian Maritime Safety Authority

## 1. INTRODUCTION

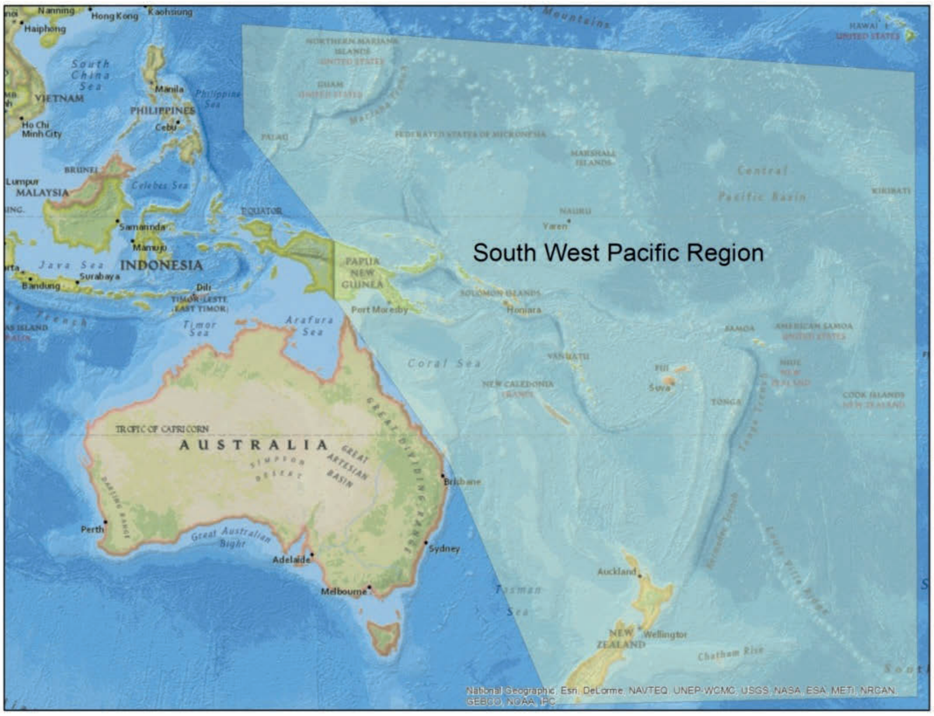
AMSA is an Australian Government regulatory safety agency with the primary role of delivering services in relation to maritime safety, maritime and aviation search and rescue and protection of the marine environment.

In the context of navigation safety, AMSA's primary responsibility includes the provision of the national aids to navigation network and navigational systems. One of the strategic objectives in this regard is to adopt technological advances to improve navigational safety.

AMSA's technical cooperation program has a strong emphasis on Australia's geographic neighbourhood and trading partners, which includes the south west Pacific region. Technical cooperation encompasses assistance activities designed to develop human resources through improvement in the level of skills, knowledge, technical know-how and productive aptitudes of the population in a developing country.[1]

AMSA's work with its neighbouring maritime authorities has been extensive in recent years, hosting numerous activities such as seminars, workshops and training courses as well as providing expert assistance with the management of aids to navigation.

*Map: AMSA's capacity building in the south west Pacific region*




## 2. CHALLENGES

Providing safe, secure and efficient shipping services to many parts of the Pacific region is highly challenging. With considerable shipping traffic growth projected in the years to come, some of the challenges faced by maritime administrations relating to navigation safety in the region include:

- a lack of suitably qualified personnel;
- limited aids to navigation infrastructure;
- outdated legislation;
- a lack of funding for the development, maintenance and upgrading of national maritime infrastructure;
- regulation of variable quality shipping, passenger ships and domestic vessels;
- privatisation of infrastructure and potential loss of community service obligations (ie. Pollution response, waste disposal etc); and
- high costs associated with maintaining technologically advanced business systems across the large and often remote Pacific islands.

The challenge for AMSA is to have constructive and on-going engagement with these remote nations – nations where governance arrangements may be poor or constantly evolving and where the capacity of both AMSA and the PICT maritime administration to provide and absorb new knowledge and processes is limited. For this reason, and to maximise cooperative and regional oversight, we take every opportunity to work with intergovernmental organisations such as the SPC to tap into existing efforts and networks.

For some time now, AMSA has recognised a lack of regional voice that Pacific Island countries have at the IMO and IALA. We have taken steps to have a stronger regional voice through promoting the importance of regional groups such as APHOMSA within the international community. It is also important to continue to nurture close and personal relationships at the senior and technical officer level of PICT maritime administrations so we keep abreast of developments within the Pacific region. In the future, we propose to renew our relationship with the IMO's regional Asia Pacific advisor (based in Manila) and other Pacific Forum meetings to raise AMSA's profile and the work we do on technical cooperation in the Pacific.

## 3. OPERATIONAL ARRANGEMENTS

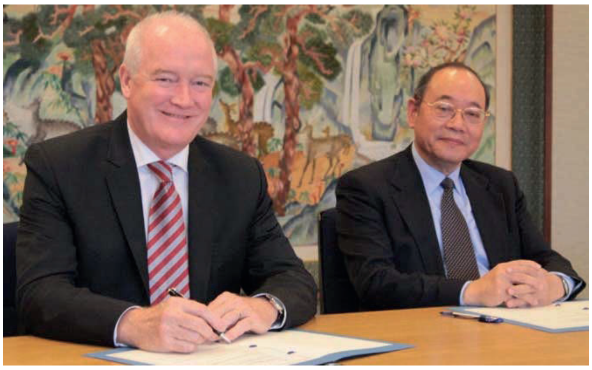
A number of operational arrangements are in place to assist AMSA in delivering its technical cooperation activities across the Pacific region.

### 3.1 International Maritime Organization (IMO)

Australia is an active member of the IMO's Technical Cooperation Committee. The IMO has developed an integrated Technical Cooperation Program which is designed to assist governments which lack the technical knowledge and resources needed to operate a shipping industry safely and efficiently.

In 2012, AMSA and the IMO signed a memorandum of understanding to support the IMO's Technical Cooperation Program activities. AMSA provides subject matter experts to assist in the delivery of this program.

*Photo: AMSA's Chief Executive Officer, Graham Peachey (left), signing the MOU on technical Cooperation with Mr Jianxin Zhu, Director of the IMO's Technical Cooperation Division*



### 3.2 IALA World Wide Academy

The IALA World Wide Academy works closely with the IMO, the International Hydrographic Office and other national authorities to improve the safety of navigation world-wide. Assessments of a number of Pacific nations have been contacted by the IALA World-Wide Academy to determine their aids to navigation capability and needs. For the Pacific region, the IALA World Wide Academy has declared the following nations as 'medium risk' and requiring capacity building assistance within the next six years:

- Cook Islands;
- Fiji;
- Nauru;
- Samoa;
- Solomon Islands;
- Tong;
- Tuvalu; and
- Vanuatu.

*Photo: In November 2013, IALA assisted the IALA World Wide Academy deliver a Level 1 Aids to Navigation Manager training course in Papua New Guinea. Nine participants completed the course successfully and gain an IALA Certificate of Competency.*

AMSA uses information provided by the IALA World Wide Academy to prioritise its capacity building activities in the Pacific region.

AMSA has also been endorsed by IALA as its 'point of contact' for coordination of IALA World Wide Academy activities in the Asia Pacific region.

### 3.3 Asia Pacific Heads of Maritime Safety Agencies (APHoMSA) forum

APHoMSA was established in 1996 in order to provide a forum for heads of maritime agencies to enhance cooperation within the Asia Pacific region. APHoMSA last met in July 2013 in Cairns, Australia. Representatives from 20 member states and 5 international organisations attended, including the IMO and IALA.

The meeting reaffirmed the importance of APHoMSA as a forum for providing maritime agencies with opportunities to share information on matters of mutual interest. The meeting also agreed to develop a regional technical cooperation action plan to be reviewed prior to each APHoMSA meeting. Development of this plan is currently in progress.

### 3.4 Secretariat for the Pacific Community (SPC)

The SPC is an international organisation that works across a number of sectors including dealing with maritime matters in the Pacific region.

The SPC has 26 members, 22 of which are made up from Pacific island countries and territories and is the implementing body for the IMO's technical cooperation activities. This involves providing technical, legal and policy advice on maritime matters and assisting countries to build their capacity to maintain compliance with international maritime obligations.

### 3.5 AMSA Technical Cooperation Strategy

AMSA's Technical Cooperation Program is driven by AMSA's Strategic Vision, Corporate Plan and a range of regional directives and strategies. In 2010, AMSA released its five year Technical Cooperation Strategy to 2015. The strategy includes an expression of AMSA's commitment to build capacity and provide technical assistance to other maritime nations, particularly those in the Asia Pacific region.

### 3.6 Memorandums of Understanding (MOU) / Agreements

AMSA has in place MOU's or Agreements with several nations in the Pacific region to facilitate the delivery of technical cooperation activities. The activities described under the agreements are broad reaching and include the provision of aids to navigation. Countries in the Pacific region with formal agreements with AMSA include:

- New Zealand;
- Papua New Guinea; and
- Cook Islands

AMSA is currently working towards a regional approach to technical cooperation and further agreements with regional agencies may be formalised in the future.

## 4. RECENT CAPACITY BUILDING INITIATIVES IN THE SOUTH WEST PACIFIC REGION

In recent years AMSA has actively engaged in aids to navigation capacity building activities in the Pacific region. Some of the key achievements of the past two years are described in the **table at Page 6**.

## 5. OPPORTUNITIES FOR FUTURE CAPACITY BUILDING INITIATIVES IN THE SOUTH WEST PACIFIC REGION

Australia and AMSA remains committed to providing assistance to maritime nations in the South West Pacific region through supporting the technical cooperation programs of the IMO, IALA World Wide-Academy, the International Hydrographic Organization and other regional maritime forums.

As a member of the IMO's Technical Cooperation Committee, AMSA will be guided by, and assist in implementing their Integrated Technical Cooperation Program (ITCP), the purpose of which is to build human and institutional capacity in developing countries for uniform and effective compliance of international maritime instruments. The ITCP commenced in the 1960s and is kept under review to ensure amendments to existing regulatory instruments and the development of new instruments at the IMO are taken into account in fostering capacity building in the maritime sector.

A short term priority is to support and encourage Competent Authorities of IALA National Member States to accredit Approved Training Organisations to deliver both Level 1 Manager and Level 2 Technician training for their own personnel and other authorities in their regions. This move is expected to enable participants of the November 2013 Aids to Navigation training course in Papua New Guinea to be able to train their own personnel to deliver aids to navigation services that are compliant with IALA's Recommendations and Guidelines.

In establishing a more sustainable maritime sector as highlighted by the Rio+20 World Sustainability Conference, IMO will focus on energy efficiency, maritime traffic management and infrastructure development as well as adoption and implementation of global standards for shipping and maritime industries. At the July 2013 meeting of the IMO's Technical Cooperation Committee, the Secretary-General announced that profiling of country maritime needs will form the basis of the IMO's technical co-operation from 2015 onwards. Profiling, which will include nations in the south west Pacific region, will play a fundamental role in formulating a needs-based technical cooperation program to assist in the development of their maritime policies.

Ensuring there is a coordinated, sustainable and strategic approach to capacity building is an on-going challenge for AMSA and requires effective and appropriate use of limited resources. To this end, AMSA actively participates in bilateral and multi-lateral fora to minimise duplication and improve project prioritisation. AMSA continues to look to strengthen existing partnerships with other governments, organisations and industry so we can add value to existing capacity building efforts. AMSA is also constantly looking at ways to improve the delivery and reporting of our technical cooperation efforts.

Recently, AMSA was invited to join the transport related issues meeting organised by the Pacific Region Infrastructure Facility (PRIF). PRIF is a multi-partner investment, coordination and technical facility for improved infrastructure in the Pacific, supported by the Asian Development Bank, the Australian Agency for International Development, the European Commission, the European Investment Bank, the New Zealand Ministry for Foreign Affairs and Trade and the World Bank Group. It provides technical assistance for advisory and project preparatory support to partner countries, a number of which target maritime transport networks and institutions in countries such as Solomon Islands, Vanuatu, Tonga, Kiribati and Papua New Guinea.

## 6. FUNDING

Increasingly, funding technical cooperation is becoming more and more challenging. To date, AMSA has relied on funding from Australian Aid as well as funds from other government departments and in-kind funding. The main facility used has been the Public Sector Linkages Program, a program that makes available up to $250,000 for strengthening whole-of-government responses to issues and priorities affecting Australia's national interest by introducing greater consistency of approach, user-friendliness, flexibility and responsiveness, and improving activity design and reporting quality.

A new initiative, the Government Partnerships for Development (GPFD) program, will replace the PSLP. The GPFD will facilitate partnerships between Australian public sector organizations and their developing country counterparts to enable exchange of skills, experience and knowledge in support of Australia's aid program objectives.

GPFD funding will be provided through an annual competitive process to eligible Australian Government agencies. The minimum total grant is $1 million over the life of the activity, and a maximum $4 million. Activities may run for a minimum of one year up to a maximum of three years.

AMSA also relies on funding from the IMO Integrated Technical Cooperation Program, primarily for resourcing of technical experts to run training courses in the region.

## 7. CONCLUSION

The skills needed to navigate a ship in often busy and environmentally sensitive waters are considerable.

AMSA's capacity building work in the south west Pacific region helps address the risks that unseaworthy and substandard shipping pose to regional interests, from industry, trade and tourism to protection of the marine environment.

Australia and AMSA remains committed to achieving these objectives by working with the IMO, IALA and other regional authorities to carefully target its capacity building work to address high priority areas. To this end, AMSA will continue working at the bilateral, regional and international level with the aim of transitioning to a more targeted, sustainable and regional approach to technical cooperation. ■

[1] ECDPM / ACE Europe, 2006, "Changing Minds and Attitudes: Towards Improved Belgian Technical Assistance" http://www.ecdpm.org/Web_ECDPM/Web/Content/Download.nsf/0/19BFB9C0D2D7B3E9C125724C00448AC2/$FILE/btc%20report%20-%20final%20final%20version%20as%20published%20on%20BTC%20website%2022122006.pdf

## RECENT CAPACITY BUILDING INITIATIVES IN THE SOUTH WEST PACIFIC REGION

| Date | Activity | Description | Pacific Nations/Forums Involved |
|---|---|---|---|
| Apr 11 | Framework to enhance safe, secure and competitive transport across Pacific island countries and territories. | In partnership with AMSA, Pacific island countries and territories and other regional and international authorities, the Secretariat of Pacific Communities (SPC) has developed a framework to enhance national efforts to achieve safe, secure and competitive transport across Pacific island countries and territories. A key component of the framework is the development and improvement of aids to navigation and hydrographic surveys. Review of the framework is scheduled to occur in April 2014. | SPC members |
| Mar 12 | Provision of advice to Papua New Guinea on aids to navigation maintenance in high use waterways | AMSA provided expert advice to the Asian Development Bank to help identify the needs of aids to navigation maintenance in high use waterways of Papua New Guinea. The advice will assist in the improvement and maintenance to a number of aids to navigation in the Papua New Guinea area, including:<br>• 70 light structures:<br>• 162 small day-markers and light beacons;<br>• production of electronic navigation charts; and<br>• extension of the automatic identification system. | Australia, Papua New Guinea. |
| Aug 12 | Workshop on Particularly Sensitive Sea Areas (PSSA), Townsville, Australia. | AMSA assisted the IMO with hosting a workshop in Townsville, Australia on Particularly Sensitive Sea Areas (PPSA) for member states of the South Pacific. . The workshop aimed to identify significant areas of the Pacific that may be considered for designation as a PSSA due to the threat of shipping activity. The workshop also provided participants with guidance on the application of IMO instruments that protect sensitive sea areas from the effects of shipping, particularly guidelines associated with identification and designation of PSSA's. | Australia, Cook Islands, Micronesia, Fiji, Kiribati, Marshall Islands, Niue, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Tong, Tuvalu and Vanuatu. |
| Nov 12 | IALA risk assessment seminar, Sydney, Australia. | IALA and AMSA jointly hosted a training seminar on the use of two contemporary IALA risk assessment models that assist authorities in managing risks associated with maritime safety and environment protection. The seminar was conducted in Australia to specifically enable skills development and participation by maritime authorities in the Pacific region. The seminar was attended by 66 delegates from 18 countries, many of which were from the Pacific region. | Australia, Cook Islands, Fiji, Nauru, New Zealand, Solomon Islands, Samoa, Papua New Guinea, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna, and the SPC. |
| Nov 12 | IALA SOLAS Chapter V obligations of coastal states training seminar, Sydney, Australia | Immediately following the risk seminar in Sydney, IALA and AMSA jointly hosted a training seminar on the obligations of coastal states under Chapter V of SOLAS. The seminar was attended by 25 delegates from 12 countries, many of which were from the south west Pacific region. | Australia, Cook Islands, Fiji, Nauru, New Zealand, Solomon Islands, Samoa, Papua New Guinea, Tokelau, Tonga, Vanuatu, Wallis and Futuna, and the SPC. |
| July 13 | Agreement of Regional Technical Cooperation Action Plan, Cairns, Australia. | At the July 2013 meeting of the Asia Pacific Heads of Maritime Safety Agencies (APHoMSA) forum in Cairns, Australia, agreement was reached to develop a regional technical cooperation action plan to be reviewed prior to each APHoMSA meeting. Development of this plan is currently in progress. | APHoMSA members |
| Nov 13 | Level 1 Aids to Navigation Manager Training Course, Papua New Guinea. | AMSA assisted the IALA World Wide Academy with the delivery of a five day modular Level 1 Aids to Navigation Manager training course in Papua New Guinea. The training course covered topics such as aids to navigation management, service delivery, risk management, review and planning, performance management and quality and heritage matters. Eleven participants from 6 countries took part in the course. Nine participants were awarded an IALA Certificate of Competence. | Papua New Guinea, Kiribati, Tonga, Solomon Islands, Fiji and Tuvalu |

## 126 INCREASED SUSTAINABILITY OF SEA TRANSPORT BY INTEGRATION OF ICT AND ITS SOLUTIONS: THE MONALISA 2.0 PROJECT

*Anders Brodje, Ulf Svedberg. Swedish Maritime Administration, Sweeden*

Efficiency of ship operations can be further enhanced by the introduction of Sea Traffic Management (STM). The MONALISA 2.0 project contributes with a holistic approach to the maritime domain by developing means for the sharing of information in order to distribute, elaborate and process common data within the whole transport chain. Through the introduction of ICT and ITS solutions, STM is further advanced by the development of new tools enabling more efficient planning, booking, monitoring of sea traffic, cargoes and passengers. It is crucial that these e-solutions are developed in a common manner and experiences from the EU-project SESAR, within the air domain, is used in order to find the safest and most cost effective solutions. As a carrier of information, the voyage numbers will provide the ultimate keys for efficient cross sectoral intermodality, in order to obtain real sharing of maritime related information. By the implementation of this enhanced STM service it is envisaged that the environmental footprint of sea transport will be reduced even further while still reducing costs and raising safety levels.

La eficiencia de las operaciones marítimas puede mejorar todavía más debido a la introducción de la Gestión de Tráfico Marítimo (STM). El proyecto MONALISA 2.0 contribuye con un enfoque holístico al espacio marítimo desarrollando medios para compartir información con el fin de distribuir, elaborar y procesar datos comunes en toda la cadena de transporte. Mediante la introducción de soluciones TIC y STI, el STM continúa avanzando gracias al desarrollo de nuevas herramientas que permiten una planificación, registro y control más eficiente del tráfico marítimo, cargamento y pasajeros. Es fundamental que estas e-soluciones se desarrollen de una forma común y que las experiencias del proyecto europeo SESAR, en el campo del espacio aéreo, se utilicen para encontrar las soluciones más seguras y más rentables. Como portador de información, el número de viajes proporcionará las principales claves para una eficiente intermodalidad intersectorial, con el fin de conseguir que se comparta realmente la información marítima relacionada. Mediante la implantación de este servicio STM mejorado se prevé que la huella medioambiental del transporte marítimo se reduzca todavía más mientras continúan disminuyendo los costes y elevándose los niveles de seguridad.

*L'efficacité du transport par mer peut encore être améliorée par l'introduction de STM (Sea Traffic Management – Gestion du trafic maritime). Le projet MONALISA 2.0 y contribue, avec une approche holistique du domaine maritime, en développant le partage des informations pour distribuer, élaborer et traiter les données communes dans toute la chaîne du transport. Avec l'introduction de solutions ICT et ITS, le STM va plus loin avec le développement de nouveaux outils permettant une planification, une réservation et une gestion du trafic, passagers et fret, plus efficaces. Il est essentiel que ces e-solutions soient développées en commun et que les expériences du projet européen SESAR, dans le domaine aérien, soient utilisées pour trouver les solutions les plus sûres et les moins onéreuses. Comme porteur d'information, le nombre de voyages fournira les clés d'une inter modalité sectorielle croisée. Il est envisagé que l'installation de ce STM amélioré réduira l'empreinte du transport maritime sur l'environnement tout en réduisant les coûts et en améliorant la sécurité.*

# Increased sustainability of sea transport by integration of ICT and ITS solutions: The MONALISA 2.0 project

Anders Brodje & Ulf Svedberg

Swedish Maritime Administration

IALA·2014·AISM

XVIII Conference · A Coruña · Spain

Anders Brodje & Ulf Svedberg, Swedish Maritime Administration

## 1. BACKGROUND

The maritime sector is a key link in the global transport chain. Approximately 90% of all world trade is conducted using sea freight. Some 51,000 merchant vessels of more than 500 gross tonnage (GT) are involved in carrying this cargo. In addition to these cargo carriers, there are some 27,000 other vessels of similar size, though they lack cargo carrying capacity. These include large fishing vessels, cruise and research vessels, as well as some 9,000 military vessels exceeding 500 GT.

Within the waters of the European Union – one of the world's major consumer markets – there are approximately 17,000 vessels transiting per day. Also, on a yearly basis, there are some 29,000 calls to ports within the area. These calls alone generate some 580,000 individual vessel movements per year within the territorial waters of EU member states.

Accident reports have shown that approximately 500-600 maritime accidents occur yearly within EU waters. The results of these accidents include potential loss of life and the immediate environmental effects of maritime accidents, loss of cargo and loss of or damage to vessels. Moreover, the effects can present severe long-term problems for marine flora and fauna.

When AIS was introduced, one of the system's major purposes was to serve as an aid for navigators in order to increase their situational awareness. The system has certainly fulfilled this. Over time AIS has come to be more and more integrated into various onboard applications. The information is fused with such information as own position on an electronic chart, allowing the navigator to better understand the current surrounding situation by also knowing facts of other vessels. Yet, AIS has also come to be widely used in many shore-based applications, for instance in VTS. However, even though a strong provider of the current situation, AIS does not tell about the future. Thus, none of the users of the information know the intentions of vessels. Navigators know their own route, and can use modern tools to plan and optimise this.

The MONALISA project, 2010-2013, has showed how supplying vessels with the capability of seeing each other's planned routes, gives the navigator a more complete picture of how surrounding vessels are planning their onward voyage. Also, shore side services are able to retrieve valuable information as well as supply vessels with advice on their routes. Such advice could be in the form of recommendations to avoid congestion in areas with high traffic, advice on environmentally sensitive areas and Maritime Safety Information.

Further, the MONALISA project has shown that implementing route optimisation on a full scale in sea transport would result in increased environmental sustainability as well as reduced costs and increased safety. With the voyage optimisation tool developed within the project, bunker consumption can be reduced by up to 12% for the average vessel. The voyage optimisation tool has been tested and verified for traffic sailing in the Baltic Sea. For the tests historic AIS data was used for analysis. In order to optimise the route for each individual ship, the voyage optimisation tool uses high resolution chart data and ship dimensions, current loading condition, etc.

A socio-economic analysis carried out within the MONALISA project, has indicated that every percent saved on bunker consumption, saves approximately 100 M€ on a yearly basis for traffic sailing in the Baltic Sea Region. Approximately half of the savings are due to less emissions cost for society, and the other half are fuel and other costs for the ship owners. Baltic Sea traffic makes up approximately 10% of the European total sea traffic, giving an indication of the potential savings in Europe alone.

In the MONALISA 2.0 project, 2013-2015, the demonstrated results from the previous project will take a major step towards deployment through joint actions through testing concrete applications and services that would allow swift commercial deployment. A joint private-public action will elaborate standards for route exchange through a common interface and common data format, thereby allowing equipment from all manufacturers to be used for the concept. The project aims at demonstrating concrete services with the use of new technology to enhance maritime safety. An area of focus within this work is the focus on making Search and Rescue as well as mass-evacuation more efficient than is currently the case and by addressing port safety. An important step in this development process is the transfer of results from previous EU investments in air traffic management to the maritime domain. By adapting and scaling ideas and solutions for traffic flow optimisation and information sharing from the aviation industry, development within the maritime domain is envisaged to be smoother, faster and less costly. A cornerstone within this work is the development of Sea Traffic Management.

## 2. SEA TRAFFIC MANAGEMENT

Sea Traffic Management (STM) is the concept of sharing and using all information from the maritime domain in real time. It facilitates seamless services in collaboration with all parties, involving both seaborne and shore-based functions. A key feature of the STM concept is that all parties involved in the maritime logistics chain *share* information.

*STM encompass all actors, actions, and systems (infrastructure) assisting maritime transport from port to port. STM is a part of the multimodal logistics chain; encompassing sea as well as shore based operations and is a network-based approach for optimal Intermodal Sea Transport. STM is performed on multiple actor levels, where each engaged actor co-produces traffic management. These actors contribute to the integrated performance of the realization of the performance targets of intermodal Sea Transport as the shared common object of interest of the ecosystem constituting Sea Transport. STM puts an emphasis on interoperable and harmonized systems allowing a ship to operate in a safe and efficient manner from port to port with a minimal impact on the environment. STM secures sea traffic flow and capacity optimization.*

STM is the dynamic, integrated management of sea traffic and maritime space, including sea traffic services, management of the maritime space and sea traffic flow management. STM is realised through the provision of facilities and seamless services in collaboration with all parties and involves seaborne as well as shore-based functions. The aim of STM is safe, environmentally friendly and efficient shipping. STM involves the aggregation of seaborne and shore-based functions required for ensuring the safe and efficient movement of vessels during all operational phases. The approach is based on experiences from Air Traffic Management (ATM) and the SESAR programme. Learning from ATM principles and experiences; structures, processes, methods and concepts will be adapted, scaled and adopted to the maritime domain.

An enabler for STM is the notion of voyage numbers. A voyage of a vessel, from port to port, can be described using a unique voyage number, where the voyage number serves as an information carrier for all parties involved. As soon as any new information with regard to the voyage, goods carried, etc., is known or modified, it is made available for others to use. By sharing information, all parties in the maritime transport chain can improve their operations. Ports will have up-to-date data on all ships and can plan accordingly. The captain will get information regarding port availability and can thus optimize his route. The key is to share information as early as possible, thus making work easier for other parties involved. Use of a voyage number can stretch from the planning of a cruise voyage years in advance, to updates on which tug boat will assist when leaving a birth. Even though information shared, this does not imply that the information is publically available. Only authorised parties will be able access the information, and the level of authorisation would vary depending on the specifics of the information.

Most sea voyages starts and ends in a port. Thus information from the involved ports will be of utmost importance in order to optimise a sea voyage. Further, information about goods carried onboard is of interest to the whole logistics chain, as described in **Figure 1.**

In order to enhance the value added to the logistics chain by maritime transport, information needs to be synchronised, making sure that no piece of information is lost or incorrect. In the end, lack of synchronisation will have a negative effect on the end users of the logistics chain. Even for a consumer, information on where goods, ordered on a web store, are is readily available: when the goods left the warehouse in Alberta, when the goods entered the Lyon sorting terminal, when on a lorry between Lyon and Berlin, in a delivery van close to the end delivery address. All of the updates are accompanied by estimated times for each leg and an updated ETA for the particular goods. Today, this information is not available in maritime transport. However, by co-ordinating the development of STM with other parts of the logistics chain, this kind of information exchange can be made possible.

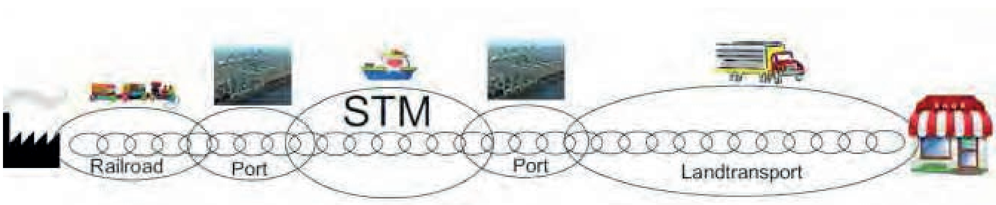



*Figure 1: How maritime information should be co-ordinated with other parties*

## 3. DEVELOPING STM

During the span of the project, MONALISA 2.0 will investigate benefits of STM in more detail. An example of such an area of focus is fuel savings due to just-in-time-arrivals in port. The aim is of course that ships should be able to save fuel and costs by using optimised routes and a speed adapted to match the availability of port services. Further development and verification of operational and technical aspects supporting the STM concept, such as route exchange between ships and shore centres and time slot allocation in congested waters, are important steps towards future deployment and will also be investigated. Standard Operating Procedures, a work initiated in the first MONALISA project, will be further developed in order to foster safe and efficient deployment.

The MONALISA 2.0 also encompass the development of several Decision Support Tools for route exchange and route optimization as well as tools developed aiming at further reducing accidents through an enhanced anti-collision aid. It is envisaged that a reduction of accidents may lead to lower insurance cost for the shipping industry apart from purely environmental benefits, both of which will be investigated in the course of the project. In an effort to enhance concept efficiency, a number of Decision Support Tools will also be integrated into the system, such as a dynamic Maritime Spatial Planning tool, providing up-to-date environmental data which will assist ships avoid environmentally sensitive areas.

As described above, sharing of information is a key feature for the success of the concept of STM. Sharing of information will be facilitated through a service oriented architecture based on the Maritime Cloud concept facilitating System Wide Information Management (SWIM). **Figure .2** below, shows the fundamental ideas of the Maritime Cloud.

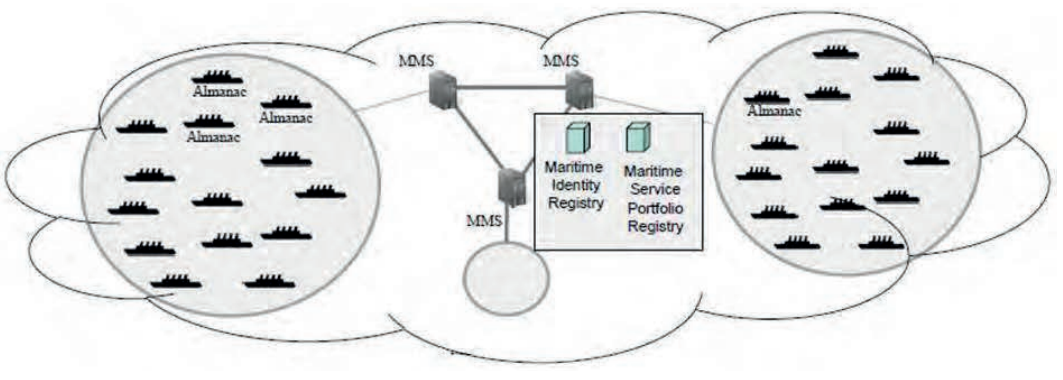



*Figure 2: The Maritime Cloud provides an infrastructure for "authorized seamless information transfer on board ship, between ships, between ship and shore and between shore authorities and other parties with many related benefits" (MSC 85/26/Add. 1 Annex 20).*

The concept of SWIM facilitates the sharing of information between different systems supporting the STM make the right information available at the right place and at the right time. In this, the Maritime Cloud infrastructure serves as an enabler for the involved systems in order for those systems to share and reuse information, thereby increasing interoperability. The SWIM concept enables participants in such a system to publish information of interest to all users, as well as request and receive information from other participants.

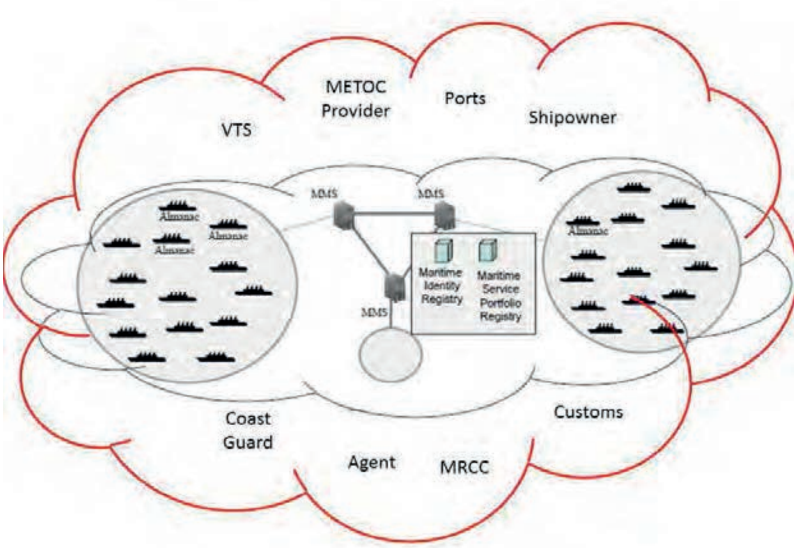



*Figure 3: The Maritime Cloud forming an infrastructure for the concept of System Wide Information Management.*

The SWIM concept allows system applications within STM to interact with one another through information services. These information services can be accessed without the knowledge of an application's underlying platform implementation. This will simplify interface requirements to already deployed ship- and shore-based systems and will ensure that new systems can be developed with minimum limitations with regard to technical aspects. **Figures .3** illustrates the concept of SWIM set into the context of the Maritime Cloud.

The development of the concept of STM will take a considerable leap forward, as many of the major manufacturers of navigational equipment have joined forces in MONALISA 2.0. A major share of the key manufacturers of navigational equipment are currently involved with the ongoing work within the project's technical advisory group, in order to develop a format and architecture allowing route/voyage plans to be seamlessly exchanged irrespective of the equipment brand.

Testing and verification of the concepts developed within the MONALISA 2.0 will be conducted both by simulation and real life testing. The latter will be facilitated through the Global e-navigation testbed and in close cooperation with research and development personnel from South Korea and Denmark. With regard to simulation, by engaging several maritime simulator centres, these centres will form a European Maritime Simulator Network (EMSN). This will be achieved by interconnecting the simulators in macro simulations using a large number of simulated ships. Simulations of entire sea traffic environments in selected test areas will form the basis for studying the effects on safety, environment and efficiency. Through the macro simulation in the EMSN and real life testing in the Global e-navigation testbed, needs for further development and investigation will be identified. An important tool in this testing and verification process is the Formal Safety Assessment.

The work in MONALISA 2.0 is well aligned with the work carried out within IMO and IALA. Work on several tasks of the proposed Strategic Implementation Plan for e-navigation is currently underway.

## 4. SUMMARY

Like all industries, shipping is supported by modern technology. Sophisticated equipment is in place on board vessels and on shore, providing more and more information. However, much the information provided cannot transfer easily between equipment and information resources. In order to transfer information between these, more often than not, manual procedures are used. Depending on the parties involved, both information requirements and procedures vary within regions and across the globe. Even internal communication within one organisation can be cumbersome and require manual handling. Due to the many parties involved in shipping and the complexity of the information flow, many information flaws and errors occur, giving birth to problems, and in some cases even accidents. This paper has described the concept Sea Traffic Management (STM), as being developed within the MONALISA 2.0 project, and how its implementation can affect the industry. The paper has presented how STM relates to other concepts and projects and how information can flow through the logistics chain, integrating maritime transport into the whole chain from producer to retailer. Early findings from the MONALISA 2.0 project have been presented followed by a discussion on how STM-based solutions will increase safety of maritime transport, whilst increasing efficiency and reducing the environmental effects of shipping.

## 7 INNOVATIVE USE OF AIDS TO NAVIGATION IN MARKING WAVE & TIDAL RENEWABLE ENERGY SITES

*Peter Douglas. Navigation Manager Northern Lighthouse Board, Scotland, United Kingdom*

The Orkney Islands, lying to the North of the United Kingdom, are exposed to the full force of the Atlantic running into the North Sea. This produces energetic wave conditions and reported tidal streams of up to 16 knots; the area is considered to contain huge untapped energy extraction potential, including some 25% of Europe's tidal energy resource.

Northern Lighthouse Board uses this opportunity to test innovative means of marking such devices, which is a particularly demanding task in areas of high tidal flow. Risk assessment is undertaken using a combination of AIS-derived data, Geographic Information Systems and IALA's IWRAP Risk Assessment software. Marking options under consideration include Virtual AIS, High-flow buoys, shore markers, leading lines and lights-in-line. Experience gained in this environment is fed back into IALA to improve Recommendation O-139 on the Marking of Man-made Structures.

Las islas Orkney, que se encuentran al norte de Reino Unido, están expuestas a toda la fuerza de las corrientes del Océano Atlántico en el mar del Norte. Esto produce situaciones de fuerte oleaje y se han registrado corrientes de marea de hasta 16 nudos; se considera que el área contiene un enorme potencial de extracción de energía sin explotar, incluyendo alrededor del 25 % de los recursos de energía mareomotriz de Europa.

El Northern Lighthouse Board utiliza esta oportunidad para ensayar innovadores medios para balizar dichos dispositivos, lo que constituye una tarea particularmente exigente en áreas de flujo de marea alto. La evaluación de riesgos se realiza utilizando una combinación de datos derivados del AIS y de Sistemas de Información Geográfica y el software para la Evaluación de Riesgos IWRAP de la IALA. Las opciones de balizamiento en estudio incluyen AIS virtuales, boyas de alto flujo, balizas de costa, líneas de enfilación y luces en línea. La experiencia adquirida en este entorno se transfiere a la IALA para mejorar la Recomendación O-139 sobre Señalización de Estructuras Artificiales.

*Les îles Orkney, au Nord du Royaume Uni, sont exposées à la pleine force de l'Atlantique entrant dans la Mer du Nord. Ceci entraîne des conditions de houle énergétique et des courants de marée allant jusqu'à 16 nœuds ; la zone est considérée comme génératrice d'une énorme source d'énergie encore inexploitée, soit environ 25% des ressources en énergie des marées de l'Europe.*

*Le Northern Lighthouse Board (Ecosse) utilise cette opportunité pour tester des moyens innovants pour baliser ces installations, une tâche particulièrement ardue dans ces zones de haut coefficient de marée. L'évaluation des risques découle d'une combinaison de données AIS, de systèmes d'informations géographiques et du logiciel d'évaluation du risque IWRAP de l'AISM. L'AIS virtuel, les bouées, les marques à terre, les feux d'alignement et les alignements de feux, sont les options de signalisation étudiées. L'expérience acquise dans cet environnement est renvoyé vers l'AISM pour améliorer la Recommandation O-139 sur la signalisation des structures en mer de construction humaine.*

# Innovative use of Aids to Navigation in marking Wave & Tidal Renewable Energy sites

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IALA·2014·AISM
*XVIII Conference · A Coruña · Spain*

## INTRODUCTION

Scotland lies on the Eastern side of the Atlantic Ocean, and is the recipient of a prevailing westerly airflow and wave impact. Although not always welcomed by residents or visitors, this weather offers opportunities in the form of significant renewable energy resources. Additionally, Scotland acts to obstruct the tidal flow between the Atlantic and the North Sea, and this results in some of the strongest tidal conditions anywhere in the world, as currents are compressed between the Scottish mainland and the Orkney Islands, a narrow area known as the Pentland Firth.

There has been long-running interest in tapping these wave and tidal resources to produce energy, however low investment levels, and the difficulties of transferring power from the coastal periphery to users concentrated in the South and East of the nation, have prevented any significant development to date. In recent years, however, a growing political interest in renewable energy combined with a growth in technological capability, much of it sourced from the oil and gas sector, have produced innovative and more efficient energy-extraction devices. Funding from both government and the energy supply industries has taken the initial concepts from prototyping through to demonstrator level and, as of this year, the first commercial level installation site, at the Inner Sound.

A major element part of this scaling process has been the opportunity to test prototyping devices. The European Marine Energy Centre (EMEC) is based in Orkney and offers a number of test berths where devices can be exposed to increasingly challenging wave and tidal conditions, with the performance of the devices monitored from shore throughout.

*OpenHydro pile-mounted turbine at EMEC tidal test site*

## OPENHYDRO PILE–MOUNTED TURBINE AT EMEC TIDAL TEST SITE

Inevitably there is potential for conflict with shipping of all sizes during this process, with risks resulting from:

- The potential for collision with vessels deploying renewable energy devices
- The potential for allision with surface piercing fixed devices
- The potential for collision with floating, submerged or semi-submerged devices
- Additional collision or grounding risks as a result of areas of sea being charted as development areas, forcing mariners away from these areas
- The potential for collision with vessels laying electrical cables or pipelines
- Limited anchoring opportunities as a result of cables or pipelines
- The potential for collision with maintenance vessels
- The potential for devices to break loose and become floating hazards
- The potential for collision with decommissioning vessels

EMEC has been operating in Orkney for eleven years, and Northern Lighthouse Board (NLB) has been fortunate to maintain a close liaison with EMEC throughout this period. In the initial absence of appropriate guidance as to how to mark and otherwise mitigate the additional risks to marine navigation, NLB and EMEC agreed an ad-hoc marking scheme for the early test sites. This was later fed back to IALA in the form of a draft Recommendation, which was submitted to the Aids to Navigation Management (ANM) Committee and subsequently emerged as IALA Recommendation O-131. At a later date, this document was merged with others to become Recommendation O-139 on the marking of man-made structures, and this document has just been re-issued.

## THE MARINE LICENSING PROCESS

All marine developments in Scottish waters require a Marine Licence, issued by government. One of the central pillars of the licensing process is to address navigation concerns, whether commercial, military, fishing or leisure in origin. NLB are a statutory consultee under this process, which obliges government to seek our views on any development. In practice, developers are strongly encouraged to discuss proposals with stakeholders such as NLB long before the actual licence application is submitted. We welcome this as it enables early comment and hopefully dissuades developers from pursuing projects which we will ultimately advise against licensing, but allows early consideration of marking within their planning processes.

As part of a licence application, developers are required to submit a Navigational Risk Assessment (NRA) commensurate with the size of the development and the type and volume of local traffic. These assessments will typically include traffic data derived from Radar, AIS and visual observation programmes, with a view to identifying the number, type and the maximum draught of vessels. In conjunction with the known renewable energy devices characteristics, an assessment can be made as to whether vessels and devices can be planned to achieve an adequate vertical separation, or whether the main means of avoiding collision is required to be by horizontal separation.

## RISK ASSESSMENT

NLB cross check the supplied NRA information against known traffic activity in the relevant area, using our own AIS data and historic knowledge. Where more than application is submitted for the same area, there may be cumulative effects; there may also be interactions with other marine activity such as oil & gas drilling or aquaculture sites. Where this is likely to be the case, we make use of our Geographic Information System (GIS) to plot the relevant areas and assess the impacts on traffic.

Another tool available from the 'IALA toolbox' is the IALA Waterways Risk Assessment Programme (IWRAP). This can be used either in its basic form with manual input data, or in the advanced version with imported AIS data, to quantify the potential for groundings or collisions before and after a particular development.

In some cases, developers have been required to organise stakeholder workshops to involve local mariners in the risk assessment process, either resulting from individual sites or cumulative impacts. This approach is similar to that of the USCG Ports and Waterways Safety Assessment (PAWSA) model adopted by IALA.

*'Pelamis' device at EMEC Wave Test site*

## MARKING AND LIGHTING

While O-139 offers a starting position for devising a suitable marking scheme for renewable energy sites, it is considered good practice to continually work towards the best possible, sustainable, marking of each proposed site, by evaluation of different ideas as the renewable energy industry continues to mature.

A particular area of concern is tidal energy sites, where the inevitably high energy flows often make marking the site with buoys impracticable. Experimentation with different buoy types has not yet produced a workable solution, although it is anticipated that a large buoy with a boat-shaped hull and a suitable mooring will eventually emerge.

In the absence of suitable buoyage, site-specific marking schemes have to be developed. It is possible that for some sub-surface devices, adequate vertical separation will result in an assessment that the most preferable option is no marking. This is certainly considered preferable to a scenario where buoyage is installed, but is either unable to remain on station, become submerged during peak tidal flows, or even become entangled with the devices they are meant to protect.

In other situations it may be possible to install shore based marking to adequately identify the limits of renewable energy sites. Such markers could include leading marks or lines to identify valid routes through the sites, although this has to be balanced against the risks of vessels being unable to maintain this course in strong tidal flows, or of encouraging night-time navigation where this has not previously been the norm.

Lights or marks in line can also be used to identify the limits of sites and thus the areas to avoid. An even less complicated approach, which NLB has proposed in one area of very low traffic, is the use of lit marker posts onshore to mark the limits of a wave converter array which runs parallel to the coast, approximately along the 10 metre contour, and therefore close to shore. This avoided the requirement to position buoys in breaking conditions on an exposed lee shore, where maintenance of buoy stations would have caused many difficulties, and would possibly have been unsustainable.

The use of AIS is also proposed by developers, keen to monitor the position of offshore devices for their own purposes, as well as to mitigate the risk of collision with vessels.

On floating or surface-piercing devices that can be in the form of a physical AtoN AIS unit; whereas submerged objects require the use of virtual AIS. In each case, the merits must be considered against the likelihood of virtual AIS being detected and responded to by the operators of vessels in that particular area, and the possibility that the object marked by virtual AIS might have broken its moorings and drifted into a position where it is no longer protected from, or even threatened by, vessels acting on the AIS data. Sometimes enthusiasm by developers needs to be tempered by consideration for the user; proposals to mark 80 floating objects in close proximity with individual AIS units, as was proposed for one site, might be of benefit to the developer and his equipment supplier, but might be less appreciated by an OOW approaching the area and watching his or her Minimum Keypad Display or ECDIS.

## CONCLUSION

Dynamic extraction devices for wave and tidal energy are in a relatively early stage of development, yet pose a more significant risk to shipping than either wind turbines, or oil & gas platforms, on account of their focus on underwater structures. Adequate marking of such devices is a challenge for aids to navigation authorities, however there is scope for imaginative use of both traditional and newer AtoN technologies to mitigate these risks. ■

*'Oyster' device at EMEC Wave Test site*
*(Aquamarine Power)*

# 70 VTS A RISK REDUCER - A QUANTITATIVE STUDY OF THE EFFECT OF VTS GREAT BELT

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In the Danish water of Great Belt a Vessel Traffic Service (VTS) offers navigational assistance and information about conditions important to shipping and safety at sea. In this paper a general method for evaluating the effect of a VTS in terms of how much VTS increases the navigational safety is presented. The method is developed based on incident reports from Great Belt VTS. Results from the Great Belt VTS leads to a conservative estimate that VTS is able to reduce the number of collision and grounding with between 60% and 90%.

Acknowledgements: The authors wish to thank Niels Jacob Mygind at the Admiral Danish Fleet and Jørgen Brandt and the operators at the Great Belt VTS for providing access to the incident reports and for inspiring discussions. The valuable inputs from Professor Jens Froese at the Jacobs University Bremen and Professor Preben Terndrup Petersen at the Technical University of Denmark are also much appreciated.

Keywords: VTS, Vessel Traffic Service, Navigational safety

En las aguas danesas del Gran Belt un Servicio de Tráfico de Buques (VTS) ofrece asistencia a la navegación e información sobre condiciones importantes para el tráfico marítimo y la seguridad en el mar. En esta ponencia se presenta un método general para la evaluación del efecto de un VTS, en términos de aumento de la seguridad de navegación gracias al VTS. El método se ha desarrollado basándose en informes de incidentes del VTS del Gran Belt. Los resultados del VTS del Gran Belt indican que, en una estimación conservadora, el VTS es capaz de reducir el número de colisiones y encallamientos entre el 60 % y el 90 %.

Agradecimientos: los autores desean dar las gracias a Niels Jacob Mygind del almirantazgo de la flota danesa y a Jørgen Brandt y los operadores del VTS del Gran Belt por permitir el acceso a informes de incidentes y por inspirar debates. También son muy apreciadas las valiosas aportaciones del profesor Jens Froese de la Jacobs University Bremen y del profesor Preben Terndrup Petersen de la Technical University of Denmark.

Palabras clave: VTS, Servicio de Tráfico de Buques, Seguridad de navegación

*Dans les eaux danoises du Grand Belt, un VTS offre aux navires assistance et informations sur les conditions de navigation et la sécurité maritime. Ce rapport présente une méthode générale d'évaluation quantitative de l'effet d'un VTS en termes d'amélioration de la sécurité de la navigation. Cette méthode est développée d'après les rapports d'incidents du VTS du Grand Belt. Les résultats tendent à estimer de façon conservative que le VTS est capable de réduire le nombre de collisions ou d'échouages de 60% à 90%.*

*Remerciements : Les auteurs remercient Niels Jacob Myging de la Marine danoise et Jørgen Brandt et les opérateurs du VTS Grand Belt de nous avoir montré les rapports d'incidents et d'avoir participé à nos discussions. Les interventions du Professeur Jens Froese, de l'Université Jacobs de Brême, et celles du Professeur Preben Terndrup Petersen, de l'Université Technique du Danemark, ont été également très appréciées.*

*Mots-clés : VTS, Vessel Traffic Service, Securité maritime.*

# VTS a Risk Reducer

# A Quantitative Study of the Effect of VTS Great Belt

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## 1. INTRODUCTION

The Baltic Sea is one of the world's most trafficked waters and the entrance through Great Belt and Fehmarn Belt is busy with many large oil tankers, bulk carriers and container vessels traveling through the area. Around 25,000 ships pass through Great Belt each year and around 40,000 ships pass through Fehmarn Belt. These numbers are expected to increase in the future. In the Great Belt area a VTS has existed since the construction of the Great Belt Bridge began in 1993. The VTS operates a Ship Reporting System offering information about conditions and incidents important to shipping and safety at sea. If necessary the service can provide individual information to a ship particularly in relation to positioning and navigation assistance or local conditions. The services provided are described in IMO resolution MSC.230-82.

With the construction of the Great Belt Bridge and the future construction of a fixed link crossing Fehmarn Belt to join Denmark and Germany a great effort is put into analyzing and ensuring the safety for the ships in the region. During work with navigational safety on the fixed link in Fehmarn Belt a range of risk reducing measures have been considered to ensure that the construction phase and the fixed link itself will be as safe as possible for the ships traveling through the waters. In the investigations it became apparent that relatively little is known about the risk reduction effect of a VTS system. It is of interest to gain quantified knowledge about the effect of the VTS as VTS is one of the most efficient risk reducers in navigational safety.

Studies from Fehmern Belt has previously examined Safety ellipses (Hansen, et al. 2013), free flow (Jensen et al. 2013) and the effect of VTS based on 2006 to 2010 data (Lehn-Schiøler et al. 2013). This paper applies the general framework from (Lehn-Schiøler et al. 2013) to the extended data including 2011. For this purpose the methodology for quantifying the effect of a VTS system in terms of how much the VTS increases the navigational safety by reducing the frequency of groundings and collisions is restated. VTS may also have an effect on minimizing the consequences of an accident if it should occur. In this case VTS may be able to inform other ships thus avoiding the accident to evolve further or VTS may be able to assist in search and rescue or in oil containment operations. The effect of consequence minimization is not considered in this paper.

The background for the study is the construction of the fixed link in Fehmarn Belt. However, the findings are of general interest, e.g.:

- When considering whether to construct a VTS
- When evaluating the cost/benefit of existing VTS systems
- When considering VTS as a risk reducing measure for navigational safety and environmental impact of new constructions

## 2. LITERATURE REVIEW

The number of studies describing the effect of a VTS system is limited; a few studies (Fujii & Mizuki, 1998; Olsen, et al., 1992) are related to the construction of the Great Belt Bridge, but they do not provide any data based quantification of the effects of the VTS. However, since the early work of Fujii and Macduff in the 70'ties (Fujii & Shiobara, 1971; MacDuff, 1974) marine traffic risk has been studied intensively in many papers. The use of Formal Safety Assessments in risk studies of harbors (Trbojevic & Carr, 2000) and in relation to construction of the Great Belt Bridge (Gimsing, 1998), the bridge between Denmark and Sweden (Rambøll Danmark, 2006) and other safety evaluations, have emphasized the need for quantitative evaluation of risk reduction.

In an analysis of navigational safety and the efficiency of VTS systems Goossens and Glansdorp (Goossens & Glansdorp, 1998) describe three levels of initiating events for accidents: Macro-strategic events, meso-strategic events and tactical events. For the macro-strategic events the reason for the accident is insufficient voyage planning; according to Goossens and Glansdorp such events account for around 20% of the accidents. Meso-strategic events occur when the navigator has insufficient information about the traffic conditions or the situation otherwise is different than expected when planning the journey. Such events account for approximately 20% of all accidents. Tactical events occur when the navigator has to make quick decisions in unforeseen situations; in (Goossens & Glansdorp, 1998) tactical events are reported to account for around 60% of all accidents.

Goossens and Glansdorp argue that the time frame for tactical initiating events is too short for the VTS operator to intervene; thus leaving a VTS with influence only on 40% of the accidents. However, as the paper was written in 1998 before the introduction of AIS, it is reasonable to believe that this new tool has made it possible for VTS operators in some cases to intervene in the tactical stage. Furthermore, early advice by the VTS operator might prevent a critical situation that requires immediate action from the navigator in occurring, such action will remove some of the accidents due to tactical events even before they arise.

## 3. METHOD

This study relies on the incident reporting system in place at the Great Belt VTS. The VTS operators monitor the traffic and provide assistance to the navigators. An incident report is generated when a serious incident occurs, or if an incident is important for future learning. The nature of these reports varies from reporting small boats fishing in a no-fishing zone to machine failures on large oil tankers. Around one third of the reports concern situations with a risk of collision or grounding. Such reports typically contain a detailed description of the involved ship(s), a detailed account for the actions on the ship and by the VTS operator and maps with radar and AIS tracks of the episode. The reports are subjective in nature as they are written by the operators. However, the procedures at the Great Belt VTS ensure reasonable consistency in what is reported.

To conduct the analysis, two effects of VTS on the navigational safety are considered:

1) **Increased awareness and information level.**

VTS has an effect from increasing the awareness of the navigators and the information level available to the navigators (macro-strategic and meso-strategic). VTS informs about the general navigational conditions and about special conditions such as slow traffic or bad weather. Furthermore, the fact that VTS monitors the traffic increases the awareness level of the navigators in the area.

2) **Acute accident avoidance.**

There is an effect of VTS on acute accident avoidance (tactical level). VTS can detect incidents which may lead to groundings and collisions and provide navigational assistance to the ships in these situations.


*Figure 3-1: Overview of the Great Belt VTS area. In July 2007 the VTS area was expanded to cover two sectors as illustrated in the figure, before this date only the southern part of the area was covered. Reports from before and after the expansion are treated alike as the analysis does not depend on the size of the area.*

The two effects are investigated based on the reports from VTS during the period 2006-2011. In this period around 25,000 ships passed through the Great Belt area each year, the VTS area can be seen in **Figure 3-1**.

## 4. EFFECT OF VTS

In the 6 year period from 2006 to 2011 approximately 150,000 ships passed through the Great Belt. For the entire VTS area the number is slightly higher as some smaller ships cross the area in the East/West direction. VTS has contact with all the navigators as they enter the VTS area and are hence able to inform the navigators about the navigational conditions and ensure that they are aware of the obstacles – both permanent and temporary – due to weather or traffic. VTS operators also provide early warnings to navigators on ships that may meet another ship at a critical location, typically operators request navigators to contact each other to make arrangements for safe passage; such early warning contacts are made around 8 times each day but, are not recorded in a report. Furthermore, the navigators are aware that they are travelling in a VTS area and are under observation and it is likely that this will heighten their level of awareness. All these factors influence the overall safety in the area in a positive direction. Under the current conditions it is found from the reports that around 131 of the 150,000 ships are involved in an incident with danger of grounding or collision.

### 4.1 Mathematical formulation

In previous work (Lehn-Schiøler et al. 2013) a general formulation for the calculation of the effect of VTS is presented based on Great Belt incident reports from 2006-2010, in this paper the analysis is extended to include 2011 data. To derive the method we assume that the number of accidents would be higher without VTS than with a VTS. The number of potential accidents that would have happened without VTS is denoted as $A_P$, and the number of accidents that are actually observed is denoted as $A_O$. The relation between the two can be written as:

$$A_O = A_P(1 - R_{VST}) \quad [1]$$

where $R_{VTS}$ is the reduction factor (between 0 and 1) on the number of accidents. If the total effect of VTS is a 60% reduction in accidents ($R_{VST}$ = 0.6), 40% of the potential accident will turn into observed accidents ( $A_O$ = $A_P$ (1-0.6)). In this equation it is unfortunately only $A_O$ that can be observed directly.

As pointed out in the previous section there are two major effects of VTS behind the reduction in the number of accidents:

- Increased information level and awareness
- Acute accident avoidance

Assuming that these effects are statistically independent a reduction of the number of critical situations of 20% due to increased information combined with a reduction in the number of critical situations that turn into accident of 50% will result in a total reduction factor of 1-(1-0.2)(1-0.5) = 0.6 or in general:

$$R_{VTS} = 1 - (1 - R_{ac})(1 - R_{aw}) \quad [2]$$

where $R_{ac}$ is the reduction factor due to acute accident prevention and $R_{aw}$ is the reduction factor due to increased awareness and information level.

### 4.2 Estimating effect on acute accident avoidance Rac

Of the 150,000 ships that have passed through the Great Belt in the six year period 131 ships are mentioned in VTS reports concerning incidents with a potential for either collision or grounding, this corresponds to approximately 22 ships per year. **Figure 4-1** shows a diagram of how these incidents evolve. The process of categorizing the incidents in the incident reports is important, but also time consuming and somewhat subjective. **Table 4-1** shows the yearly average number of various types of situations from the Great Belt VTS incident reports.

From the diagram it can be seen that some reports ($N_A$ =20.7 per year) concern situations where VTS offer navigational assistance to the ships and some ($A_{NP}$=1.2 per year) reports concern accidents that were not predictable or were not detected by the VTS until after the accident had occurred. There are most likely a number of unpredicted incidents that do not lead to accidents and are therefore unreported. As there are no reliable counts of these incidents they are excluded from the analysis.

During the six year period VTS has been in contact with 104 ships that are involved in a critical situation ($S_C = 17.3$ per year). These ships are either heading towards shallow water or are getting close to a critical ship – ship situation. From the reports it is evident that some of these situations would have resulted in an accident without the intervention of the VTS. However, it is also evident that most of the situations would have been handled last minute by the navigator(s) or avoided by pure luck. A fairly common situation is when a ship approaches shallow waters and is informed by VTS, in this case it is likely that the navigator in some cases would have checked the map and location before an accident would occur.

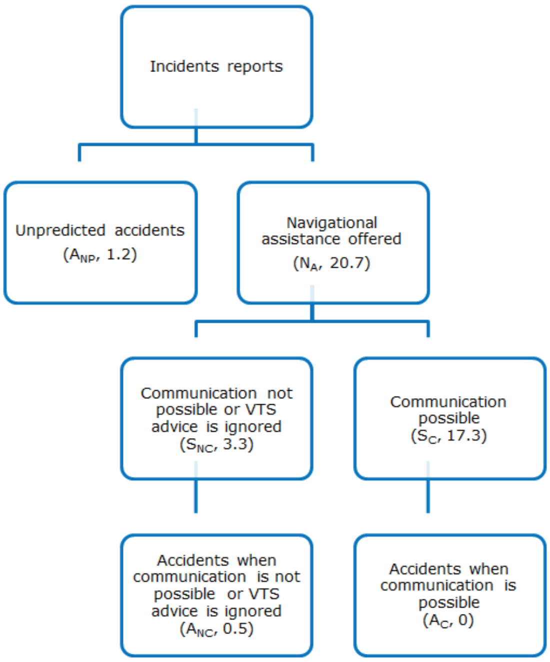


*Figure 4-1: Breakdown of incident reports concerning groundings and collision (per year).*

Situations where VTS was not able to contact the ship or where the VTS advice was ignored ($S_{NC}$) are examined to estimate the fraction of critical situations that would result in an accident. Here we see that in 20 (3.3 per year) cases VTS cannot contact the ship during a critical situation or the VTS advice was ignored. Three of these situations result in an accident ($A_{NC}$). That is, the fraction of critical situations that evolve into an accident ($F_A$) when VTS cannot communicate with the ship or VTS advice was ignored is:

$$F_A = \frac{A_{NC}}{S_{NC}} = \frac{0.5}{3.3} = 15\%, \quad [3]$$

We now assume that the fraction of critical situations that evolve into an accident when VTS cannot communicate with the ship or when VTS advice was ignored is approximately the same for the ships that *was* contacted by the VTS ($S_C$). This yields that the number of accidents without acute VTS intervention would have been:

$$A_A = S_C F_A = 17.3 \times 15\% = 2.6 \quad [4]$$

That is, the actual number of accidents avoided in acute situations ($A_A$) is a small fraction of the number of situations in which VTS offered assistance.

The number of accidents that are observed in the area ($A_O$), is a sum of unpredicted accidents ($A_{NP}$), accidents where VTS could not contact the ship or where VTS advice was ignored ($A_{NC}$) and accidents where VTS did contact the ship ($A_C$)

$$A_O = A_{NP} + A_{NC} + A_C = 1.2 + 0.5 + 0 = 1.7 \quad [5]$$

| Symbol | Description | Count | Per year |
|---|---|---|---|
| $A_{NP}$ | Unpredicted accidents - accidents that could not be or were not predicted by the VTS | 7 | 1.2 |
| $N_A$ | Navigational assistance offered | 124 | 20.7 |
| $S_{NC}$ | Communication not possible. Number of situations where a ship could not be contacted by VTS or ship ignored VTS advice in a critical situation | 20 | 3.3 |
| $S_C$ | Communication possible. Number of situations where a ship was successfully contacted by VTS in a critical situation | 104 | 17.3 |
| $A_{NC}$ | Accidents where VTS was not able to contact the ship or VTS advice was ignored | 3 | 0.5 |
| $A_C$ | Accidents when communication is possible | 0 | 0 |

*Table 4-1: Observed statistics from the Great Belt VTS incident reports from the period 2006-2011*

Adding the number of avoided accidents ($A_A$) to the observed accidents, an estimate for the total number accidents that would have occurred without the acute accident avoidance effect of VTS is found and converted to a ratio of avoided accidents:

$$R_{ac} = \frac{A_A}{A_A + A_O} = \frac{2.6}{2.6 + 1.7}\ 61\% \quad [6]$$

Or in general:

$$R_{ac} = \frac{S_C F_A}{A_{NP} + A_{NC} + A_C + S_C F_A} \quad [7]$$

The estimate of $R_{ac}$ relies on an estimate of the fraction of critical situations that turn into accidents ($F_A$). In Great Belt this fraction is estimated to be 15% based on 3 observed accidents in 20 critical situations. As the data material behind estimation of $F_A$ is limited, the calculation of $R_{ac}$ has been subjected to a sensitivity study using one or five accidents instead of three. With these low and high estimate the value of $R_{ac}$ would be 42% and 66% respectively.

## 4.3 Total effect of VTS

To estimate the total effect of the VTS on the navigational safety the effect of acute accident prevention must be combined with the effect of an increased awareness and information level. By rearranging equation 1 we get:

$$A_P = \frac{A_O}{(1 - R_{VTS})}, \quad [8]$$

The total number of potential accidents without VTS ($A_P$) is written as a function of the number of observed accidents ($A_O$) and the total effect of the VTS ($R_{VTS}$). With $R_{VTS}$ as described by equation 2 the number of total accidents becomes a function of the estimated effect of acute accident avoidance ($R_{ac}$= 61%) and the effect of increased awareness $R_{aw}$.

$$A_P = \frac{A_O}{(1 - R_{ac})(1 - R_{aw})} \quad [9]$$

To illustrate the effect of increased awareness and information the number of avoided accidents calculated as the number of potential accidents minus the number of observed accidents ($A_P$-$A_O$) per year is plotted in **Figure 4-2**.

A comparison with the situation before the VTS was established is not accurate as routes have been changed as a consequence of building the Great Belt Bridge, the intensity in traffic has changed, ferries have stopped operating and AIS has been introduced in the period. Still a rough indication could be gained by examining historical accident data. The Danish maritime authorities keeps rigorously track of accidents involving Danish ships and such accident registrations are available dating back to 1893 and can be downloaded from the web site of the Danish Maritime Museum [1].

In the 5 year period 1983-1987 just before construction of the Great Belt Bridge started accidents involving Danish ships in the Great Belt area have been counted based on these reports. A total of 19 accidents (3.8 per year) involving Danish ships were found. According to passage registration from VTS Great Belt Danish ships only account for approximately 20% of the ship traffic and the real number of accidents in the area could therefore easily have been higher. Comparing with the 1.7 observed accidents per year from the VTS incident reports yields a low estimate of 2.1 (3.8-1.7) avoided accidents in the period. As the 3.8 accidents per year only represent 20% of the ship traffic a significantly higher actual accident count would be expected. A conservative estimate is to double the number of occurring accidents; with this assumption the number of avoided accidents would have been 5.9 ($2 \times 3.8 - 1.7$), with a high estimate of 5 times as many accidents the number of avoided accidents would have been 17.3 per year period. From **Figure 4-2** this leads to an effect of increased information and awareness of 40% and 75% respectively. These numbers are very rough estimates and should be treated as such.

Values for the total effect of VTS can be found by combining equation 2 with the estimate of $R_{ac}$ for various values of $R_{aw}$, values for the total effect of VTS can be found in **Table 4-2**. In lack of observed data about the effect of increased awareness and information a best guess based on the incident reports and the historic accident counts is that the reduction in accidents from increased awareness and information is in the range of 25%-75%. This results in a total accident reduction effect of the Great Belt VTS of 60% to 90% where 60% is considered a very conservative value. A generalised formulation that can be applied to analyse the effect of other VTS centres can be found in (Lehn-Schiøler et al. 2013).

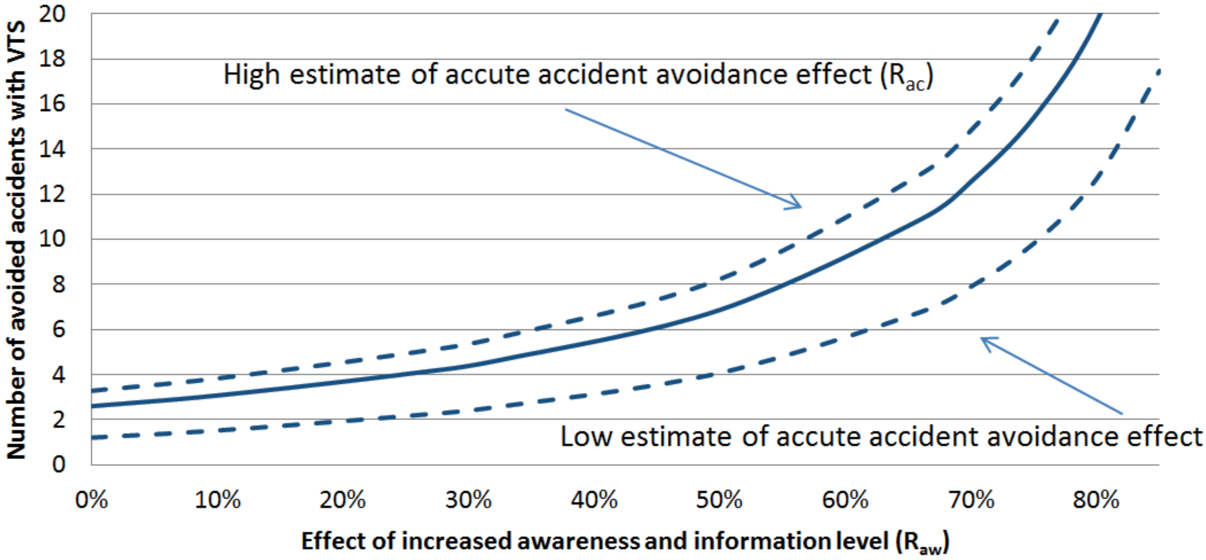


*Figure 4-2: The total number of avoided accidents in the area without a VTS can be written as the number of potential accidents (Ap) minus the number of observed accidents (Ao). The influence of increased awareness and information level on the number of avoided accidents per year is depicted above. Calculations are based on the estimate of $R_{ac}$.*

Values for the total effect of VTS can be found by combining equation 2 with the estimate of $R_{ac}$ for various values of $R_{aw}$, values for the total effect of VTS can be found in **Table 4-2**. In lack of observed data about the effect of increased awareness and information a best guess based on the incident reports and the historic accident counts is that the reduction in accidents from increased awareness and information is in the range of 25%-75%. This results in a total accident reduction effect of the Great Belt VTS of 60% to 90% where 60% is considered a very conservative value. A generalised formulation that can be applied to analyse the effect of other VTS centres can be found in (Lehn-Schiøler et al. 2013).

| Effect of increased awareness and information level ($R_{aw}$) | Effect of acute accident avoidance ($R_{ac}$) | | |
|---|---|---|---|
| | Low (43%) | Medium (61%) | High (66%) |
| | Overall effect of VTS ($R_{VTS}$) | | |
| 0% | 42% | 61% | 66% |
| 10% | 48% | 65% | 70% |
| 25% | 56% | 71% | 75% |
| 50% | 71% | 80% | 83% |
| 75% | 85% | 90% | 92% |

Table 4-2: By utilizing equation 2 the total effect of the Great belt VTS system is calculated for various combinations of the acute accident avoidance effect and the effect of increased information and awareness, the low medium and high estimates for $R_{ac}$ is derived in section 4.2.

During the period 2006-2011, 10 accidents have been reported in the VTS area; of these 7 accidents were not detected beforehand by the VTS. If this is a general trend it shows that when a VTS system is present most of the accidents that occur are from dangerous situations that were not predicted or could not be predicted by the VTS. The positive side to this is that when VTS detects a dangerous situation they are most often able to prevent the situation from evolving into an accident.

## CONCLUSION

This paper proposes a general procedure to evaluate the effect of a VTS and applies this method to analyze the effect of the VTS in Great Belt. The procedure is based on incident reports from the VTS and uses these to quantify and combine two different effects of the VTS: The effect of acute accident avoidance and the effect of increased awareness and information level.

The Great Belt is heavily trafficked and difficult to navigate. Even under such conditions the number of accidents and the number of VTS incident reports are limited. It is therefore evident that any estimates based on the incident reports are uncertain; hence also the estimate of the effect of VTS. Our analysis of the effect of the Great Belt

VTS extends previous work to include data from 2011. Results are consistent with previous findings and show an estimated 60% to 90% reduction of the frequency of collision and grounding. A 60% reduction of the accident frequency is considered a very conservative estimate.

This paper provides a case study of the Great Belt VTS; even though every VTS system is expected to be different, the effect of a VTS is likely to be similar under similar conditions such as traffic intensity and the nature of the water way. The procedure can easily be applied to quantify the effect of other VTS systems where the results cannot be transferred directly as long as incident reports are available. Examples of this include coastal, river, and harbor VTS. ■

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[1] http://www.maritime-museum.dk/videnscenter/soeulykke.asp

## 71 THE SAFETY OF THE HUMAN ELEMENT IN THE MAINTENANCE OF MARINE AIDS TO NAVIGATION

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The marine traffic during the last four decades has quadruplicated, reaching in the year 2008, 32 billions tons-miles, with a clear decreasing tend of accidents in this regard. Nevertheless, paradoxically, sometimes men or women who ensure the safety of others, through the maintenance of marine aids to navigation, perform their duties in unsafe conditions and without appropriate protection elements.

The present document reveals the analysis performed by the Chilean Aids to Navigation Service regarding the improvements introduced on personal safety equipment of lighthouse specialists.

El tráfico marítimo se ha cuadruplicado durante las últimas cuatro décadas, alcanzando 32 000 millones de toneladas-milla en el año 2008, pero manteniendo una clara tendencia decreciente de accidentes. Sin embargo, paradójicamente, a veces las personas que garantizan la seguridad de otros mediante el mantenimiento de las ayudas a la navegación marítima realizan sus tareas en condiciones inseguras y sin los elementos de protección adecuados.

Este documento revela el análisis realizado por el Servicio Chileno de Ayudas a la Navegación respecto a las mejoras introducidas en los equipos de seguridad personal de los especialistas en faros.

*Le trafic maritime a quadruplé dans les quatre dernières années, atteignant, en 2008, 32 milliards de tonnes-milles, avec un net déclin du nombre d'accidents. Cependant, et paradoxalement, quelquefois les hommes et les femmes qui assurent la sécurité des autres par l'entretien des aides à la navigation maritime, accomplissent leur tâche dans des conditions d'insécurité et sans protection.*

*Ce rapport décrit l'analyse faite par le Service de signalisation maritime du Chili concernant les améliorations apportées dans les équipements de sécurité du personnel d'entretien des phares.*

# The safety of the human element in the maintenance of marine aids to navigation

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IALA·2014·AISM

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## 1. INTRODUCTION

The first lighthouse in Chile was built in the year 1837, due to the urgent need of indicating sailors the entrance to port, resulting from the emerging maritime traffic.

Years later, in 1845, and in another part of the world, Europe, different machineries such as the mechanical loom, the steamship, the telegraph and the locomotive were invented, among others, giving rise to a period in the world history known as the "Industrial Revolution". This period was characterized by the forming of a new social class, the working class, which was exploited, working 14 to 16 hours a day.

In October 30th 1857, two lighthouse keepers were recruited for the "Valparaíso" lighthouse, who performed their functions equipped with precarious elements of the age.

It was not until the XIX Century, post Industrial Revolution, that measures were adopted to diminish the amount of occupational accidents, which were increasing in ocurrence and severity, mainly triggered by constraints such as: the invention of new machines, ignorance of their operation, the grouping of workers in confined spaces, to name a few. From then on, early iniciatives aiming at preventing accidents and preserving the lives of workers began to emerge.

## 2. THE PREVENTION OF RISKS RELATED TO LIGHTHOUSE SPECIALISTS OF THE CHILEAN NAVY

In Chile, the management and maintenance of the Aids to Navigation Network is assumed by the Navy through the Aids to Navigation Service. This way, lighthouse specialists, as members of the Chilean Navy, in the field of risk prevention are ruled by the " Regulations for Risk Prevention and Protection of the Environment of the Navy".

These rules, as being general, do not make a specific reference on conditions or safety equipment and protective clothing for lighthouse specialists. The above mentioned encouraged the conduction of a technical study in order to establish the regulations oriented to the definition or standarization of the minimun safety equipment required.

## 3. THE ANALYSIS PROCESS OF THE PERSONAL PROTECTION ELEMENTS OF THE LIGHTHOUSE SPECIALISTS

The analysis process of the personal protection elements began by identifying the duties they performed, associated hazards they are exposed to and consequences to their physical integrity.

Afterward, the national and institutional regulations in force were reviewed in order to determine the legal framework governing this area and the definition of the personal protection equipment established by the same. At the same time, the analysis of these allowed to define the characteristics of the new personal protective clothing required.

## 4. THE NEW PERSONAL SAFETY EQUIPMENT AND PROTECTIVE CLOTHING OF THE LIGHTHOUSE SPECIALISTS IN CHILE.

This new protective clothing aims at satisfying the minimum personal protection needs and their compatibility to the different climates of the country, and the variety of tasks they perform, in line with two basic concepts: a) to be ergonomic and b) to facilitate the development of technical works. As a result of the present study, three different protective clothing were defined: a) basic working cloth, which can be complemented with life jackets, when on board vessels, b) clothing and equipment for work at height and c) clothing for clearing operations with electric saws.

## 5. CONCLUSIONS AND RECOMMENDATIONS

The lighthouse specialist is exposed to a variety of unsafe conditions which make it an activity with a high risk level. Nevertheless, as being these activities part of the routine job have contributed to develop special skills that allow the Aids to Navigation Service Specialists to register very low accident rates. However, it is considered to be necessary, to increase the personal protection equipment of the lighthouse specialists which will permit to decrease even more the risks to which they are exposed to. ■

## 77 SEA PERIL MANAGEMENT AND ROLE OF VTS

*Ugur Karabay. Ministry of Transport, Maritime and Communication, Turkey*

Although "Occurring Sea Peril" may seem unpredictable (fortuitous) by the definition, minimizing the risk and damage with proactive approach before sea peril occurs is important as much as managing the sea peril crises when the unpredictable risk occurred. In order to prevent the sinking, capsizing, collision, making water, loss of lives and cargoes during severe weather and sea conditions which especially occur under difficult meteorological conditions, local Vts Centers and Authorities can take a decision of bringing the vessel to a safe harbor or to relatively more secure waterway, if there is any avaliable decision like this. This decision can be taken through opening straits or channels in proper traffic way or directing vessel to safe waiting areas (drifting or anchorage) or if there is possibility of directly berthing at a safe port with proper vts information and advices.

I intend to establish a reference document which will study about liabilities / legal responsibilities of Vts Centers and Authorities on losses and damages, and the matters which should be considered by Vts, for minimizing the risk and damage which may occur as a result of sea peril under any circumstance.

It is possible to minimize losses and damages by examining the best practice and efficient Vts / Maritime Domain Management even if this subject is not still clear in all written rules and principles in current maritime laws.

Aunque el «Peligro Marino Sobrevenido» puede parecer impredecible (fortuito) por definición, minimizar el riesgo y los daños con un enfoque proactivo antes de que se produzca el peligro es tan importante como gestionar la crisis de peligro marino cuando se produce un riesgo impredecible. Para prevenir el hundimiento, la zozobra, la colisión, el naufragio y la pérdida de vidas y cargamento durante episodios climatológicos y marinos severos que tienen lugar especialmente bajo condiciones meteorológicas difíciles, los Centros VTS y las Autoridades locales pueden tomar la decisión de llevar el buque a un puerto seguro o a una vía navegable relativamente más segura, si tienen a su disposición una medida como esta. Esta decisión puede materializarse mediante la apertura de estrechos o canales en la vía de tráfico adecuada o dirigiendo el buque a áreas de espera seguras (deriva o anclaje) o, si existe la posibilidad, atracando directamente en un puerto seguro con la información y los avisos adecuados del VTS.

Pretendo establecer un documento de referencia que estudiará las obligaciones/ responsabilidades legales de los Centros VTS y las Autoridades sobre las pérdidas y daños, y las cuestiones que deben considerar los VTS para minimizar el riesgo y los daños que se puedan producir como resultado de un peligro marino bajo cualquier circunstancia.

Es posible minimizar las pérdidas y los daños examinando las buenas prácticas y la eficiente Gestión del Espacio Marítimo/VTS incluso si este tema todavía no es evidente en todas las normas y principios escritos en el derecho marítimo actual.

*Bien que l'arrivée d'un péril paraisse imprévisible par définition, minimiser le risque et les dommages par une approche active avant qu'il arrive est aussi important que la gestion en cas de crises lorsque que le danger est avéré. Pour prévenir un naufrage, un chavirement, une collision, une prise d'eau, la perte de vies et de fret par mauvais temps et conditions de mer difficiles, qui se produisent dans le cas de mauvaises conditions météorologiques, les centres VTS et les autorités responsables peuvent prendre la décision de guider le navire vers un port ou une voie de navigation plus sûre, si ces options existent. Cette décision peut être d'ouvrir des détroits ou chenaux au trafic ou de diriger le navire vers des zones d'attente (à flot ou ancré) ou, si possible, vers un quai dans un port sûr grâce aux informations et conseils du VTS.*

*J'ai essayé de faire un document de référence en traitant des responsabilités légales des autorités et centres VTS en cas de pertes et de dommages, et des aspects qui doivent être étudiés par les VTS pour réduire le risque et les dommages qui peuvent résulter du danger en mer, en toutes circonstances.*

*Il est possible de minimiser les pertes et les dommages en examinant la meilleure méthode et un VTS/Gestion du domaine maritime efficace, même si ce sujet n'est pas encore clair dans les règles et principes des lois actuelles.*

# Sea peril management and role of VTS

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IALA·2014·AISM

XVIII Conference · A Coruña · Spain

Uğur Karabay, Directorate General for Coastal Safety, Turkey

## DEFINITION OF SEA PERIL IN MARITIME LAW?

*"A peril of the sea ... is a **sea damage**, **occurring at sea** and **nobody's fault**. "*

OR

*"... there must be some **casualty**, something which could **not be foreseen** as **one of the necessary incidents of the adventure**.... "*

OR

*"... perils of the sea ... in relation to **damage to goods** carried on a vessel, must be perils which could **not be foreseen or guarded against as probable incidents of the intended voyage**. "*

*"... perils of the sea ... **fortuitous accidents** and **casualties exclusive of the ordinary winds and waves**."*

## THE ELEMENTS OF 'PERILS OF THE SEA'

- FORTUITOUS

A fortuity is something that is unintentional and inevitable. A fortuitous loss must not be one **not caused intentionally** and **also not a result of inevitable deterioration** generated by the ordinary action of the winds and waves.

- ACCIDENTAL

Perils of the sea as commonly known as occurrences that involve something **fortuitous** and **unexpected** that **these two elements work together in the operation of a sea peril**. When an accident or a casualty takes place, it happens **unexpectedly** and it happens **unintentionally** and unplanned.

- WEATHER CONDITION

The exclusion of 'ordinary winds and waves' from the definition of 'perils of the sea' as provided by **Rule for Construction 7** of the **Marine Insurance Act 1906** tends to show that the criterion of perils of the sea only points to **weather which is extraordinary or abnormal**.

- ACTION OF THE SEA

In the operation of a sea peril, the action of the sea is important where the sea and the seawater, in certain cases, must be the destroying agent to a particular loss. However, such operation of the **sea peril will not be affected by** (**negligence or unskillfulness of the master or crew)** any **human action.**

- INCIDENTAL TO THE COURSE OF NAVIGATION

It has also been established that not every casualty or accident that takes place on a ship at sea can simply be categorised as a peril of the sea. In order to qualify as a sea peril, the **happening leading to the loss** must be one that **takes place in the course of navigation** and **incidental to the navigation**.

**FINALLY DEFINITION OF PERIL OF SEA** SHOULD CONTAIN SOME CASES ON DAMAGE OR CASUALITY IN THAT THESE ARE **FORTUITOUS**, **ACCIDENTALLY**, **BAD WEATHER CONDITION, ACTION OF SEA**.

## WHAT IS MAIN PURPOSE OF VTS?

According to **SOLAS chapter V** on Safety of Navigation: ***"Vessel traffic services** (VTS) **contribute to safety** of life at sea, safety and efficiency of navigation and **protection of the marine environment**, adjacent shore areas, work sites and offshore installations **from possible adverse effects of maritime traffic**."*

## WHAT ARE VTS SERVICES RENDERED?

**According to IMO Res. A.857(20);**

- **Information Service**
- **Navigational Assistance Service**
- **Traffic Organization Service**

## VTS RENDERED INFORMATION SERVICE

The information service is provided by **broadcasting information** at fixed times and intervals or **when deemed necessary by the VTS** or at the request of a vessel, and may include for example reports on the position, identity and intentions of other traffic; waterway conditions; **weather**; **hazards; or any other factors that may influence the vessel's transit.**

## VTS RENDERED NAVIGATIONAL ASSISTANCE SERVICE

The navigational assistance service is especially important **in difficult navigational or meteorological circumstances or in case of defects or deficiencies**. This service is normally rendered at the request of a vessel or by the VTS when deemed necessary.

## VTS RENDERED TRAFFIC ORGANIZATION SERVICE

The traffic organization service concerns the operational management of traffic and the **forward planning of vessel movements to prevent congestion and dangerous situations**, and is particularly relevant in times of high traffic density or when the movement of special transports may affect the flow of other traffic.

## WHERE IS CONNECTION IN BETWEEN VTS AND PERIL OF SEA?

The vessel is under risk of peril of sea in the designated VTS area or adjacent sea areas, VTS should give meteorological information in proper timing and frequently, advice about coming voyage planning in difficult weather and sea conditions as decision-supporter to the master and warn if ship has any restriction ( low speed, small size or old ship etc. ) and direct vessel to safer seas, safe anchorage or safe waiting (port or drifting) area or ? If sinking danger is inevitable pre-designated Place of Refuge / IMO Res. A.949(23)?

## WHEN/HOW VTS CAN BE EFFECTIVE ON PERIL OF SEA?

I. **BEFORE PERIL OF SEA (PROACTIVE APPROACH AND RISK MINIMAZING)**

II. **DURING OR AFTER PERIL OF SEA (EFFECTIVE CRISIS MANAGEMENT AND LOSS MINIMAZING APPROACH)**

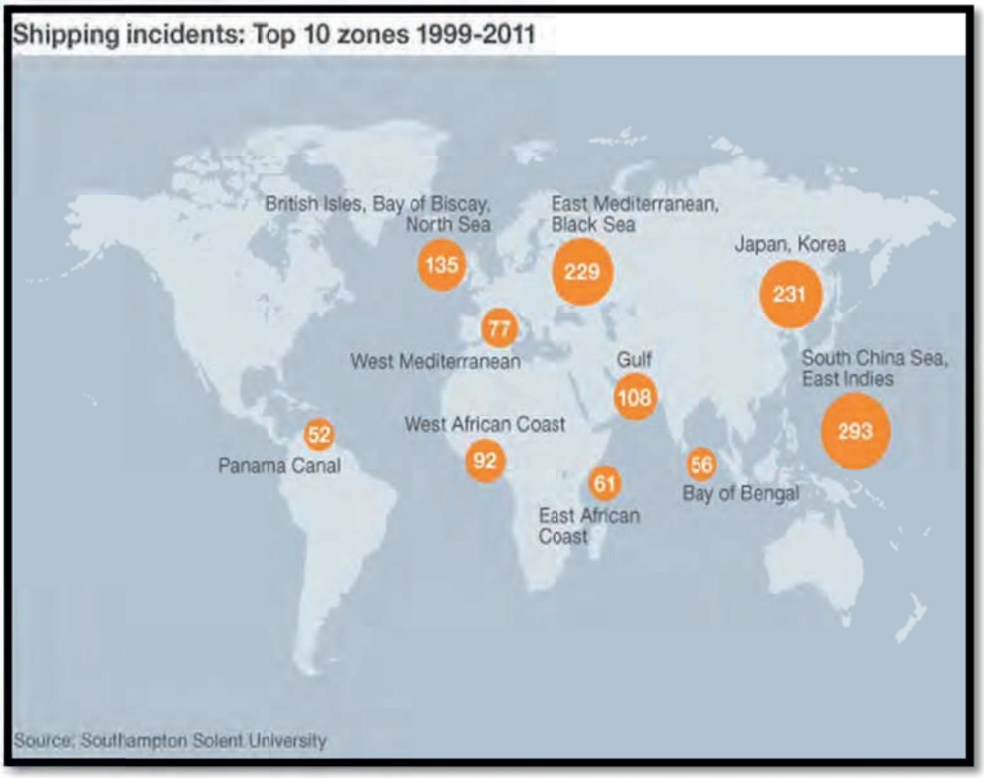
## ROLE OF VTS BEFORE PERIL OF SEA

I. Bad weather forecast or gale warning over the designated VTS area or adjacent sea areas VTS should follow carefully all developments and warnings must broadcast to all stations in proper time and frequently. (IMO A.857(20) 2.3.1)

II. If vessels are waiting for passage time for strait or channel in safe anchorage or drifting area VTS should warn all waiting vessels for passage one by one for bad weather condition and heavy sea condition where is developing. (IMO A.857(20) 2.3.1)

III. Vessels are navigating in bad weather and sea conditions should have priority to transfer safer sea areas even forecasted bad weather conditions nearly to develop therefore traffic organization must plan upon minimizing the risk of sea peril. (IMO A.857(20) 2.3.3)

IV. If possible suspend the vessel traffic temporarily towards to meteorological risk area till risks in normalization process while transferring vessels in risk to the safer sea areas.



| CAUSES OF LOSS LAST DECADE, 2001 - 2012 | 2001 - 2002 | 2002 - 2003 | 2003 - 2004 | 2004 - 2005 | 2005 - 2006 | 2006 - 2007 | 2007 - 2008 | 2008 - 2009 | 2009 - 2010 | 2010 - 2011 | 2011 - 2012 | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Collision (involving vessels) | 20 | 21 | 13 | 24 | 25 | 16 | 11 | 13 | 10 | 3 | 6 | 162 |
| Contact (e.g. harbour wall) | 2 | 1 | 3 | 4 | 4 | 2 | 1 | | 1 | | 2 | 20 |
| Foundered (sunk, submerged) | 51 | 59 | 72 | 62 | 61 | 68 | 74 | 62 | 58 | 50 | 52 | 669 |
| Fire/explosion | 35 | 22 | 21 | 18 | 18 | 15 | 17 | 14 | 12 | 6 | 11 | 189 |
| Hull damage (holed, cracks, etc.) | 24 | 12 | 7 | 7 | 5 | 11 | 3 | 8 | 3 | 3 | 5 | 88 |
| Missing/overdue | | | 1 | 3 | 1 | 1 | | | 1 | | | 7 |
| Machinery damage/failure | 15 | 13 | 9 | 10 | 7 | 17 | 8 | 7 | 3 | 5 | 6 | 100 |
| Piracy | | | 1 | 1 | | 1 | | 1 | 2 | | | 6 |
| Wrecked/stranded (aground) | 22 | 34 | 28 | 23 | 26 | 39 | 33 | 24 | 18 | 24 | 23 | 294 |
| Miscellaneous | 8 | 7 | 1 | 2 | 2 | 2 | 1 | 2 | 2 | | 1 | 28 |
| Grand Total | 177 | 169 | 156 | 154 | 149 | 172 | 148 | 131 | 110 | 91 | 106 | 1,563 |

Note: Each period runs from 26 Nov to 25 Nov the following year.

Source: Lloyd's List Intelligence Casualty Statistics. Analysis: AGCS.

## ROLE OF VTS DURING AND AFTER PERIL OF SEA

V. VTS should render navigational assistance to vessel in difficult navigational or meteorological circumstances accordingly. (IMO A.857(20) 2.3.3)

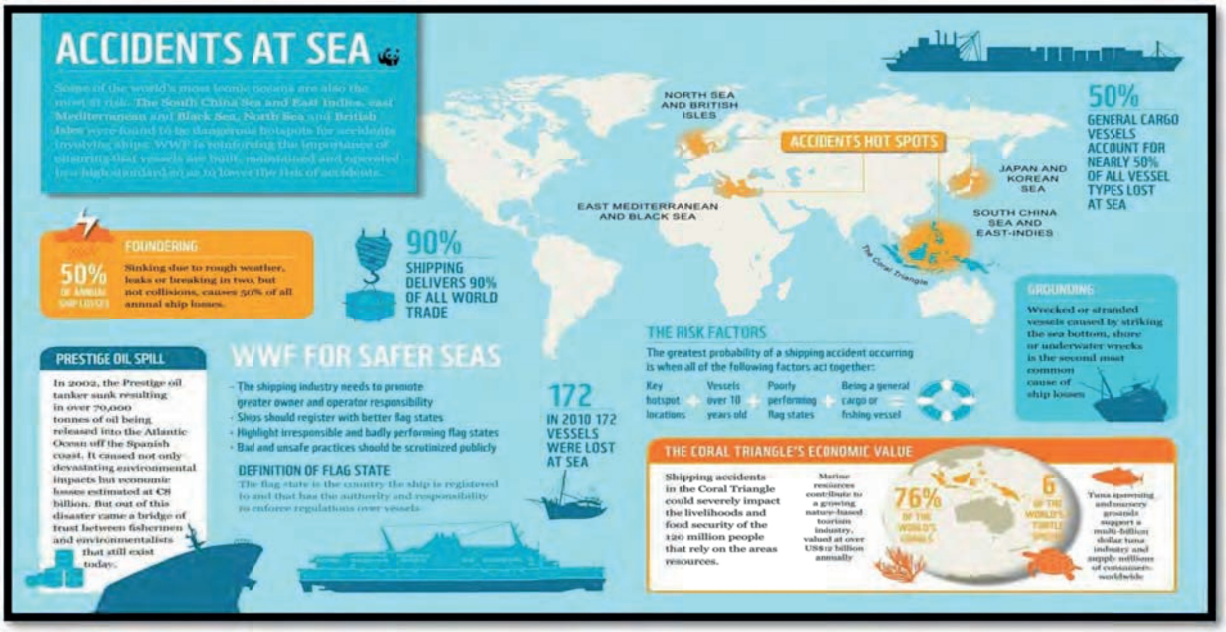
VI. If possible VTS can advise nearest contingency anchorage or safer waiting areas.

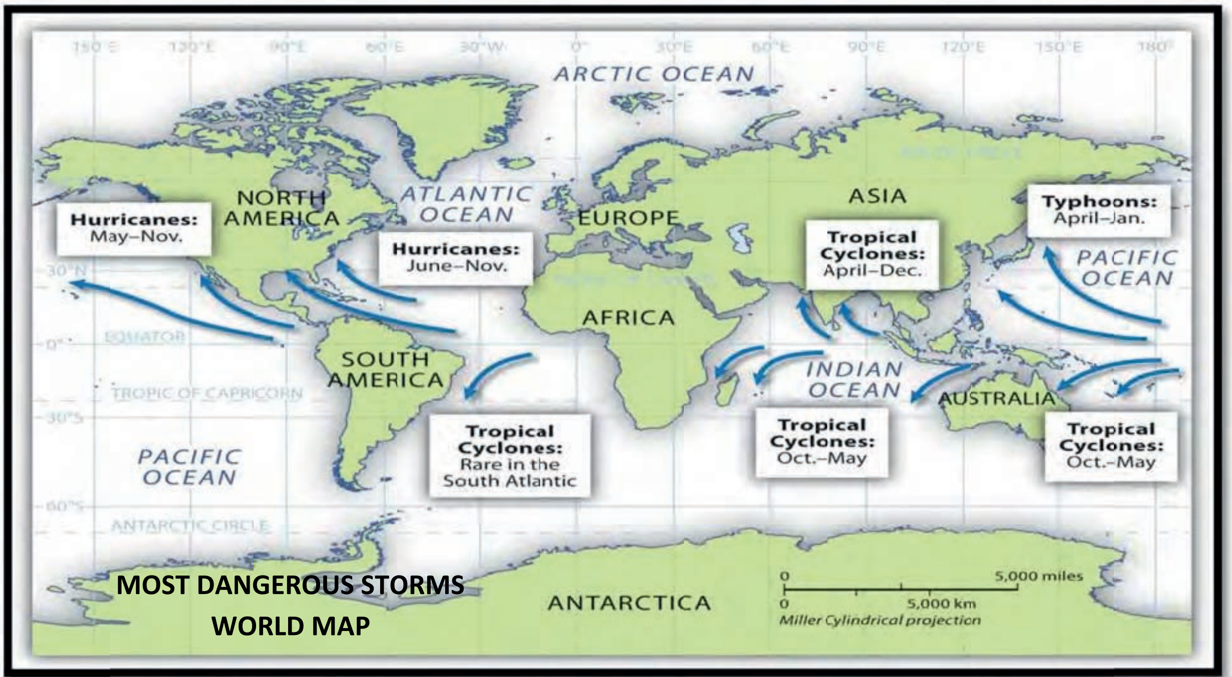
VII. If vessel is inevitable sinking danger, VTS could direct to pre-designated place of refuge?

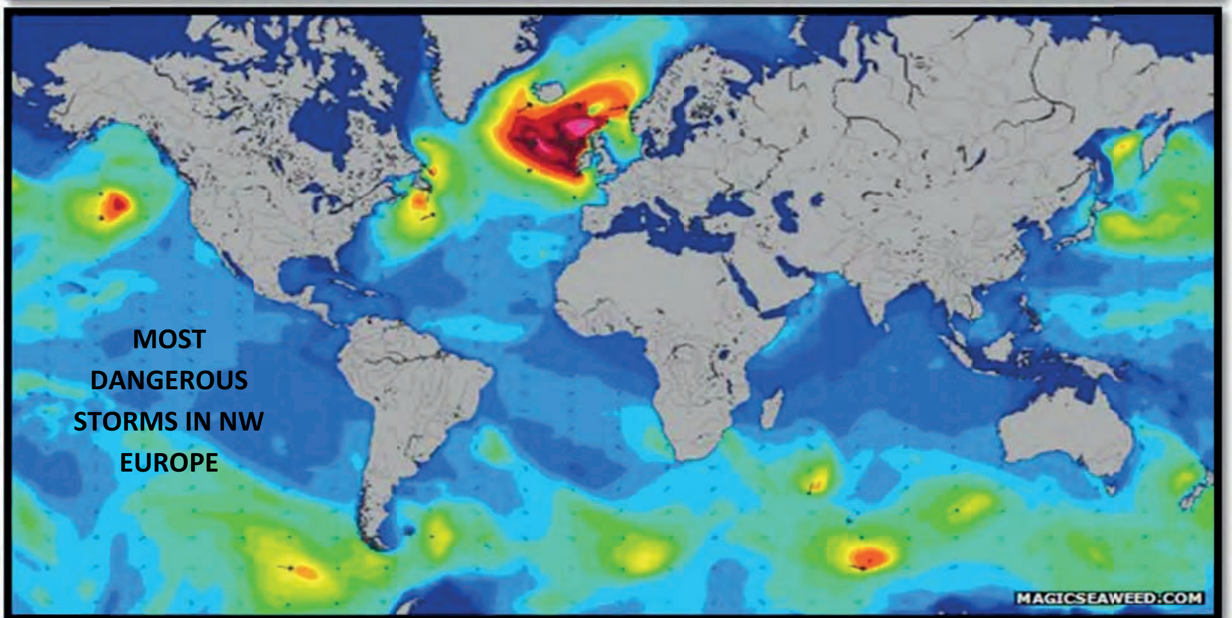
VIII. VTS should help to establish proper communication directly or indirectly in between vessel in peril of sea and MRCC/MRSC or if possible nearest marine rescue team.

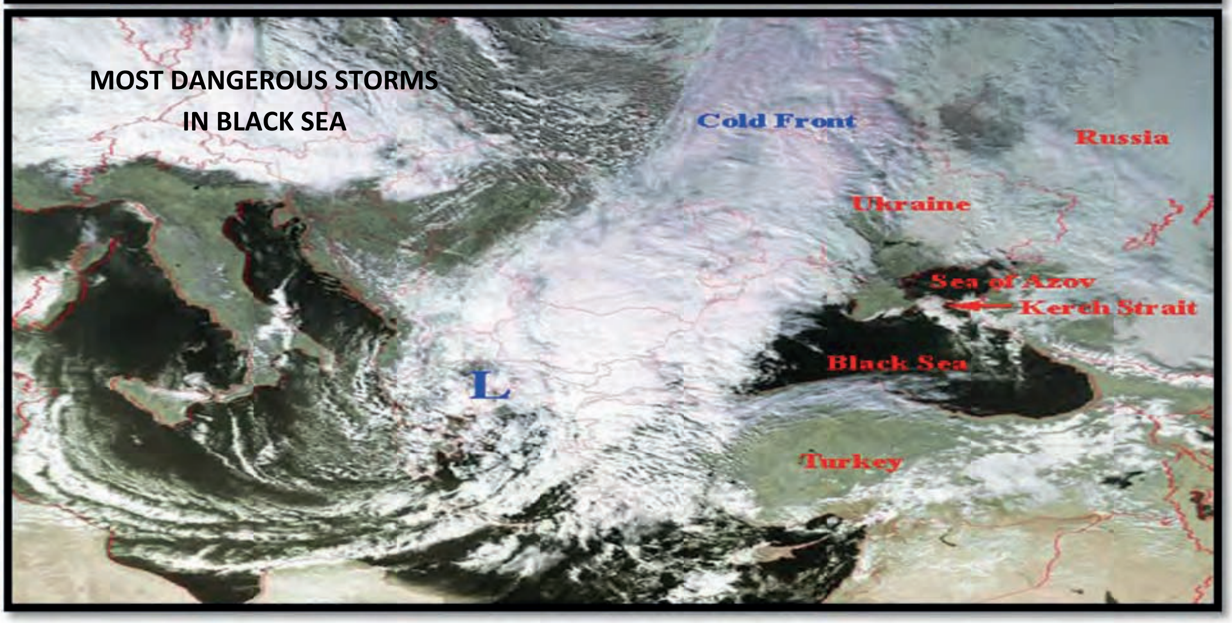
IX. VTS should direct vessels in vicinity of vessel in peril of sea for save lives at sea.

X. Support rescue operations in any case for save lives and prosperity.




ARCTIC OCEAN
NORTH AMERICA
ATLANTIC OCEAN
EUROPE
ASIA
Hurricanes: May–Nov.
Hurricanes: June–Nov.
Tropical Cyclones: April–Dec.
Typhoons: April–Jan.
PACIFIC OCEAN
AFRICA
SOUTH AMERICA
INDIAN OCEAN
AUSTRALIA
Tropical Cyclones: Rare in the South Atlantic
Tropical Cyclones: Oct.–May
Tropical Cyclones: Oct.–May
PACIFIC OCEAN
ANTARCTICA
5,000 miles
5,000 km
Miller Cylindrical projection
MOST DANGEROUS STORMS
WORLD MAP


MOST
DANGEROUS
STORMS IN NW
EUROPE
MAGICSEAWEED.COM


MOST DANGEROUS STORMS
IN BLACK SEA
Cold Front
Russia
Ukraine
Sea of Azov
Kerch Strait
Black Sea
L
Turkey

## CONCLUSIONS

- Now we can better understand that bad weather and sea conditions are trigger for more than %50 of loss vessels and lives at sea all over the world due to foundering.
- VTS must be more effective on sea peril management with before and after meaning actions to be taken

## RECOMMENDATIONS

- **IALA VTS Committee can develop** a guideline for " Role of VTS in Peril of Sea" or VTS Decision-supporter Tool for Masters voyage planning in bad weather and sea conditions also decision-maker Tool for vessel traffic planners and senior VTS'os ?
- **IALA Council can support** "VTS Decision-supporter Tool for Masters on voyage planning in bad weather and sea conditions also decision-maker Tool for Vessel Traffic Planners and Supervisor VTS'Os" and **send to IMO concerned Committees either insert as a new subject on IMO Res. A 587(20) revision works which is going on in VTS Committee.**

## FINAL CONCLUSION

- Finally **how we can reduce risk of foundering and peril of sea globally** with prescribe on port state controls for sub-standard vessels, realistic seaworthiness inspections, disincentive marine insurance policy rules, strict class societies rules and inspections, developed Ism Code and proper policies, MSC, NCSR, PPR and all other relevant IMO committees. **After all what could be the effective role of VTS globally in this equation with multiple variables for safety of life and property at sea??? .**

## 130 Future VTS services in the 6 e-Navigation areas, beyond territorial waters

*Jon Leon Ervik. Norwegian Coastal Administration, Norway*

IMO has decided to implement five e-navigation solutions. The solutions seek to improve cooperation and interaction between ships, shore, and vice versa. Several maritime service portfolios will be developed to support ship traffic in the six defined areas, which go beyond the limits of territorial waters. In the future, Vessel Traffic Services (VTS) will play a central role for enhanced safety and more efficient maritime traffic.

VTS is an important tool for authorities wanting to influence monitoring and maritime activities. The governmental authorities want to ensure a minimal loss of life and to prevent damage to the environment and property. In addition, VTS systems should play a central role in providing services to the maritime traffic.

The development of e-navigation raises important questions on the current status of VTS, such as:
Do we today utilize the potential that VTS has to offer?
Will e-navigation challenge the freedom of the seas principle or support it?
Are there similarities or lessons to be learned from the aviation industry?
Do we already have the technology we need?
Have we already established practices that transcend territorial waters?

Several coastal States have decided to exercise authority against and cooperate with ships that sail beyond their own territorial waters.

This presentation will give examples, look at the benefits for all parts in the maritime transport community, and show how Norway – in cooperation with other countries – has introduced VTS related services, sensors and reporting procedures beyond territorial waters.

IMO ha decidido implementar cinco soluciones de e-navegación. Las soluciones pretenden mejorar la cooperación e interacción entre barcos, tierra, y viceversa. Se desarrollarán varios catálogos de servicios marítimos que apoyarán el tráfico de barcos en las seis zonas definidas que van más allá de los límites de aguas territoriales. En el futuro, los Servicios de Tráfico de Buques (VTS) desempeñarán un papel principal en la seguridad mejorada y el tráfico marítimo más eficiente.

El VTS es una herramienta importante para las autoridades que desean intervenir en las actividades de control y marítimas. Las autoridades gubernamentales quieren garantizar una mínima pérdida de vidas y prevenir los daños al medio ambiente y la propiedad. Además, los sistemas VTS deberían tener un papel principal en el suministro de servicios al tráfico marítimo. El desarrollo de la e-navegación plantea importantes preguntas acerca del estado actual del VTS, como son:

¿Utilizamos hoy en día el potencial que ofrece el VTS?
¿Desafiará la e-navegación el principio de libertad de los mares o lo apoyará?
¿Hay parecidos en o lecciones que aprender de la industria de la aviación?
¿Tenemos ya la tecnología que necesitamos?
¿Hemos establecido ya prácticas que van más allá de aguas territoriales?

Varios estados costeros han decidido ejercer la autoridad frente a los barcos que navegan más allá de sus propias aguas territoriales y cooperar.

Esta presentación expondrá ejemplos, examinará las ventajas de todos los participantes de la comunidad de transporte marítimo y mostrará cómo Noruega, junto con otros países, ha introducido los servicios, sensores y procedimientos de información relacionados con VTS más allá de aguas territoriales.

*L'OMI a décidé de mettre en œuvre cinq solutions e-Navigation. Ces solutions visent à améliorer la coopération et l'interaction entre navires et terre et vice versa. Plusieurs portefeuilles de services maritimes vont être créés pour aider le trafic maritime dans les six zones définies, qui s'étendent au-delà des eaux territoriales. Dans l'avenir, les services de trafic maritime (VTS) joueront un rôle central dans l'amélioration de la sécurité et de l'efficacité du trafic maritime.*
*Le VTS est un outil important pour les autorités qui veulent influencer la surveillance et les activités maritimes. Les autorités gouvernementales veulent garder à un niveau minimum les pertes de vie en mer et éviter les dommages à l'environnement et aux biens. En outre, les systèmes VTS devront jouer un rôle de premier plan dans la fourniture de services au trafic maritime.*

*Le développement de l'e-Navigation soulève d'importantes questions sur le statut actuel des VTS, par exemple:*
*Utilisons-nous aujourd'hui le potentiel qu'offre le VTS?*
*L'e-Navigation va-t-elle mettre en question le principe de liberté des mers ou va-t-elle le conforter ?*
*Y a-t-il des similitudes ou des leçons à retirer de l'industrie aérienne?*
*Possédons-nous déjà la technologie dont nous avons besoin?*
*Avons-nous déjà établi des pratiques qui transcendent les eaux territoriales ?*
*Plusieurs états côtiers ont décidé d'aller contre et coopèrent avec des navires situés en-dehors de leurs eaux territoriales.*

*Cette présentation donnera des exemples, examinera les avantages pour toutes les parties de la communauté maritime et montrera comment la Norvège – en collaboration avec d'autres pays – a introduit des services liés aux VTS, des capteurs et des procédures de compte-rendu en dehors de ses eaux territoriales.*

Paper not available

2014

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