MARITIME UK

# BEING A RESPONSIBLE INDUSTRY

## Maritime Autonomous Ship Systems (MASS) UK Industry Conduct Principles and Code of Practice

A Voluntary Code
Version 4
November 2020

MARITIME UK

**MARITIME UK** is the umbrella body for the maritime sector, bringing together the shipping, ports, services, engineering, science, and leisure marine industries. Our purpose is to champion and enable a thriving maritime sector.

Supporting over 1 million jobs and adding £46.1bn to our economy, maritime is responsible for facilitating 95% of UK global trade, worth over £500bn per year. The UK maritime workforce is 42% more productive than the average UK worker.

Maritime makes a greater contribution to the UK economy than both rail and air combined.

The sector is the fundamental enabler of British global trade and exports its own innovative products and services. With cutting-edge technology, high-quality design & manufacturing, unparalleled expertise in services and major investment opportunities, the UK is the natural home for global maritime business.

Maritime is a vital part of our island nation's heritage and of our modern economy – supporting jobs, driving innovation and enabling trade. The sector also enables millions of people to enjoy the recreational benefits of the UK's coastal and inland waterways.

Our members are: Belfast Maritime Consortium, British Marine, British Ports Association, CLIA UK & Ireland, Institute of Chartered Shipbrokers, London International Shipping Week, Maritime London, Maritime UK South West, Mersey Maritime, Nautilus International, Seafarers UK, Society of Maritime Industries, Solent LEP, The Baltic Exchange, Trinity House, UK Chamber of Shipping and the UK Major Ports Group.

# Contents

# Foreword

## 1 BACKGROUND

**1.1** The development of Maritime Autonomous Ship Systems (MASS) has continued at a very significant pace over the last few years with more MASS entering operation all the time. They come in a variety of sizes and have a very diverse set of operational capabilities which all place their own unique demands on those who own and operate them and the remainder of the Maritime Community. MASS are an element of the development of Robotics and Artificial Intelligence (RAI) systems across the various transport sectors.

**1.2** The term MASS (Maritime Autonomous Surface Ship) has also been adopted by the Maritime Safety Committee (MSC) of the International Maritime Organization (IMO) for their scoping exercise which was accepted at MSC 98 on the 13th June 2017. The MSC Working and Correspondence Groups started their work in May 2018; there was an intersessional working group meeting in September 2019 and work continues although progress has been delayed by the impact of the pandemic. Other scoping exercises are being undertaken by the Legal (LEG) and the Facilitation of International Maritime Traffic (FAL) committees. Information concerning their work is available through IMODOCS.

**1.3** Version 4 of this Code of Practice ("Code") has been prepared by the UK Maritime Autonomous Systems Regulatory Working Group (MASRWG) and has been published by Maritime UK through the Society of Maritime Industries. It has been prepared in two parts. Part 1 is a set of Industry Conduct Principles, which supercedes the previous Code of Conduct published in 2016, and Part 2 is the Code of Practice.

**1.4** The primary aim of this Code is to establish practical guidance, standards, and best practice for those who design, build, manufacture (including testing and commissioning), own, operate and control autonomous and semi-autonomous MASS primarily less than 24m. It will also establish some principles and guidance which will be applicable for those operating larger MASS while the more detailed regulatory framework for MASS is developed under the Merchant Shipping Act 1995.

**1.5** The Code focusses on surface ships, seagoing vessels and watercraft (per SOLAS Chapter V – Safety of Navigation) but does include some references to other Maritime Autonomous Systems (MAS), such as Autonomous Underwater Vehicles (AUV), Remotely Operated Vehicles (ROV) and Uncrewed Air Systems (UAS). It is stressed that these systems have their own operating guidelines which are not replicated in this Code but may be deployed from MASS. The Code will be updated as required when guidance from the IMO Regulatory Scoping Exercise is published, and as the MCA develops policies to meet the needs of forthcoming technological, commercial and regulatory developments.

**1.6** The Code deals with the important subject of Remote Control Centres and their HR and technical requirements.

**1.7** The intent is to ensure equivalence with the provisions of IMO's current legal instruments (COLREGS, SOLAS, MARPOL, and STCW) and to provide links to related documentation (e.g. ISPS, IMDG, ISM, Fire Safety Code and the Load Line Convention).

**1.8** The Code also aligns with other relevant documents, for example the Lloyds Register Crewless Marine Systems Code and the European Defence Agency-sponsored SARUMS Best Practice Guide for Crewless Maritime Systems.

**1.9** The Code provides guidance for MASS which are to be registered in the United Kingdom, including those less than 24 metres in length, and to other similar MASS operating within United Kingdom Waters (i.e. UK Territorial and Inland Waters per UNCLOS, 1982).

**1.10** It is considered that it can also be applied effectively to MASS operating in other parts of the world under similar environmental and operating conditions to those of the UK, provided bilateral consents from appropriate national maritime administrations/authorities are in place and are fully documented.

**1.11** United Kingdom registered MASS, to which this Code applies, when operating outside of United Kingdom Waters, may however be subject to additional requirements of overseas administrations. Owners/Operators should contact the relevant administration controlling those waters regarding the acceptability of the Code and any other requirements to which they may have to adhere. This includes the MCA when in UK waters.

**1.12** Compliance with the Code in no way obviates the need for MASS operations to comply with relevant bylaws made by either the local/navigation authority or the port/harbour authority for the area in which the MASS operates. Local authorities may, for instance, have powers to require MASS to have third-party insurance cover, and to set the level of that cover.

**1.13** Additionally, recognising that some MASS operate both at sea and on inland waterways, attention is drawn to the common approach to ship safety adopted by the major UK inland navigation authorities. Owners/operators of such ships should also comply with any applicable requirements of any relevant authority for the area of operation. It should be noted that local authorities may also have powers over the use of the foreshore and landing places, and to issue licenses for their use.

**1.14** Designers and builders of MASS will need to pay special regard to the intended area of operation and the working conditions in which a MASS will be subjected when selecting the standards for the design and specification of the craft, and the materials, products or components to be used in its construction. The builder, repairer or Owners/Operators of a MASS, as appropriate, should take all reasonable measures to ensure that a product, material or component fitted, or used in accordance with the measures in the Code, is suitable for the purpose intended, having regard to its location onboard the MASS, the area of operation and the weather conditions which may be encountered.

**1.15** When new standards are developed and finalised by the British Standards Institution (BSI), European Committee for Standardization (CEN), International Maritime Organization (IMO), International Organization for Standardisation (ISO), International Association of Lighthouse Authorities (IALA), International Electro-technical Commission (IEC) or any other international bodies, which impact upon the requirements of the Code, amendment of the Code may be considered immediately.

**1.16** In accordance with the EU Directive 1998/34/EC, as amended by 98/48/EC, laying down a procedure for the provision of information in the field of technical standards and regulations, any requirement for goods or materials to comply with a specified standard should be satisfied by compliance with:

- *a relevant standard or Code of practice of a national standards body or equivalent body of any EEA State; or*
- *any relevant international standard recognised for use in any EEA State; or*
- *any relevant technical regulation with mandatory or de facto mandatory application for marketing or use in any EEA State in so far as the standard, Code of practice, technical regulation or process in question enables the requirements for safety and fitness for purpose of this Code to be met in an equivalent manner. This should include consideration and acceptance of sub-contracted materials.*

**1.17** It is important to stress that, whilst all reasonable measures have been taken to develop standards which will result in the production of safe and seaworthy MASS, total safety at sea can never be guaranteed. Therefore, owners/operators of a MASS are encouraged to take out an appropriate policy of insurance. It is advised such insurance should provide cover against any foreseeable claims that may arise. It is advised, if a policy of insurance is in force, that a copy of the Certificate of Insurance be either displayed (if practicable) or available for inspection.

## 2 ENVIRONMENTAL CONSIDERATIONS

**2.1** MASS operations will also need to respect any environmental designations applicable to the area in which the MASS operates. For example, in England, Marine Protected Areas (MPAs) are designated in territorial waters to protect marine wildlife of national and international importance. These include Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Sites of Specific Scientific Interest (SSSIs), Ramsar sites (if applicable) and Marine Conservation Zones (MCZs). A large proportion of estuaries, for example, will have one or more of these designations. Operating a MASS in designated areas, particularly at times of the year when there is the potential for disturbance to wildlife (e.g. migrating birds), may be an activity which requires assent from the relevant environmental or conservation authority and their advice should be sought.

**2.2** The Code also summarises the requirements for environmental protection and carriage of cargoes and dangerous goods where appropriate. These are covered by other regulations which should be consulted for full details.

## 3 HEALTH AND SAFETY REGULATIONS

**3.1** The Owner/Operator of a MASS is responsible for the health and safety of anyone working on or around the MASS. When the Owner/Operator employs support crew, the Merchant Shipping and Fishing Vessels (Health and Safety at Work) Regulations 1997 (SI 1997 No. 2962), and other regulations made under these, apply. Regulations applicable to offices ashore should be considered for Remote Control Centres.

**3.2** Every employer is to be aware of any risks affecting workers and others and to ensure that appropriate measures are taken to minimise them through improving procedures or equipment where necessary. Employers must instruct those affected about the risks and how to ensure their own health and safety and the health and safety of others.

**3.3** The Provision and Use of Work Equipment Regulations 1998 (PUWER) impose duties on the employer, self-employed person, and to any person who has control to any extent of work equipment.

## 4 AUTHORISATION OF RECOGNISED ORGANISATIONS (ROs)

**4.1** The Code has been developed with input from a number of elements of the UK MASS industry. It is hoped that Maritime Administrations may be able to use the Code as a basis for their instructions to their Recognised Organisations (RO), or other flag State authorised bodies, to facilitate due regulatory compliance.

**4.2** The potential for authorisation of an RO has been influenced by the requirement to have a local capability for the efficient handling of the needs of owners and operators of some classes of MASS. Authorised RO are generally permitted to charge for undertaking Code of Practice examination and certification processes as a provision of their authorisation. Arrangements for charges will be made directly between the RO (or the RO's authorised person) and the party requesting such services.

## 5 CONTRIBUTING ORGANISATIONS

**5.1** The organisations that contributed to the development of the MASS Code of Practice are listed below.

- The Maritime and Coastguard Agency (MCA)
- Atlas Elektronik UK Ltd
- AutoNaut
- BAE Systems
- Bibby Maritime Limited
- BMT Group
- Birch Reynardson & Co
- British Marine
- Bureau Veritas
- Comité Maritime International (CMI)
- Commissioners of Irish Lights
- Connected Places Catapult
- Department for Transport
- Drone Major Group
- Dynautics Ltd
- EP Barrus
- Frazer Nash Consultancy
- Fugro
- HT Chambers
- Institute of Marine Engineering, Science & Technology (IMarEST)
- International Association of Institutes of Navigation (IAIN)
- International Marine Contractors Association (IMCA)
- International Federation of Ship Masters' Associations (IFSMA)
- Knowledge Transfer Network
- L3HARRIS
- Lloyds Register EMEA
- Ministry of Defence
- MSubs Ltd
- National Oceanography Centre
- National Physical Laboratory
- Nautical Institute
- North of England P&I Club
- Ocean Infinity
- Plymouth Marine Laboratory
- QinetiQ
- RYA
- SEA-KIT International
- Seabot XR
- Seebyte
- Seiche
- Setfords
- Sonardyne International Ltd
- Thales UK
- The Honourable Company of Master Mariners
- The Shipowners Club
- The UK Chamber of Shipping
- Trinity House
- UK Hydrographic Office
- UK Maritime Pilots Association
- UNECE – Working Party on Inland Water Transport (SC.3)
- University of Plymouth
- University of Southampton
- Valeport Ltd
- Warsash Maritime Academy – Southampton Solent University

The Code will be reviewed at regular intervals by the MAS Regulatory Working Group in consultation with the appropriate UK Maritime authorities and the MAS Steering Group.

MARITIME UK

PART 1

# MASS INDUSTRY CONDUCT PRINCIPLES

**The MASS Industry, companies, organisations and individuals working within it are committed to behaving ethically and with integrity in all aspects of business. Success of the MASS Industry and development of the appropriate regulatory controls depends on maintaining a good corporate reputation. Every organisation and employee within the industry has an important role to play. This outlines the Industry's commitment under this Code and spells out the responsibilities of those who manage the Industry.**

# 1 Scope

## 1.1 SUMMARY

**1.1.1** This is a summary of the principles of business conduct expected of all designers, manufacturers, owners and operators of MASS providing practical guidance on how to deal with important issues.

**1.1.2** The MASS Industry Conduct Statement ("Statement") is intended to be a guide that every organisation using this Code is expected to meet. Its contents complement and underscore legal requirements and are not intended to substitute any requirement of law. As a general rule, users of this Code are expected to be responsible for understanding and complying with the laws, regulations or policies that relate to their activities.

# 2 Application

## 2.1 STATEMENT

**2.1.1** This Statement applies to, and is supported by all organisations adopting this Code, their employees, agents and subcontractors when dealing within the scope of their contractual duties. It shall apply to all dealings that are reasonably considered within the normal course of business, including, but not limited to, dealings with customers, contractors, stakeholders, competitors and regulators. It can be adopted by any organisation within the industry and this is encouraged.

## 2.2 GUIDELINES

**2.2.1** All organisations adopting this Code and their agents resolve to respect the following guidelines:

- *To observe a general obligation to display responsible and ethical behaviour in relation to the design, manufacture, distribution, operation, maintenance and final disposal of their systems.*
- *To encourage and support communication and dialogue with regulators and relevant authorities.*
- *To follow the principles set out by this Code to the best of their abilities.*

# 3 Industry Manager's Responsibilities

## 3.1 RESPONSIBILITIES

**3.1.1** Those who manage or supervise others within the MASS Industry have additional responsibilities under this Code. These include:

- *Making sure the Code is provided to, explained to and understood by employees they manage and supervise.*
- *Providing guidance to those they manage or supervise on how they can meet the Code's requirements.*
- *Promoting the principles by setting a personal example.*
- *Ensuring employees receive training and guidance on applying the Code.*
- *Monitoring compliance with the Code by employees they manage or supervise.*
- *Ensuring that third parties, especially within their supply chain, are aware of, and follow, the policies and principles of this Code when appropriate.*
- *Creating an environment where employees can contribute to the industry's development and be recognised for doing so.*

# 4 Health and Safety

## 4.1 CONSIDERATIONS

**4.1.1** The MASS industry's activities and operations can have an impact on the health and safety of their employees, subcontractors and others working within it, both ashore and afloat. The industry has a responsibility to make sure it limits the potential for accidents to occur. Complying with all relevant safety rules and procedures is an essential minimum.

**4.1.2** It will also aim to prevent accidents happening by identifying and understanding the risks present in the workplace and daily operating environment, and by understanding how accidents can occur. It should seek to identify those areas that can be improved to protect the safety of all those in the industry and how identified risks can be mitigated.

**4.1.3** Everyone within the industry has a responsibility for safety in the workplace and must be familiar with and comply with each company's Health and Safety Policy and all local requirements and by thinking through the risks and hazards in our workplace and daily operating environment.

**INDUSTRY PRINCIPLE 1 – HEALTH AND SAFETY**

**Users of this Code will maintain healthy and secure workplaces and promote safe working practices during all stages of the MASS design, build, maintenance and operation lifecycle.**

# 5 Environment

## 5.1 ENVIRONMENTAL MANAGEMENT AND PROTECTION

**5.1.1** The MASS industry is committed to high standards of environmental management and protection. This includes giving appropriate consideration to the management of environmental impacts in the development, design, procurement, manufacture, test, training delivery, maintenance, support and disposal of our products.

**5.1.2** In addition, it will comply with the law and relevant environmental regulations.

**5.1.3** The industry will be proactive in contributing to the achievements of these high standards. It has the responsibility to think carefully about the environmental impacts of its products. It must use best practice engineering and management techniques and processes to understand the potential use of the product by customers. The industry's environmental responsibilities cover the whole lifecycle of the product. It should consider how products and components, including fuels, batteries and chemicals, could be designed and manufactured with recyclability and responsible disposal in mind.

**5.1.4** By doing this it can reduce the environmental impact of systems and services at all stages from design, assessment, development, manufacture and in-service support, through to removal from service and disposal at end of life.

**INDUSTRY PRINCIPLE 2 – ENVIRONMENT**

**Users of this Code will embrace a commitment to use resources effectively and to minimise the adverse impact of its products, activities and operations on the environment.**

# 6 Product Safety Design and Construction

## 6.1 SAFETY

**6.1.1** The MASS industry will agree with customers the level of safety that is required, i.e. what risks are acceptable, and will work to ensure that it delivers products that meet or exceed that level. It will not agree to a level of safety that is unlawful or unethical.

**6.1.2** Industry policies and practices are built on a set of principles of product safety that apply throughout the product's life, and that may extend beyond the formal end of the project.

**6.1.3** The safety of products relies on the application of safety policies and processes, and on the behaviours and attitudes of all within the industry. There is a chain of accountability for product safety and signatories are responsible for ensuring that the products both match their design and have the agreed level of safety.

**6.1.4** Information about product safety will be shared with customers and within the Industry and it will try to learn from anything about the performance and use of products that can be used to improve safety.

**6.1.5** Everyone within the industry should be aware of the product safety implications of their role and ensure that operations are in full compliance both with the law and with each company's safety policies and processes. Any concerns regarding the safety of a product, or the application of policies and processes, should be raised immediately.

**6.1.6** The MASS industry will ensure that it employs Suitably Qualified and Experienced Personnel (SQEP) in the design and construction of its systems. It will source good quality, traceable, consistent materials and components and use appropriate design, build and test standards where applicable to ensure quality, safe and predictable products are delivered to customers.

## 6.2 CYBER SAFETY AND SECURITY

**6.2.1** All aspects of Cyber Safety and Security should be embedded in the initial design of all software and hardware in MASS. The integration of these systems needs to be considered throughout the design process. Consequent updates and patches could have unforeseen, undesirable adverse effects on the functions and security integrity of the whole system.

**INDUSTRY PRINCIPLE 3 – PRODUCT SAFETY DESIGN AND CONSTRUCTION**

**Users of this Code will work with each customer to agree the level of safety required for a specific operational situation of each product through its life. They will suggest designs or modifications to mitigate, where possible, any identified or perceived risks.**

# 7 Customer Information

## 7.1 PROTECTIVE MARKING

**7.1.1** Improper or unauthorised handling of protectively marked and commercially sensitive information may damage the national security of the countries in which business is done. It also damages the Industry and may harm the operational and financial performance of companies within the industry.

**7.1.2** The MASS industry has responsibility to:

- *Handle Classified and/or Protectively marked information in accordance with all applicable laws and local procedures.*
- *Refrain from discussing or working with classified information in a public area where the conversation may be overheard, or information compromised.*
- *Not discuss classified information with anyone unless it is confirmed that they have a need to know and the appropriate clearance.*

**INDUSTRY PRINCIPLE 4 – CUSTOMER INFORMATION**

**Users of this Code will handle customer protectively marked and commercially sensitive information confidentially and, as a minimum, in accordance with appropriate regulations, policies and processes.**

# 8 Assurance Certification and Authorisation for use

## 8.1 PROCEDURES

**8.1.1** The MASS industry recognises the critical importance of Assurance, Certification and Authorisation for the use of all MASS, including Cyber Security. It will incorporate existing standards, where appropriate, Industry wide: a common agreed Risk Assessment Based Assurance Framework; an agreed Certification process using a Testing and Evaluation Roadmap; and an appropriate process to issue a Certified Clearance for Use for MASS.

**8.1.2** Manufacturers and operators that hold correct ISO9001:2015 certification will have rigorous quality systems in place that ensure high and consistent design, test, build and operational standards. ISO 27001 gives details of the International Standard that lays out the specifications for implementing an information security management system.

**8.1.3** The industry recognises that achieving international standardisation will take time. However, it will participate fully in its development and will ensure that it adopts its own best practice complementary to achieving the end state.

**INDUSTRY PRINCIPLE 5 – ASSURANCE AND AUTHORISATION**

**Users of this Code are fully committed to developing and applying agreed Assurance, Certification and Clearance for Use processes to enable demonstrable confidence in its products and systems and compliance with existing regulations**

# 9 Trade Restrictions and Export Controls

## 9.1 RESTRICTIONS

**9.1.1** The MASS industry will be involved with International, cross-border business and as such must be familiar with the appropriate national policies and procedures for handling goods, technology and data or providing services which may come into or go outside of a country.

**9.1.2** Involvement may mean simply having contact with a foreign or dual national inside a company facility for instance at a trade show. It can mean sending a technical drawing to a potential supplier in another country or submitting a proposal to a foreign government.

**9.1.3** If the Industry fails to observe export control laws, companies (and individuals) may face fines, criminal prosecution and loss of export privileges.

**9.1.4** Company policies and procedures must take these regulations and laws into account and so it is important to be familiar with them.

**9.1.5** Companies will provide training to those employees who are involved in export and import, or that regularly have contact with foreign nationals.

**INDUSTRY PRINCIPLE 6 – TRADE RESTRICTIONS AND EXPORTS**

**Users of this Code will comply with all applicable laws and regulations and export controls when importing and exporting products, services and information.**

# 10 Operational Responsibilities

## 10.1 RESPONSIBILITIES

**10.1.1** The MASS industry will demonstrate a world leading responsible and effective approach to the conduct of operations when deploying MASS. Full regard will be taken to observe other activities within the maritime domain and seek to use their best endeavours to ensure safe integration of MASS. Operations will fully comply with local rules and regulations governing safe operations of vessels at sea and environmental issues.

**10.1.2** A thorough risk assessment process will be applied to each MASS operation and consideration given to, and approval obtained when appropriate, from any local controlling authority.

**10.1.3** Nothing in this Code removes the responsibility for each organisation to develop and apply its own standard operating procedures, including those used to plan the conduct and authorisation of operations, and system operating manuals.

**INDUSTRY PRINCIPLE 7 – OPERATIONAL RESPONSIBILITIES**

**Users of this Code will at all times conduct MASS operations in a safe and effective manner with full regard for other users of the maritime domain.**

# 11 Regulatory and Legislative Compliance

## 11.1 COMPLIANCE

**1.1.1** The Industry recognises that regulatory development governing MASS is still in progress. It will fully contribute to that development using informed judgment and practical experience. In the meantime, the Industry will conduct activities and operations in full recognition of the status of MASS with respect to:

- *International Regulations for Preventing Collisions at Sea, 1972, amended in November 2003*
- *Other maritime laws, rules and conventions where applicable*
- *Local or temporary arrangements in place in the areas of MASS operations*

**11.1.2** The underlying principle is to avoid collisions and incidents at sea, injury and loss of life and damage to the environment. The Industry agrees to adopt the necessary practices to achieve these aims.

**INDUSTRY PRINCIPLE 8 – REGULATORY COMPLIANCE**

**Users of this Code will seek to use their best endeavours to ensure compliance with all applicable regulations. They will fully contribute to the development of special rules and regulations covering MASS operations.**

# 12 Training and Development

## 12.1 THE HUMAN ELEMENT

**12.1.1** The MASS industry recognises the critical importance of training and development to its success. In particular:

- *MASS Operators will be trained and certified to at least the same recognised standards as far as the equivalent conventionally manned vessel.*
- *Companies within the Industry will have staff development processes in place to capture and progress skill generation.*
- *The MASS industry acknowledges that in time the desire is for standardisation with training syllabi and courses for a wide range of Uncrewed and autonomous systems. In the meantime, it is important that training is provided to the highest standards possible and wherever possible to a level that would be an assessed as suitable by an external and accredited organisation resulting in Suitably Qualified and Experienced Personnel (SQEP).*

**INDUSTRY PRINCIPLE 9 – TRAINING AND DEVELOPMENT**

**Users of this Code will ensure the appropriate level of training and certification for all MASS Operators. They will enable staff development and the sharing of best practice.**

MARITIME UK

PART 2

# UK CODE OF PRACTICE

# 1 Terms and Terminology

**In this Code the following terms and terminologies have been established for the sake of clarity, taking into account the working draft of ISO 23860. It is stressed that they will need to be amended and adapted as the International and UK regulatory organisations charged with the overall policies for MASS complete their phased work.**

**"Administration"**, for the purpose of this Code, means the UK Maritime and Coastguard Agency.

**"Annual examination"** means a general or partial examination of the ship, craft or vessel, its machinery, fittings and equipment, as far as can readily be seen, to ascertain that it has been satisfactorily maintained as required by the Code and that the arrangements, fittings and equipment provided are as documented in the Record of Particulars and Record of Equipment. The hull, shell fittings, external steering and propulsion components of the craft or vessel should be examined out of the water at intervals not exceeding 5 years. The RO may stipulate a lesser interval in consideration of hull construction material, condition, age or the type and service of the craft or vessel.

**"Approved"** means approved by, or acceptable to, the MCA under Merchant Shipping Act (1995), and associated regulations, as a matter of English Law and Jurisdiction, unless otherwise specified in the Code.

**"Area of operation"** are those identified and promulgated in this and other similar Codes and are as shown at Table 1-1 below:

**Table 1-1: Areas of Operation**

| Area | Definition |
|---|---|
| **Area Category 6** | To sea, within 3 miles from a nominated departure point(s) and never more than 3 miles from land, in favourable weather and daylight. |
| **Area Category 5** | Area Category 5 – within 3 miles of land and not more than 3 miles radius from either the point of departure to sea or the seaward boundary of protected waters (see definition of "protected waters") in favourable weather. |
| **Area Category 4** | Up to 20 miles from a safe haven, in favourable weather and in daylight |
| **Area Category 3** | Up to 20 miles from a safe haven |
| **Area Category 2** | Up to 60 miles from a safe haven |
| **Area Category 1** | Up to 150 miles from a safe haven |
| **Area Category 0** | Unrestricted service |

**"as amended"** refers to any other document that replaces, revokes or amends the document that the term "as amended" follows.

**"Authorised person"** means a person who by reason of relevant professional qualifications, practical experience or expertise is authorised by the RO chosen by the owner/Operators to carry out examinations required within the Code.

**"Automatic"** - Pertaining to a process or device that, under specified conditions, functions without human intervention (ISO/TR 11065).

**"Autonomy"** - In the context of ships, autonomy (e.g. as in "Autonomous Ship") means that the ship can operate without human intervention, related to one or more ship functions, for the full or limited periods of the ship operations or voyage.

**"Autonomous Ship System"** - All physical and human elements that together ensure sustainable operation of an autonomous ship in its intended operations or voyage.

**"Cargo"** for the purpose of the Code means all items which are transported by the ship except fuel for the ship, ballast (either solid or liquid), consumables to be used on board, permanent outfit and equipment of the ship, stores and spare gear for the vessel.

**"Certificate"** means the certificate appropriate to a ship to which the Code is applied which the Merchant Shipping (Small Workboats and Pilot Boats) Regulations 1998 (SI 1998 No. 1609), as amended, require to have been issued.

**"Charter"** means an agreement between the Owner(s)/Operators and another party which allows that other party to operate the ship, and the "Charterer" is that other party.

**"Code"** means this Code unless another Code is specified.

**"Company"** means the owner of the ship or any other organisation or person such as the manager, or the bareboat charterer, who has assumed responsibility for the operation of the ship from the ship owner and who, on assuming such responsibility, has agreed to take over all duties and responsibility imposed by the Code (and by extension the associated IMO instruments).

**"Company Security Officer"** - means the person designated by the Company for ensuring that a ship security assessment is carried out; that a ship security plan is developed, submitted for approval, and thereafter implemented and maintained and for liaison with port facility security officers and the ship security officer.

**"Compartment"** means all spaces within the watertight or fire-resisting boundaries on any one level which have inter-communicating access.

**"Competent harbour authority"** has the same meaning as it has in the Pilotage Act 1987.

**"Competent Authority"**, in respect of operating qualifications (Ch 0), means either the MCA or an organisation that issues Certificates of Competence which has applied for and been granted recognition by the MCA as having the appropriate technical and administrative expertise in accordance with the procedures established for vessels of any type or size.

**"Compliance examination"** means an examination of the ship, its machinery, fittings and equipment, by an authorised person, to ascertain that the ship's structure, machinery, fittings and equipment comply with the requirements of the Code. Part of the examination should be conducted when the ship is out of the water. Part of the examination should be conducted when the ship is in the water.

For simple waterborne craft (e.g. RHIBs) of a design, with no through hull fittings below the water line the Responsible Organisation may exercise discretion in carrying out the compliance examination entirely out of the water.

**"Control position"** means a location on the ship/seagoing vessel/watercraft during any periods of manned operation from which control of propulsion, steering and other systems can be exercised.

**"Control Station"** – See "Remote Control Centre".

**"Controller"** means a person undertaking control functions appropriate for the Level of Control of the MASS. The controller may report to either a Watch Officer or the Master depending on the constitution of the control function, the MASS category and the required Level of Control.

**"Coxswain"** refers to any person controlling the MASS, either remotely (depending on the category of control applicable to the MASS during an operation) or to a person controlling the MASS from an onboard control station during any period of operation under direct manned control (e.g. pilotage).

**"Crew"** means a person employed or engaged in any capacity on-board a ship on the business of the ship or any person engaged in the direct control and operation of the ship from a remote location.

**"Crewless Ship"** means a ship with no crew on board. Crew does not include passengers, special personnel etc.

**"Daylight"** means from civil twilight before sunrise until civil twilight after sunset.

**"Decked vessel"** means a MASS with a continuous watertight weather deck which extends from stem to stern and has positive freeboard throughout, in any condition of loading of the MASS. Where an appropriate ISO standard is used, the definition should be taken from those standards as applicable.

**"Degrees of Autonomy"** The following Degrees of Autonomy have been established by the International Maritime Organization for their Regulatory Scoping Exercise.

**Table 1-2: Degrees of Autonomy (IMO)**

| | |
|---|---|
| **1** | **Ship with automated processes and decision support.**<br>Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control. |
| **2** | **Remotely controlled ship with seafarers on board.**<br>The ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions. |
| **3** | **Remotely controlled ship without seafarers on board.**<br>The ship is controlled and operated from another location. There are no seafarers on board. |
| **4** | **Fully autonomous ship.**<br>The operating system of the ship is able to make decisions and determine actions by itself. |

N.B. The above list does not represent a hierarchic order. It should be noted that MASS could be operating at one or more degrees of autonomy during the duration of a single voyage.

**"Design Category"** means a description of the wind and sea conditions for which a MASS is considered suitable under the EC Directive 94/25/EC of 16th June 1994, as amended by 2003/44/EC, on the approximation of the laws, regulations and administrative provisions of the Member States relating to recreational craft and used for the application of relevant ISO and CEN standards. See Table 1-3 below:

**Table 1-3: Design Categories**

| Design category | Wind force (Beaufort scale) | Significant wave height (HS, metres) |
|---|---|---|
| **A - 'Ocean'** | Exceeding 8 | Exceeding 4 |
| **B - 'Offshore'** | Up to, and including, 8 | Up to, and including, 4 |
| **C - 'Inshore'** | Up to, and including, 6 | Up to, and including, 2 |
| **D - 'Sheltered waters'** | Up to, and including, 4 | Up to, and including, 0.5 |

**"Designated Person Ashore"** identified in the IMO ISM Code as a person ashore who should be designated by the company who has direct access to the highest level of management.

**"Dynamic Positioning"** is a system that automatically controls a vessel's position and heading exclusively by means of active thrust.

**"Emergency Stop"** means the ability to reduce propulsion to a safe state in a timely manner. In this context:

- ***"a safe state"*** *means a level at which it is not likely to cause damage either directly or indirectly. Note that some MASS (e.g. wave propelled) may not have any means of cutting propulsion power to zero; but in a harbour or sheltered waters the wave propulsive power may reasonably be expected to be a safely low level;*
- ***"in a timely manner"*** *means within a time that is short enough to ensure that the risk from uncontrolled propulsive power can be contained before it is likely to cause damage. In open ocean conditions this may be relaxed, whereas in a docking situation the propulsion may need to be cut more quickly, within seconds or less;*
- *"**Full Shut Down**" means the ability to turn off all systems as required on the MASS remotely, for example in the case of a fire.*

**"Fail Safe"** is a design feature or practice that in the event of a specific type of failure, inherently responds in a way that will cause no or minimal harm to other equipment, to the environment or to people. Unlike inherent safety to a particular hazard, a system being "fail-safe" does not mean that failure is impossible or improbable, but rather that the system's design prevents or mitigates unsafe consequences of the system's failure. That is, if and when a "fail-safe" system fails, it remains at least as safe as it was before the failure. Since many types of failure are possible, failure mode and effects analysis are used to examine failure situations and recommend safety design and procedures.

**"Length" and "(L)"** in relation to a ship means the greater of the following distances:

- *96% of the total length on the waterline at 85% of the least moulded depth measured from the top of the keel, OR the length from the fore-side of the stem to the axis of the rudder stock on that waterline.*
- *Where the stem contour is concave above the waterline at 85% of the least moulded depth, both the forward terminal of the total length and the fore-side of the stem respectively shall be taken at the vertical projection to that waterline of the aftermost point of the stem contour (above that waterline). In ships designed with a rake of keel the waterline on which this length is measured shall be parallel to the designed waterline;*

**"Levels of control"** A number of systems for categorising the level of control applicable to MASS have been developed, notably by the European Defence Agency's Safety and Regulations for European Crewless Maritime Systems (SARUMS) group.

**Table 1-4: Level of Control Definitions**

| Level | Name | Description |
|---|---|---|
| 0 | Crewed | MASS is controlled by operators aboard |
| 1 | Operated | Under Operated control all cognitive functionality is within the human operator. The operator has direct contact with the MASS over e.g., continuous radio (R/C) and/or cable (e.g., tethered UUVs and ROVs). The operator makes all decisions, directs and controls all vehicle and mission functions. |
| 2 | Directed | Under Directed control some degree of reasoning and ability to respond is implemented into the MASS. It may sense the environment, report its state and suggest one or several actions. It may also suggest possible actions to the operator, such as e.g. prompting the operator for information or decisions. However, the authority to make decisions is with the operator. The MASS will act only if commanded and/or permitted to do so. |
| 3 | Delegated | The MASS is now authorised to execute some functions. It may sense environment, report its state and define actions and report its intention. The operator has the option to object to (veto) intentions declared by the MASS during a certain time, after which the MASS will act. The initiative emanates from the MASS and decision-making is shared between the operator and the MASS. |
| 4 | Monitored | The MASS will sense environment and report its state. The MASS defines actions, decides, acts and reports its action. The operator may monitor the events. |
| 5 | Autonomous | The MASS will sense environment, define possible actions, decide and act. The Crewless Vessel is afforded a maximum degree of independence and self-determination within the context of the system capabilities and limitations. Autonomous functions are invoked by the on-board systems at occasions decided by the same, without notifying any external units or operators. |

Definitions for Level of Control (LoC) are shown at Table 1-4 and should be considered alongside the Degrees of Autonomy in Table 1-2. In practice, levels of control may be different for different functions aboard the same MASS (e.g. a MASS navigating under LoC4, may also deploy a payload that is controlled at LoC2). The LoC applied to the MASS may also change during a voyage (e.g. LoC 1 in a VTS, but LoC 4 in open ocean passage).

**"Master"** is defined in s.313 of the Merchant Shipping Act 1995 as the individual in "command or charge of a ship". For the purposes of this Code, the term "master" should mean a specific person officially designated by the owner of the MASS as discharging the responsibilities of the Master of the MASS. This will be an employee of the company who has been assessed as competent to discharge these responsibilities in accordance with the provisions of this Code. This person may be located anywhere provided that the required level of command, control and communication can be maintained to discharge these duties.

**"MASS"** – Maritime Autonomous Ship System. This definition of MASS used in the Code encompasses a vessel and all associated onboard, offboard and RCC systems.

**"MASS"** – Maritime Autonomous Surface Ship is a term adopted by the IMO for their scoping exercise which means, for the purpose of this Code, a surface ship that is capable of being operated without a human onboard in charge of that ship and for which the level of control may encompass any of those shown at Table 1-4.

**"MASS Watch Officer"** is the individual who has responsibility for the MASS when it is operational.

**"Operator"** – An entity (e.g. a company) that discharges the responsibilities necessary to maintain the MASS in a seaworthy condition and compliant with all relevant IMO Instruments and national legislation. The operator is also responsible for ensuring that all staff concerned with the control of MASS hold appropriate qualifications as required by IMO instruments and national legislation.

**"Owner"** – The title holder of the MASS. If the "Company" is not the Owner, then the Owner shall report the name and details of the Operating Company to the Maritime Administration.

**"Recognised Organisation (RO)"**. Under the provisions of SOLAS 1974/1988 regulation 1/6, MARPOL Annex 1 regulation 6, MARPOL Annex II regulation 8, MARPOL Annex IV regulation 4, MARPOL Annex VI regulation 5, LLC 1966/1988 article 13, TONNAGE 1969 article 7 and AFS 2001 Annex 4 regulation 1, the inspection and survey of ships shall be carried out by officers of the Flag State Administration in accordance with IMO's RO Code. The Flag State Administration may, however, entrust the inspections and surveys either to surveyors nominated for the purpose or to organizations recognized by it. The IMO reference is MSC.349(92) dated 21 June 2013.

**"Remote Control"** – Operational control of some or all ship operations or functions, at a point remote from the ship.

**"Remote Control Centre"** (RCC) is a site off the ship from which control of an autonomous ship can be executed. The RCC may be located either ashore or afloat and may exercise varying degrees of control as defined under "Levels of Control". An RCC may consist of more than one Control Station or Room.

**"Remote Monitoring"** – Monitoring some or all ship operations or functions at a point remote from the ship.

**"Shipowner"** – One who owns or operates a ship, whether a person, a corporation or other legal entity, and any person acting on behalf of the Owner or Operator.

**"Ship Security Officer"** – means a person accountable to the master, designated by the Company as responsible for the security of the ship, including implementation and maintenance of the ship security plan and for liaison with the company security officer and port facility security officers.

**"Unattended"** – Used for a control position, e.g. an unattended bridge, without a crew available to operate it.

**"Uncrewed"** – This term is reserved for a ship with no crew on board. Crew does not include passengers or special personnel.

# 2 Application

**This Code applies to all Maritime Autonomous Surface Ships less than 24 metres in length. It also provides general guidance only for large MASS while operated in Territorial and Inland waters, for reward, for pleasure and recreation, or for other purposes, while on domestic voyages from the United Kingdom.**

## 2.1 CLASSES OF MARITIME AUTONOMOUS SURFACE SHIP (MASS)

**2.1.1** The Code identifies several classes of ships within a MASS based on their intended use, size, speed and potential hazard to other ships and shipping. The intention of these classes is to discriminate those MASS that are inherently unlikely to cause a hazard to most other marine users, by virtue of their size and speed, from those classes of MASS that by nature of their size and speed, are likely to pose an equivalent hazard to that posed by manned vessels to other marine users. These classes are primarily derived from the existing categories that are contained within either the COLREGS or the Load Line convention and are purposely selected to maintain commonality of requirement with those instruments wherever possible.

**2.1.2** The classes also reflect the feasible level of situational awareness that can be provided, given size and payload constraints.

**2.1.3** Classes of MASS ships are shown below at Table 2-1. It should be noted that this Code will primarily apply to Ultra- Light, Light, Small classes and some High-Speed ships. Exemptions may be specially considered on a case- by-case basis. Operating speeds need to be taken into account in all risk assessments, noting the various requirements of the COLREGS.

**Table 2-1: Classes of MASS**

| Class of MASS | Characteristic | Notes |
|---|---|---|
| **Ultra-light** | Length overall <7m | *Derived from MCA High-Speed Craft Code (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/292155/hsc_2000_rev06-09_full-comp-all.pdf)<br><br>where ∇ = moulded displacement, in $m^3$, of the craft corresponding to the design waterline. |
| **Light** | Length overall ≥ 7m to <13m | |
| **Small** | Length overall ≥ 13m to <24m | |
| **Large** | Length ≥24m | |
| **High-Speed** | Operating speed V is not less than V = 7.19 ∇⅙ knots | |

**2.1.4** For the purposes of this Code, these classes will apply to MASS constructed on or after 1 January 2019. Derogations from these classes may be appropriate in certain circumstances where risk to other marine traffic can be proven to be reduced and may be considered by the relevant authority. However, this will normally be the exception to the rule.

## 2.2 STANDARDS

**2.2.1** This Code provides standards which may be appropriate for Owners/Operators to select to use for the various categories of MASS envisaged. The Code is based on an approach to which appropriate standards can be applied, noting that many of the existing Instruments and Regulations are derived from the SOLAS Regulations, which, for some MASS, may not be appropriate.

**2.2.2** Ultra-Light MASS, as defined above, which are not used for financial gain or reward do not have to comply with the requirements for registration, or certification. This comparative freedom from regulation is in part based on an assumption that the sector will, as a matter of self-discipline and shared safety responsibility, pay proper regard to safety matters.

**2.2.3** If an crewless MASS is not a “pleasure or recreational MASS” it is considered to be used for reward for the purposes of this Code unless engaged on Government business.

**2.2.4** It is the responsibility of the Owner/Operator to ensure that a MASS (and any associated RCC) is properly maintained, examined and manned in accordance with the Code. The Code applies whether the Owner/Operator is corporate, private or of a charitable nature.

## 2.3 CERTIFICATION

**2.3.1** As per current national and international processes and practices, a MASS must comply with all the requirements of this Code for the relevant class of MASS and for the intended operating area where it is considered necessary, to the satisfaction of an appropriate RO to be issued with a certificate for a particular area of operation. The requirement for, and issue of, certificates, will reflect the development of best practice and is included in this Code to demonstrate the clear intent of the Industry to show to the wider maritime community that crewless MASS should not be exempt from established procedures wherever they are relevant and specifically where they will contribute to overall safety standards..

**2.3.2** When issued to a MASS, a certificate should normally be valid for a period not exceeding five years.

## 2.4 INTERPRETATION

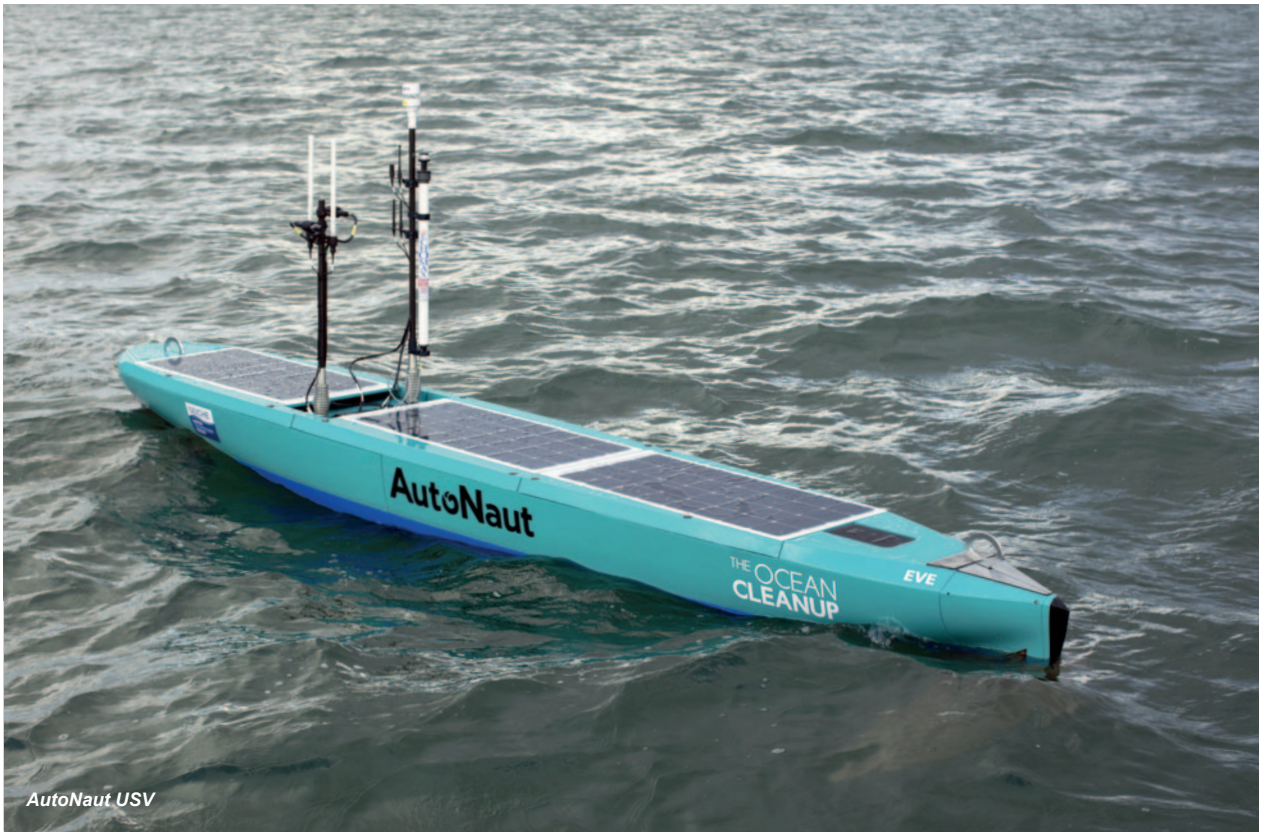
**2.4.1** Where a question of application of the Code or an interpretation of a part of the Code arises, the Owner/Operator of the MASS concerned should in the first instance seek clarification from the RO. In situations where it is not possible to resolve an issue of interpretation the RO may apply in writing for advice on interpretation to the Administration, who may consult with others as deemed appropriate.

## 2.5 EQUIVALENT STANDARDS

**2.5.1** When the Code requires that a particular piece of equipment or machinery should be provided or carried in a MASS, or that any particular provision should be made to a specified standard, consideration may be given to application to the Administration to permit any other piece of equipment or machinery to be provided or carried, or any other provision to be made. For MASS less than 24 metres in length this is likely to be unnecessary. If an application is made, the Administration will need to be satisfied by trials or otherwise that the alternative is at least as effective as that stipulated within the Code.

## 2.6 CARRIAGE OF ADDITIONAL EQUIPMENT

**2.6.1** Equipment on board, which is expected to be relied on in situations affecting safety or pollution prevention, must be in an operational condition. If such equipment is inoperative and is in excess of the equipment required by this Code it should either be repaired, removed or if removal is not practical, clearly marked as inoperative and secured. The status of the (inoperable) equipment should also be reported at the relevant RCC and/or within the control system of the vessel. Reference should also be made to MGN79 on Safety Equipment and Pollution Prevention Equipment carried in excess of Statutory Requirements.



*AutoNaut USV*

# 3 Operations

## 3.1 OBJECTIVE

**The objective of this Chapter is to help Owners and Operators to identify and produce the information required regarding a specific MASS, however and wherever it is to be operated, that will be required to support and inform other Chapters of this Code. It also offers best practice on achieving permissions for MASS trials and operations.**

## 3.2 SCOPE

**3.2.1** The purpose of this Chapter is twofold. Firstly, to help Owners and Operators outline the information required regarding the MASS that will be required to support and inform other Chapters of this Code. This will be required to support and inform the design, manufacture, in-service support and disposal elements of a suitable design Code and to inform risk assessments as part of the design procedure. It is NOT intended to describe in detail the operation of all types of MASS and the appropriate procedures to be used.

**3.2.2** The second part of this chapter outlines the activities and planning that may be required to achieve the requisite permissions to conduct MASS operations in the Territorial Waters and EEZ of a Coastal State. It is intended to encapsulate the experience gained thus far in MASS trials and operations and promulgate “best practice” as currently understood.

## 3.3 OPERATION TYPE

**3.3.1** The operation type should define the purpose of the MASS and its main operational phases. For example, a cargo ship voyage might comprise loading, departure, voyage, arrival and unloading. These phases might each be subject to different levels of control (LoC) and speed/manoeuvring envelopes.

**3.3.2** Alternatively, a long-term monitoring or survey voyage might comprise departure, transit, operation on station, return transit, arrival. These phases may also have varying levels of control, speed, limitations on manoeuvring. For example – a MASS may transit at high speed to a survey area, during which one method of control may be appropriate, but when on station may operate at a much lower speed, which may materially change the risk of operation and allow a different level of control during this phase.

**3.3.3** Crewless MASS may be designed to operate in particular areas of operation, as shown in Table 1-1 of this Code, which will also imply Design Category allocations as at Table 1-3 of this Code.

## 3.4 SHIP TYPE

**3.4.1** MASS will have a number of different categories, according to criteria, including (but not limited to) the following:

- *Purpose (e.g. Naval, Survey, Cargo, Workboat, OSV, Tug);*
- *GT and LOA;*
- *Cargo Type (if applicable);*
- *Propulsion method.*

**3.4.2** This will inform the relevant IMO instruments that will apply and are addressed in other chapters of the Code. These factors may also influence the LoC applied in certain phases of voyage. For example, it may be assessed as inappropriate for MASS carrying polluting or dangerous cargos to be operated under LoC5 in high-traffic areas.

**3.4.3** Size should be based on existing convention dimensions, defined in terms of length, GT, and similar – see MASS classes in Table 2-1.

## 3.5 DEGREES OF AUTONOMY AND LEVELS OF CONTROL

**3.5.1** The Code includes the Degrees of Autonomy which have been established by IMO for their Regulatory Scoping Exercise and complementary Levels of Control which are in use by MASS owners and operators. There are several sets of definitions which have been put forward so neither set of Degrees or Levels in this Code should be considered definitive. They are issued as guidelines only.

**3.5.2** The planned control methods (and associated LoC) should be clearly defined and it should be noted that these may vary across different phases of a voyage.

## 3.6 ENVIRONMENTAL DEMANDS

**3.6.1** This Section should identify any particular environmental demands imposed by the perceived role and /or operating area of the vessel/craft and should specifically include the following factors:

- *Ice Navigation requirement;*
- *Max / Min Sea temperatures;*
- *Max / Min Air temperatures;*
- *Humidity;*
- *Atmospheric pressure.*

## 3.7 OPERATIONAL AND EVALUATION DEPLOYMENT PLANNING AND AUTHORISATIONS

**3.7.1** Valuable experience has been gained over the last few years by the UK MASS Industry in completing the necessary negotiations with the required Marine Waterspace Authorities in order to achieve the required authorisation and approvals to operate. In most cases this experience has been developed via a series of “one-off” requests which has, of necessity, led to extended negotiation with the authorities nominally unfamiliar with MASS operations and requirements, and an ‘Industry’ unfamiliar with the route to achieve all the necessary contacts and approvals. In order to support this on-going requirement and assist this process (for both parties) the following advice in this chapter is a culmination of current ‘best practice’.

**3.7.2** IMO has produced Interim Guidelines for MASS Trials at IMODOCS - MSC Circular 1604 ("MSC 101/WP.8" dated 12 June 2019). These guidelines have been developed to assist relevant authorities and relevant stakeholders with ensuring that the trials of MASS related systems and infrastructure are conducted safely, securely, and with due regard for protection of the environment.

**3.7.3** A recommended MASS Operational and Evaluation Trials Plan is provided as Annex A to this chapter. Although by no means exhaustive, it does provide a useful format to begin the engagement with the relevant Waterspace Authorities and facilitate the process of the operational approvals.

**3.7.4** The map of MASS UK Operational and Evaluation areas at Figure 3-1 below, illustrates that there have already been significant operational and trials deployments of MASS, drawn from a sample of the Industry activity, and this coverage is continuing to grow rapidly. This shows a wide selection of UK deployments options, UK operational deployments, and dedicated Waterspace trials areas and MoD facilities that are available to would-be operators, including the Solent LEP range and the Smart Sound Plymouth initiatives.

**Figure 3-1: MASS UK Operational and Evaluation Areas**

**3.7.5** For trials activities, as opposed to operational deployments, it will take a detailed process of review and selection by the 'Operator' to identify and match the necessary functional and operational requirements to the Waterspace availability and conditions needed.

**3.7.6** To achieve a successful, authorised and approved MASS deployment a number of Waterspace Authorities may need to be consulted dependent on the area requirements and the extent of the evaluation tasking. This may include the area authorities from inshore to offshore 'ownerships' who may need to be consulted to cover the whole deployment planned operations and also the waterfront support facilities, communications and surveillance requirements. The principal points of contact are the Harbour Masters (HM) and Inner Harbour Authorities, the MCA local Office, Marine Scotland, and, potentially other UK Government Departments, MMO (Marine Management Organisation) especially where sensor and transmitter operating licences may be required. Initial contact to the local HM is recommended in order to gain a full appreciation of the bounded area and adjacent authorities, and other constraints such as environmental restrictions.

**3.7.7** Notice to Mariners and appropriate radio navigation warnings (e.g. RNW and WZ) should be issued as appropriate.

**3.7.8** During the planning phase of any MASS Operational deployment the following additional operators and or authorities should also be considered, and notification issued and or clearance obtained where relevant:

- *Fishermen (Bulletin of intended ops);*
- *Offshore operators (i.e. Oil & Gas, and Renewable Energy operators/owners);*
- *Established local water sport leisure clubs and organisations;*
- *Other stakeholders with economical, safety or environmental interests in intended location.*

**3.7.9** In working to achieve the necessary approvals, it is expected that a suite of HSE documentation should be provided to support the mission and assure the relevant approving authorities that full consideration to the safety and risk management of the intended operation or evaluation trial has been completed. This may include a full HSE Plan, Launch and Recovery Risk Assessment, Emergency Recovery Plan and Procedure, and the outline Mission Plan and Method Statement. These documents will support the approval application and ensure all operations are conducted within the intent of this Code. It also provides proof of the application of Industry Best Practice and cognizance of the sensitivity and responsibility to societal acceptance of autonomous systems.

**3.7.10** The format of the assessment will be judged by the owner/operator as appropriate to the intended operation and could include full formal safety assessments but as minimum will be to the standard expected by the Health and Safety Executive.

***Thales UK Centre of Autonomy***

## ANNEX A TO CHAPTER 3

## MASS OPERATIONAL AND EVALUATION TRIALS PLAN

The purpose of the Operational and Trials Plan proforma is to facilitate the initial contact with a chosen Waterspace Authority and to begin the process of operational deployment planning and approvals. The format provides a recognisable standard (to the Authority) and holds UK MASS CoP endorsement. It concisely covers the essential planning information necessary for the approvals discussion to develop on both sides towards the ultimate signature of the Authority Approval to Operate.

The blank Proforma is available on the Maritime UK web at **www.maritimeuk.org**, through the Media Centre and Resources tabs and is shown on the following pages.

### OPERATIONAL AND TRIALS PLAN PROFORMA

| **Plan reference:** | | |
|---|---|---|
| Trial serial number | | |
| Date code | | [YYYY-MM-DD] |
| Trials identifier name | | |
| Launch Location / Home Port | | |
| Operations area | | |

| **MASS Owner/Shipowner Contact details:** | |
|---|---|
| Corporate Name | Address |
| Owner/Ship Owner | |
| Main Operator / Responsible person<br>Master Operating & Emergency contacts<br>Designated person ashore | Definitions as per Ch 2 of the CoP |
| Insurance Company and Policy Number | |

| **Contact person(s):** | | | |
|---|---|---|---|
| Name(s) | Email address(es) | Telephone number(s) | Title / Responsibility / Training and Experience |
| | People and experience relevant to operation conduct and execution | | |

| **Date and location of operation:** | |
|---|---|
| Please identify the intended operational area(s). Use the most appropriate means of defining location such as co-ordinates latitudes/longitudes or by marking on a chart image to be inserted or attached. Add further lines if more locations are needed | |
| Location(s) | L1: including Charts and areas to be employed |
| | L2: |

| Schedule: | | |
|---|---|---|
| Dates / times | Location | Activities |
| | [e.g. L1] | [e.g. station keeping, target towing, high speed runs] |
| | | [or detail Operational window for trials/Ops to allow flexibility for delays, programme changes or weather] |

| Uncrewed craft details: | | | |
|---|---|---|---|
| Total number of Crewless craft | | | |
| Please complete the following, and create a separate table for each craft involved in the trial: | | | |
| Name(s) | | | |
| AIS Transmission? | Yes/No. Note – AIS should normally be fitted. | MMSI: | |
| Length overall | | Beam | |
| Draught | | Displacement | |
| Max speed | | Operational speed | |
| Propulsion type | [e.g. twin propeller] | Fuel | [e.g. Lithium ion battery] |
| Payloads | [and detail any towed sensors: size and depth] | | |
| Visual & sound identification | [e.g. port of Origin & Destination, vessel description; shapes, lights, sound signals, flags] | | |
| Design and Build Assurance details if available (Including Load Line requirements if appropriate) | | | |
| Picture of Vessel | Add attachment picture, for visual identification | | |

| Main Remote Control Centre: | |
|---|---|
| If there are several Remote Control Centres, please provide details for the main centre or a central point of contact for the duration of the trial. | |
| Location | |
| Contact details | |
| Control link type 1 | |
| Frequency 1 | |
| Control link type 2 | |
| Frequency 2 | |
| Details of OFCOM license if appropriate | |

| Safety Case: | |
|---|---|
| Safety Case / Risk Assessment | Reference to attached Documents |
| Please specify the consequences in the event of a failure of command and control datalink: | |
| [e.g. propulsion will stop after a timeout of 15 seconds]<br>Include use of guard ship/support vessels employed or on immediate stand-by<br>Immediate salvage of 'vessel not under command' (Total power loss or Command Link failure) | |

| Support craft: | |
|---|---|
| Number and type of support craft | |
| Name / call sign | |
| Phone number | |
| MMSI if transmitting on UAIS | |
| Intended role during trial, and station/proximity during trial/Ops | [including, Time to close to crewless craft & station keeping requirements] |
| Crewless craft recovery method | [Including role to tow vessel to and from harbour facility or launch area] |

| Brief description of trials operations: |
|---|
| Please provide a description of intended operations |
| [e.g. – the USV will be running a survey pattern in an area South of Bear Island, typically comprising a raster pattern or 20 lines, spacing 10m apart and 500m long, South of Bear Island and clear of shipping lanes;<br>a manned support craft will remain in line of sight within 300m of the USV for the duration of the trial] |

| Additional information: |
|---|
| [e.g. – this is similar to trial serial number or date (yyyy-mm-dd].<br>[Other authorities/contacts to be informed e.g. adjacent waterspace authorities, intended trials promulgations, collaborative trials with other operators, communication broadcasts] |

| Post Operation Review: |
|---|
| [e.g. Lessons Identified, Debrief issues, Feedback to appropriate authorities] |

| Approval (If required): |
|---|
| Constraints |
| [e.g. approved for daylight operations, support boat to keep watch on Channel 13] |

| Approval signature: | |
|---|---|
| Appropriate authority | [e.g. Which authorities have been consulted] |
| Name | |
| Signature | |

# 4 Cyber Security Considerations for MASS (Autonomous and Remotely Controlled)

## 4.1 OBJECTIVE

**The objective of this Chapter is to provide guidance on the requirements for Cyber Safety and Security for MASS operations.**

## 4.2 SCOPE

**4.2.1** The objectives of this Code are to ensure that all aspects of Cyber Safety and Security are addressed for all MASS operations.

## 4.3 GENERAL

**4.3.1** We are currently living in what is commonly referred to as the 4th Industrial revolution, the digital age. Over the past 50 years technology has advanced and evolved in ways unimaginable in the 1970's. A business computer system would have required a whole floor, in a large building, to house its data storage system, Now a mobile phone can hold more data, access it faster and communicate it to, virtually, anywhere on the planet with a suitable communication network.

**4.3.2** Advances in material technology and miniaturisation techniques have allowed the creation of computer memory chips with capacities measured in Peta bytes (PB = 1×10^15) and Exa bytes (EB = 1×10^18). New technology has allowed the development of processor chips which can perform billions of operations per second (GHz). This has resulted in small, very fast, large memory capacity devices which are capable of dealing with large amounts of data very rapidly. Modern hardware and advanced software combined with advanced communications technology, allow businesses and people to communicate and share information anywhere on the planet. Cloud computing has allowed us to remotely store, access and share massive amounts of data on demand. There is no area of our working or private lives that has not been impacted by these technologies. In addition to being able to use these systems for complicated local; tasks, we can communicate instantly with friends and family, collaborate with business colleagues, carry out online banking, shopping, education, video conferences, stream music and video and, more recently, perform remote audits, inspections, competence assessments and monitor performance. Dedicated machines are used to control and monitor industrial processes automatically and generate alarms if the system detects anomalies which require human intervention.

**4.3.3** This technology, collectively known as Information Technology (IT), uses computer systems to process data or information. Combined with a communication system and associated peripheral equipment, such as sensors, specific data can be mined, processed, manipulated and analysed to provide monitoring and control of any system.

**4.3.4** Artificial intelligence (AI) and machine learning (ML) are processes by which an IT system monitors large amounts of data and identifies trends and anomalies and can improve processes and performance, such as digital twin and predictive maintenance (PM).

**4.3.5** To enable computer systems to communicate with each other, systems are connected or "networked" together. In this way computer systems, physically located miles apart, can collaborate and share information. This is also the method use to allow a computer to control a system or asset, such as a MASS vessel.

**4.3.6** The availability of this technology and the ability to gather large amounts of data has given rise to new areas of business. Generally known as data mining, the gathering of vast amounts of data has, through AI, allowed the online habits of businesses and individuals to be tracked, and analysed, to produce large datasets which can be used for marketing and advertising purposes. Generally personal information is not gathered, but the sites you visit, what you purchase and when are. This information is gathered through "Cookies", which are often a condition you must agree to, to be able to access a site. Marketing companies are able to assess when and what you are most likely to buy and bombard you with advertising via websites. Although not illegal this can be very annoying but generally not harmful.

**4.3.7** This interest, and need, for data has led to these "data points" being very, very valuable. Data is often referred to as the "new" gold or oil.

## 4.4 CYBERCRIME

**4.4.1** Cybercrime is the unauthorized access to computer systems and networks with the intention of:

- *Accessing a computer system to steal, intercept or manipulate data to use for nefarious purposes.*
- *Taking control of a system or assets.*
- *Using another computer system to illegally access legitimate confidential information (Banks, Governments, Companies, Individuals).*

**4.4.2** A stand-alone computer system or a local network of computers, with no external communications network connections, are quite secure and not vulnerable to Cyberattack However if the computer system, or local network, contains sensitive data and information the system should be protected against local intrusion or attack by using passwords, encryption, screen locks and preventing unauthorized access to the system or location.

**4.4.3** Once a computer system is connected to an external network it is vulnerable to attack from anyone with access, authorised or unauthorised, to that network and more stringent Cybersecurity should be employed.

## 4.5 CYBERCRIME IN THE UK

**4.5.1** For the year ending March 2018 the UK office for National statistics (ONS) released its Crime survey for England and Wales (CSEW) showing that 4.5 million Cybercrimes were committed, of these 3.24 million were fraud related and 1.23 million computer misuse related (this includes hacking crimes). These crimes affected around 17 million UK citizens and resulted in the loss of £130 billion being stolen.

## 4.6 SOME CYBERCRIME STATISTICS FROM 2019, COURTESY OF SAFE AT LAST[1]

**4.6.1** Cybercrime is a very lucrative market and is estimated to be worth billions/trillions every year. Some recent statistics show:

- *Cybercrime generates around $1.5 trillion per year*
- *A hack occurs every 39 seconds*
- *Global Cybercrime damages are estimated to cost $6 trillion per year by 2021*
- *Hackers earn around $30,000 per job, whilst their managers can make up to $2 million*

[1] For more in depth information and statistics visit https://safeatlast.co.uk

- *60% of fraud goes through mobile devices, 80% of which are generated from mobile apps*
- *$1,077 is the average cash amount attackers demand*
- *81% of the US population has a social media account*
- *Chinese Cyberattacks accounted for over 20% of Cyberattacks in 2017*
- *$80 billion held in cryptocurrency is laundered annually*

**4.6.2** According to reports (Cybriant – Appendix 1) as much as 0.8% of global GDP is lost to Cybercrime. In 2017 Cybercriminals extorted around $1.5 trillion globally with $5 million attributed to ransomware. It is estimated that over the next 5 years private companies could lose more than $5 trillion dollars to Cybercrime. 53% of Cyberattacks result in average losses of over $500,000.

**4.6.3** On the 30th September 2020, the United Nations International Maritime Organisation (IMO) suffered a Cyberattack which disrupted many of its systems.

**4.6.4** On the same day the French maritime transport and logistics giant CMA CGM S.A. revealed it was also the victim of a malware attack, on 28th September 2020, that affected some servers on its network. This follows similar attacks on Maersk (2017), COSCO (2018) and MSC (April 2020) raising fears that the maritime industry, which accounts for the transportation of 90% of global trade, is regarded as a highly valued target for Cybercriminals.

**4.6.5** Cyber-crime is an unfortunate fact that we must live with. It is a very lucrative market estimated to be worth billions every year. Innovative cyber security software and systems are constantly being developed but Cybercriminals then develop more divisive methods to circumvent the security systems and so the process continues. Cyber threats, similar to health and safety hazards, are always present and the best form of defence against them is to maintain a robust cyber security policy, which remains up to date, aware and informed of the latest threats and take the appropriate action to defend against them.

**4.6.6** As we progress to more automated and networked systems, such as MASS vessels, more extreme forms of Cybercrime could include:

- *Hijacking of vessels and cargoes for personal use/financial gain*
- *Holding vessels and cargoes for ransom*
- *Environmental terrorism, (threatening to release chemical cargoes or running vessel aground)*
- *Terrorism (taking control of vessels to damage other vessels, assets or reputations.*

## 4.7 CYBERCRIMINALS

**4.7.1** A Cybercriminal is anyone who attempts to access a computer system or network without the appropriate authority or permission with the intention of committing a Cybercrime to:

- *Perform reconnaissance of Networks, Computers, ICT systems, IoT and OT Devices etc;*
- *Discover potential software and hardware vulnerabilities;*
- *Exploit identified vulnerabilities;*
- *Propagate malicious code and infect ICT systems (Install viruses, trojans, worms and malware etc);*
- *Gain administrator privileges and create user accounts;*
- *Modify, delete, steal, encrypt/decrypt passwords, confidential files, configurations*
- *Steal money, crypto currency, and Personally Identifiable Information (PII) such as credit card details, ID number, healthcare information etc;*
- *Ransom and Blackmail for money;*
- *Steal confidential data for sale on the Dark web;*
- *Render servers and critical devices inoperative;*
- *Jeopardise the confidentiality, integrity and accessibility of data; and*

- *Negatively affect the reputation and credibility of organisations and individuals.*
- *Taking control of a system or asset*
- *Accessing other people's accounts*
- *Industrial espionage*
- *Government instability prior to an overthrow*

**4.7.2** A Cybercriminal could be an individual working alone or a group of people acting together such as:

- *An organised crime gang*
- *A competitor organization*
- *A foreign government (or department of)*

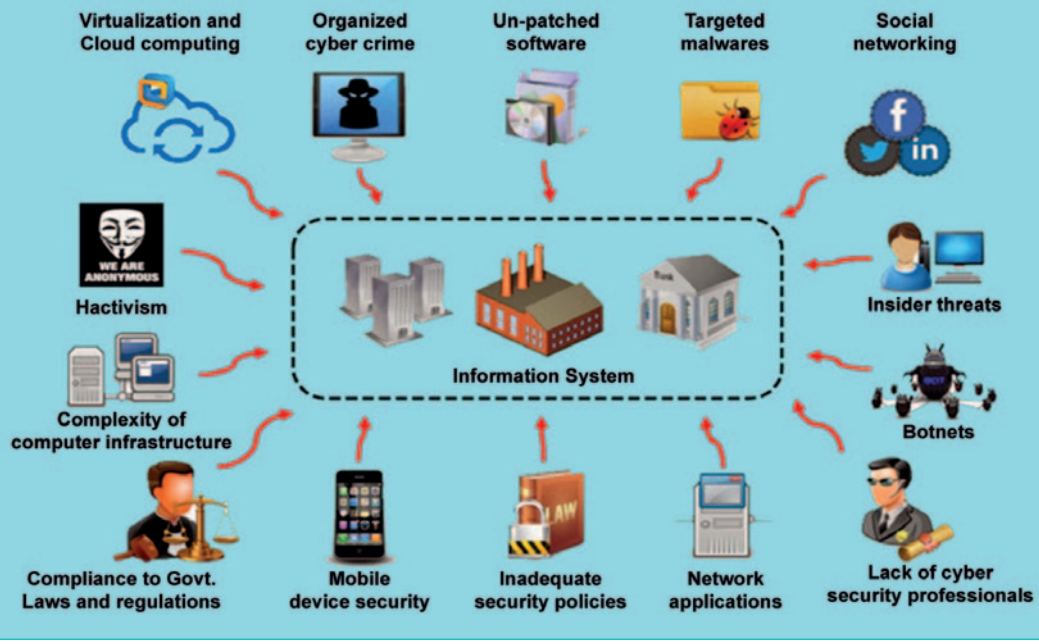
**4.7.3** The list of potential Cybercrimes is huge but commonly used methods include:

- *Targeting disgruntled former employee, current employees, contractors*
- *Phishing emails- attempting to gain access credential*
- *Social Engineering*
- *Loss or theft of equipment and rogue USB Devices*
- *Password guessing through Brute-Force attack*
- *Unchanged default credentials, weak passwords on web, application or network devices (Particularly IoT devices)*
- *Systems and Application Vulnerabilities (updated and poorly patched software)*
- *SQL injection through entry field of websites/ browsers*
- *Cross-Site scripting (XSS)*
- *Passwords or data lacking strong cyphers or encryption*
- *Distributed denial of service (DDoS) Botnets*

## 4.8 THREAT/ATTACK VECTORS

**4.8.1** Cybercriminals will investigate a target and determine which threat/attack vector to employ depending on their findings.

**Figure 4-1 Typical threat/attack vectors** *(Courtesy of Threat Vector Security)*



## 4.9 CYBER SECURITY

**4.9.1** Cyber security is a process used to control and protect an organisations computer systems, networks, and data from, and reduce the risk of, Cyberattack.

**4.9.2** Cyber security's core function is to protect our devices we use (smartphones, laptops, tablets, computers, network and routers), data and the services we access - both online and at work - from theft, damage or unauthorised access.

**4.9.3** The traditional approach to cyber security focuses on the protection of data and controlling access to the IT systems components. Advanced technology such as “smart” equipment and the Internet of Things (IoT) have changed how IT is integrated into systems and is deployed and operated. These new systems, which are complicated, connected and can generate large amounts of data now demand a much more comprehensive cyber security approach. It is no longer sufficient for a cyber security system to consider just the IT system; it must also take account of the operational technology (OT) system. This is generally referred to as IT/OT convergence.

## 4.10 IT/OT CONVERGENCE

**4.10.1** IT/OT convergence is the integration of information technology (IT) systems with operational technology (OT) systems. IT systems are used for data-centric computing; OT systems monitor events, processes and devices, and make adjustments in enterprise and industrial operations.

## 4.11 THE DIFFERENCE BETWEEN IT AND OT

**4.11.1** Traditional IT cyber security protects the IT system and data held in it but OT cyber security protects the complete system (vessel, people and environment).

**4.11.2** The traditional, IT based, definition of cyber security can be stated as: “Technologies, processes, and practices designed to prevent malware from doing damage or harm to networks, computers, programs, or data.”

**4.11.3** But modern, distributed, interconnected remote systems demand a more comprehensive and robust OT based cyber security system which can be defined as:

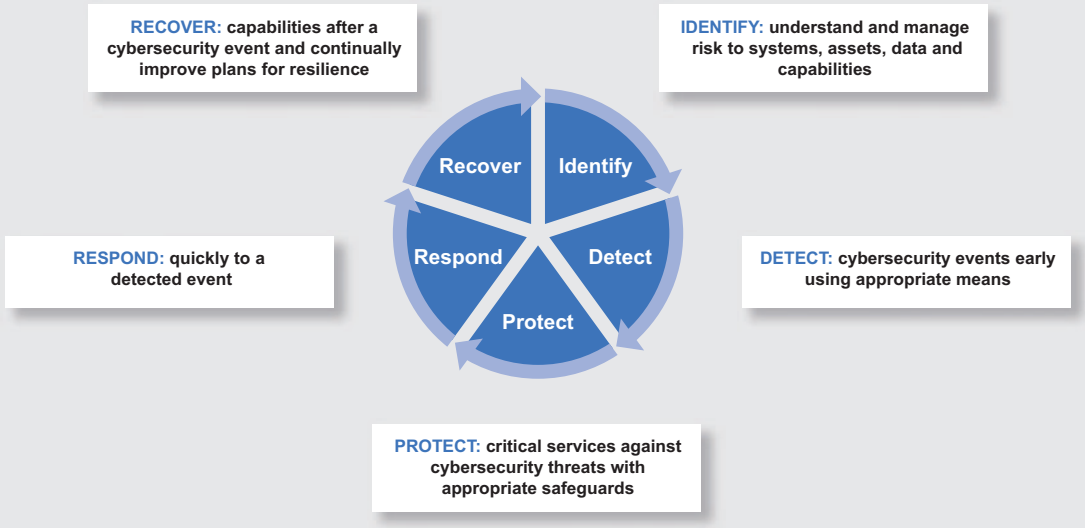
- *Technologies, processes, and practices designed to prevent the intended or unintended use of a cyber technology system to do damage to the cyber technology (networks, computers, programs, data), and vessel or harm to people, and environment.”*

**4.11.4** To achieve this level of protection we need to be able to verify the satisfactory performance of the OT cyber security system by:

- *Ensuring correct, safe, efficient and reliable operation through Software quality engineering.*
- *Preventing malicious and non-malicious threats through the cyber security system.*

**4.11.5** Functional testing will help assess a system against “known” errors or threats but makes no allowance for, as yet, unknown events. Using a maturity model provides ongoing monitoring, assessment and improvement to a cyber security system and will help defend against these unknown events.

**Figure 4-2 - Proactive model to ensure future protection** *(Courtesy of the Athens Group)*




**4.11.6** As technology advances OT systems will become networked such as in MASS/USV vessel control systems where the operator may be located in a remote control centre (RCC) but the vessel could be hundreds of miles away.

## 4.12 WHAT IS A ROBUST CYBER SECURITY SYSTEM?

**4.12.1** As previously stated, a robust cyber security system must address potential issues across the complete system and should include policies and procedures which:

- *Address both IT and OT components of the system*
- *Defines roles and responsibilities*
- *Defines who requires what access to various parts of the system*
- *Defines personnel access control policy*
- *Defines security protocols such as password control, lifespan and renewals*
- *Defines actions to be taken if a breach results from a Cyberattack*
- *Defines actions to be taken if a Cyberattack occurs without breach*
- *Defines the actions to be taken to ensure that the systems remain protected against newly created cyber threats.*

**4.12.2** A robust cyber security system should begin at the equipment design and planning stage. Many modern systems contain components provided by many different OEM's. In many cases the IT and communications equipment is added after the system is built. This approach could introduce potential for a Cyberattack, if the integration of this equipment is not fully understood. Even if the equipment is integrated, commissioned and operates successfully, when an upgrade or a software patch is applied to improve and enhance performance what effect will that have on another manufacturer's equipment? Cyber access point could be unintentionally created leaving the system vulnerable to attack from criminals. How many times have official Microsoft upgrades caused unexpected issues with Windows? If the system is, initially, designed with products specifically selected to integrate together then any later upgrades are less likely to cause problems.

## THREAT/ATTACK VECTOR RISK MANAGEMENT MATRIX

Owners and operators of MASS should produce a Risk Management Matrix to cover all threat and attack vectors. An example matrix is shown is at Table 4-1 following.

**Table 4-1 Personnel**

| Domain | Sub Domain | Threat/Attack Vector | Mitigation procedure |
|---|---|---|---|
| Personnel | Employees | Lack of understanding of cyber threats | Ongoing training and education |
| | | Unsuitable security history | Vetting during hiring process/Security Clearance? |
| | | Malware | Ongoing training and education |
| | | Keyloggers | Ongoing training and education |
| | | Social Engineering - Phishing | Ongoing training and education |
| | | Social Engineering - Spam | Ongoing training and education |
| | | Access level | Software access control procedure |
| | | Password control | IT procedures - robust passwords, not written down |
| | | | Change regularly, protect, do not reveal |
| | | | Regular penetration test to check staff awareness |
| | | Physical security | Training, Access control, Key Cards |
| | | | Security zones relevant to function |
| | | | IT procedures - robust passwords, not written down |
| | | | Screen locks, signing out of machine if left |
| | | | Working from home with company equipment |
| | | | Mobile devices |
| | Third Party Could include maintenance, cleaners, visitors, clients | Access Control | Training, Access control, Key Cards |
| | | Security history | Vetting of contracting company staff |
| | | | Accompany at all times while on premises |
| | | | Record of On/Off premises |
| | Disgruntled Staff | | Interview to resolve, monitor and observe |
| | | | Vetting during hiring |
| | | | Equal, fair, open, and non-discriminatory policies |
| | | | Limit access to sensitive areas and software |

| Table 4-1 Remote Control Centre | | | |
|---|---|---|---|
| **Domain** | **Sub Domain** | **Threat/Attack Vector** | **Mitigation procedure** |
| **Remote Control Centre** | Building security | Access Control | Access Control policy |
| | | | Keycards |
| | | | Security zoning depending on role |
| | | | Security patrols during quiet times |
| | | | Security cameras/recording and erasing policy |
| | | | Regular log of events |
| | | | Security breach procedure |
| | | | Reference list of emergency contact numbers |
| | | | Duty call out register |
| | | | Procedures to follow in an emergency |
| | | | Separate recreation area where staff can access net for social media for personal access - not connected to operational networks |
| | Equipment | Security | Robust IT/OT policy, encryption, regular tests |
| | | | IT and communications equipment, servers and routers |
| | | | In secure, access controlled location |
| | | | Regular security exercises to check staff responses |
| | | | Monitor for unusual activity/response |
| | | | Consider segmenting network to ensure that staff net access is not connected to operational systems |
| | | | Regular checks to ensure no devices have been added |
| | | | Regular system scans for run authorised software |
| | | Equipment Specification | System components specifically designed to be integrated to ensure correct functionality |
| | | | Back-up power supplies |
| | | | Alternative networks available |
| | | | Suitable spare equipment level maintained |
| | | | Ensure equipment compliance with appropriate standards for cyber/ communications etc |
| | | | Ensure adequate cooling |
| | | | Ensure adequate fire suppression system |
| | Operations | | Robust access and security policy |
| | | | Appropriate training and qualifications |
| | | | Maintain environment appropriate to operations |
| | | | Adequate back up control positions |
| | | | Reserve controllers available in event of illness etc |
| | | | No unauthorised "Smart" devices in the operations area |
| | | | Equipment logs for equipment, serial no. etc |

## Table 4-1 Vessel

| CREWED | | | |
|---|---|---|---|
| **Domain** | **Sub Domain** | **Threat/Attack Vector** | **Mitigation procedure** |
| **Vessel** | Personnel<br>See Domain 1 on page 38 | Shoreside security | Appropriate control for emergency services, pilots etc |
| | Vessel Access<br>See Building security in Domain 2 on page 39 | | |
| | Equipment<br>See equipment section on page 39 | | Secure dockside location with access control |
| | Operations<br>See operations in Domain 2 on page 39 | | |

| UNCREWED | | | |
|---|---|---|---|
| **Domain** | **Sub Domain** | **Threat/Attack Vector** | **Mitigation procedure** |
| **Vessel** | As for Crewed above | Equipment security | Control, network, and communications equipment located in secure, access controlled compartments |
| | | Prior to deployment | Full system checks and inspection for unusual devices |
| | | | Full IT and communications system checks for normal operations and control |
| | | Post deployment | Full system checks and inspection for unusual devices |
| | | | Full IT and communications system checks for normal operations and control |
| | | | Analyse all activity logs for anomalies |

## 4.13 CYBER SECURITY STANDARDS

**4.13.1** Many organizations consider cyber security to be a priority. The need to implement effective cyber security strategies grows every day. Cybercriminals continuously derive more sophisticated techniques for executing attacks. This has led to the development of various frameworks meant to assist organizations in achieving robust cyber security programs. Therefore, businesses should understand the top cyber security frameworks for enhancing their security postures. Cyber security frameworks refer to defined structures containing processes, practices, and technologies which companies can use to secure network and computer systems from security threats. Businesses should understand cyber security frameworks for enhancing organizational security.

**4.13.2** IMO resolution MSC.428(98) was adopted in 2017 and there are ongoing discussions at IMO to address 'Cyber risk management in Safety Management Systems'. For the shipping industry, resolution MSC.428(98) established a clear intent that the regulatory requirements of the Organization for cyber risk management were embodied in the provisions of SOLAS chapter IX and the ISM Code. Administrations are expected to clarify and enforce this intent. Effective management of cyber risks by companies, in accordance with the international regulatory requirements, is understood to be demonstrated by:

- *evidence of the continuous improvement of approved safety management systems conforming to the requirements of the ISM Code to take into account cyber risks; and*
- *implementation of policies and procedures for effective cyber risk management.*

The proper management of cyber risks is expected to be verified by Administrations during the first annual review of a company's Document of Compliance following 1 January 2021.

**4.13.3** Key cyber security frameworks are detailed below:

### 1. ISO IEC 27001/ISO 27002

The ISO 27001 cyber security framework consists of international standards which recommend the requirements for managing information security management systems (ISMS). ISO 27001 observes a risk-based process that requires businesses to put in place measures for detecting security threats that impact their information systems. To address the identified threats, ISO 27001 standards recommend various controls. An organization should select proper controls that can mitigate security risks to ensure it remains protected from attacks. In total, ISO 27001 advocates a total of 114 controls, which are categorized into 14 different categories. Some of the categories include information security policies containing two controls; information security organization with seven controls that detail the responsibilities for various tasks; human resource security category with six controls for enabling employees to understand their responsibility in maintaining information security; among others.

On the other hand, the ISO 27002 framework comprises of international standards that detail the controls which an organization should use to manage the security of information systems. The ISO 27002 is designed for use alongside ISO 27001, and most organizations use both to demonstrate their commitment to complying with various requirements required by different regulations. Some of the information security controls recommended in the ISO 27002 standard include policies for enhancing information security, controls such as asset inventory for managing IT assets, access controls for various business requirements and for managing user access, and operations security controls.

**https://www.iso.org/isoiec-27001-information-security.html**
**https://www.iso27001security.com/html/27002.html**

## 2. NIST Cyber security Framework

NIST (The US National Institute of Standards and Technology) is part of the U.S. Department of Commerce. The NIST Cyber security Framework was developed to respond to the presidential Executive Order 13636. The executive order purpose to enhance the security of the country's critical infrastructure, thus protecting them from internal and external attacks. Although the design of the framework aims at securing critical infrastructures, private organizations implement it to strengthen their cyber defenses. NIST CSF describes five functions that manage the risks to data and information security. The functions are: identify; protect; detect; respond; and recover.

- *The identify function guides organizations in detecting security risks to asset management, business environment, and IT governance through comprehensive risk assessment and management processes.*
- *The detect function defines security controls for protecting data and information systems. These include access control, training and awareness, data security, procedures for information protection, and maintaining protective technologies.*
- *Detect provides guidelines for detecting anomalies in security, monitoring systems, and networks to uncover security incidences, among others.*
- *The response function includes recommendations for planning responses to security events, mitigation procedures, communication processes during a response, and activities for improving security resiliency.*
- *The recovery function provides guidelines that a company can use to recover from attacks.*

**https://www.nist.gov/cyberframework**

## 3. IASME Governance

IASME governance refers to cyber security standards designed to enable small and medium-sized enterprises to realize adequate information assurance. The IASME governance outlines a criterion in which a business can be certified as having implemented the relevant cyber security measures. The standard enables companies to demonstrate to new or existing customers their readiness in protecting business or personal data. In short, it is used to accredit a business's cyber security posture. The IASME governance accreditation is similar to that of an ISO 27001 certification. However, implementing and maintaining the standard comes with reduced costs, administrative overheads, and complexities. IASME standards certification includes free cyber security insurance for businesses operating within the UK.

**https://www.iasme.co.uk/audited-iasme-governance/**

## 4. SOC 2

The American Institute of Certified Public Accountants (AICPA) developed the SOC 2 framework. The framework purpose to enable organizations that collect and store personal customer information in cloud services to maintain proper security. Also, the framework provides SaaS companies with guidelines and requirements for mitigating data breach risks and for strengthening their cyber security postures. Also, the SOC 2 framework details the security requirements which vendors and third parties must conform. The requirements guide them in conducting both external and internal threat analysis to identify potential cyber security threats. SOC 2 contains a total of 61 compliance requirements, and this makes it among the most challenging frameworks to implement. The requirements include guidelines for destroying confidential information, monitoring systems for security anomalies, procedures for responding to security events, internal communication guidelines, among others.

**https://www.aicpa.org/interestareas/frc/assuranceadvisoryservices/aicpasoc2report.html**

## 5. CIS v7

The body responsible for developing and maintaining the CIS v7 framework is the Center for Information Security (CIS). CIS v7 lists 20 actionable cyber security requirements meant for enhancing the security standards of all organizations. Most companies perceive the security requirements as best practices since the CIS has a credible reputation for developing baseline security programs. The framework categorizes the information security controls into three implementation groups. Implementation group 1 is for businesses that have limited cyber security expertise and resources. Implementation group 2 is for all organizations with moderate technical experience and resources in implementing the sub controls, whereas implementation group 3 targets companies with vast cyber security expertise and resources. CIS v7 stands out from the rest since it enables organizations to create budget-friendly cyber security programs. It also allows them to prioritize cyber security efforts.

**https://www.cisecurity.org/controls/**

## 6. NIST 800-53

NIST created NIST 800-53 publication for enabling federal agencies to realize effective cyber security practices. The framework focuses on information security requirements designed to enable federal agencies to secure information and information systems. Besides, NIST 800-53 provides governmental organizations with the requirements for allowing them to comply with FISMA (Federal Information Security Management Act) requirements. NIST 800-53 is unique as it contains more than 900 security requirements, making it among the most complicated frameworks for organizations to implement. The requirements recommended in the framework include controls for enhancing physical security, penetration testing, guidelines for implementing security assessments and authorization policies or procedures, among others. NIST 800-53 is a useful framework for organizations maintaining federal information systems, companies with systems that interact with federal information systems, or institutions seeking FISMA compliance.

**https://nvd.nist.gov/800-53**

## 7. COBIT

COBIT (Control Objectives for Information and Related Technologies) is a cyber security framework that integrates a business's best aspects to its IT security, governance, and management. ISACA (Information Systems Audit and Control Association) developed and maintains the framework. The COBIT cyber security framework is useful for companies aiming at improving production quality and at the same time, adhere to enhanced security practices. The factors that led to the creation of the framework are the necessity to meet all stakeholder cyber security expectations, end to end procedure controls for enterprises, and the need to develop a single but integrated security framework.

**http://www.isaca.org/cobit/pages/default.aspx**

## 8. COSO

COSO (Committee of Sponsoring Organizations) is a framework that allows organizations to identify and manage cyber security risks. The core points behind the development of the framework include monitoring, auditing, reporting, controlling, among others. Also, the framework consists of 17 requirements, which are categorized into five different categories. The categories are control environment, risk assessments, control activities, information and communication, and monitoring and controlling. All of the framework's components collaborate to establish sound processes for identifying and managing risks. A company using the framework routinely identifies and assess security risks at all organizational levels, thus improving its cyber security strategies. Also, the framework

recommends communication processes for communicating information risks and security objectives up or down in an organization. The framework further allows for continuous monitoring of security events to permit prompt responses.

**https://www.coso.org/Pages/default.aspx**

## 9. TC CYBER

The TC CYBER (Technical Committee on Cyber Security) framework was developed to improve the telecommunication standards across countries located within the European zones. The framework recommends a set of requirements for improving privacy awareness for individuals or organizations. It focuses on ensuring that organizations and individuals can enjoy high levels of privacy when using various telecommunication channels. Moreover, the framework recommends measures for enhancing communication security. Although the framework specifically addresses telecommunication privacy and security in European zones, other countries around the world also use it.

**https://www.etsi.org/cyber-security/tc-cyber-roadmap**

## 10. HITRUST CSF

HITRUST (Health Information Trust Alliance) cyber security framework addresses the various measures for enhancing security. The framework was developed to cater to the security issues organizations within the health industry face when managing IT security. This is through providing such institutions with efficient, comprehensive, and flexible approaches to managing risks and meeting various compliance regulations. In particular, the framework integrates various compliance regulations for securing personal information. Such include Singapore's Personal Data Protection Act and interprets relevant requirement recites from the General Data Protection Regulation. Also, the HITRUST cyber security framework is regularly revised to ensure it includes data protection requirements that are specific to the HIPPA regulation.

**https://hitrustalliance.net/hitrust-csf/**

## 11. CISQ

CISQ (Consortium for IT Software Quality) provides security standards that developers should maintain when developing software applications. Additionally, developers use the CISQ standards to measure the size and quality of a software program. More so, CISQ standards enable software developers to assess the risks and vulnerabilities present in a completed application or one that is under development. As a result, they can efficiently address all threats to ensure users access and use secure software applications. The vulnerabilities and exploits which the Open Web Application Security Project (OWASP), SANS Institute, and CWE (Common Weaknesses Enumeration) identify forms the basis upon which the CISQ standards are developed and maintained.

**https://www.it-cisq.org/**

## 12. Ten Steps to Cyber security

The Ten Steps to Cyber security is an initiative by the UK's Department for Business. It provides business executives with a cyber security overview. The framework recognizes the importance of providing executives with knowledge of cyber security issues that impact business development or growth, and the various measures used to mitigate such problems. This is to enable them to make better-informed management decisions in regards to organizational cyber security. As such, the framework uses broad descriptions but with lesser technicalities to explain the various cyber risks, defenses, mitigation measures, and solutions, thus enabling a business to employ a company-wide approach for enhancing cyber security.

**https://www.ncsc.gov.uk/collection/10-steps-to-cyber-security.**

## 13. FedRAMP

FedRAMP (Federal Risk and Authorization Management Program) is a framework designed for government agencies. The framework provides standardized guidelines that can enable federal agencies to evaluate cyber threats and risks to the different infrastructure platforms, and cloud-based services and software solutions. Furthermore, the framework permits the reuse of existing security packages and assessments across various governmental agencies. The framework is also based on the continuous monitoring of IT infrastructure and cloud products to facilitate a real-time cyber security program. More importantly, FedRAMP focuses on shifting from tedious, tethered, and insecure IT to more secure mobile and quick IT. The aim is to ensure federal agencies have access to modern and reliable technologies, but without compromising their security.

To achieve the desired security levels, FedRAMP collaborates with cloud and cyber security experts involved in maintaining other security frameworks. These include NSA, DoD, NIST, GSA, OMB, and other groups in private sectors. The main goals of FedRAMP are to accelerate cloud migrations by reusing authorizations and assessments, enhance confidence in cloud security, ensure that federal agencies consistently apply recommended security practices, and to increase automation for continuous monitoring.

**https://www.fedramp.gov/**

## 14. HIPAA

HIPAA (Health Insurance Portability and Accountability Act) contains various guidelines for enabling organizations to implement sufficient controls for securing employee or customer health information. HIPAA standards also require healthcare organizations to comply since they collect and store health information for all patients. The standards comprise of different security requirements that need organizations to demonstrate a clear understanding of how to implement and use them. Such requirements include training employees at all levels the best practices for collecting and storing health data. Besides, HIPAA requires companies to create and maintain appropriate procedures for conducting risk assessments. The process should also include methods for managing identified risks.

**https://www.hhs.gov/hipaa/index.html**

## 15. GDPR

GDPR (General Data Protection Regulation) is one of the latest frameworks enacted to secure personally identifiable information belonging to European citizens. The regulation framework provides a set of mandatory security requirements that organizations in different parts of the world must implement. As such, it is a global framework that protects the data of all EU citizens. Non-compliance leads to huge penalties, and this has caused most companies to comply with the requirements. GDPR requirements include implementing suitable controls for restricting unauthorized access to stored data. These are access control measures such as least privilege and role-based access controls, and multi-factor authentication schemes. Organizations or websites must also acquire a data owner's consent before they can use data for reasons such as marketing or advertising. Data breaches that result from a company's inability to implement security controls amounts to non-compliance.

**https://gdpr-info.eu/**

## 16. FISMA

FISMA (Federal Information Systems Management Act) is a framework designed for federal agencies. The compliance standard outlines a set of security requirements that government agencies can use to enhance their cyber security posture. The security standards aim at ascertaining that federal agencies implement adequate measures for protecting critical information systems from different types of attacks. Moreover, the framework

requires vendors or third-parties interacting with a government agency to conform to the stipulated security recommendations. The main aim of the security standard is to enable federal agencies to develop and maintain highly effective cyber security programs. To achieve this, the standard consists of a comprehensive cyber security framework with nine steps for securing government operations and IT assets. These are:

- *Categorizing information with respect to security levels*
- *Identify minimum security controls for protecting information*
- *Refine the controls by using risk assessments*
- *Implement and document the controls and develop a security plan*
- *Evaluate the effectiveness of implemented controls*
- *Determine security risks to federal systems or data*
- *Authorize the use of secure information systems*
- *Continuous monitoring of implemented controls.*

**https://www.dhs.gov/cisa/federal-information-security-modernization-act**

## 17. NY DFS

NY DFS (New York Department of Financial Services) is a cyber security framework that covers all institutions operating under DFS registrations, charters, or licenses. The framework consists of several cyber security requirements that can enhance the security postures of financial organizations and the third parties they interact with for different businesses. Among others, NY DFS requires organizations to identify security threats that can affect their networks or information systems. Also, the framework necessitates companies to adopt sufficient security infrastructure for protecting all IT assets from the identified risks. Notwithstanding, organizations covered by the NY DFS must implement systems for detecting cyber security events.

**https://www.dfs.ny.gov/docs/legal/regulations/adoptions/dfsrf500txt.pdf**

## 18. NERC CIP

NERC CIP (North American Electric Reliability Corporation Critical Infrastructure Protection) is a cyber security framework that contains standards for protecting critical infrastructures and assets. In total, the framework has nine standards comprising of 45 requirements. For example, the sabotage reporting standard requires an electric organization to report unusual occurrences and security disturbances to relevant bodies. The critical cyber asset identification standard makes it mandatory for an entity to document all cyber assets considered to be critical. Also, personnel and training standard requires employees with access to critical cyber assets to complete security and awareness training. Other standards included in the NERC CIP framework are electronic security perimeter, incident response, managing systems security, and maintaining recovery plans.

**https://www.nerc.com/pa/Stand/Reliability%20Standards/CIP-013-1.pdf**

## 19. SCAP

SCAP (Security Content Automation Protocol), is a regulation standard containing security specifications for standardizing the communication of security products and tools. The specifications aim is to standardize the processes through which security software programs communicate security issues, configuration information, and vulnerabilities. Through the standardized specifications, SCAP intends to enable a company to measure, express, and organize security data using universal criteria and formats. As such, the security software can allow a business to maintain enterprise security by utilizing processes such as verifying and installing security patches

automatically. Others are testing and verifying the security configurations of implemented systems and investigating incidences that can compromise system or network security.

**https://www.open-scap.org/features/standards/**

## 20. ANSI

The ANSI (American National Standards Institute) framework contains standards, information, and technical reports which outline procedures for implementing and maintaining Industrial Automation and Control Systems (IACS). The framework applies to all organizations that implement or manage IACS systems. The framework consists of four categories as defined by ANSI. The first category contains foundational information like security models, terminologies, and concepts. The second category addresses the aspects involved in creating and maintaining IACS cyber security programs. The third and fourth categories outline requirements for secure system integration and security requirements for product development, respectively.

**https://www.ansi.org/**

## 21. NIST SP 800-12

This framework provides an overview of control and computer security within an organization. Also, NIST SP 800-12 focuses on the different security controls an organization can implement to achieve a strengthened cyber security defense. Although most of the control and security requirements were designed for federal and governmental agencies, they are highly applicable to private organizations seeking to enhance their cyber security programs. NIST SP 800-12 enables companies to maintain policies and programs for securing sensitive IT infrastructure and data.

**https://csrc.nist.gov/CSRC/media/Publications/sp/800-12/rev-1/draft/documents/sp800_12_r1_draft.pdf**

## 22. NIST SP 800-14

NIST SP 800-14 is a unique publication that provides detailed descriptions of commonly used security principles. The publication enables organizations to understand all that needs to be included in cyber security policies. As a result, businesses ensure to develop holistic cyber security programs and policies covering essential data and systems. Besides, the publications outline specific measures which companies should use to strengthen already implemented security policies. In total, the NIST SP 800-14 framework describes eight security principles with a total of 14 cyber security practices.

**https://ws680.nist.gov/publication/get_pdf.cfm?pub_id=890092**

## 23. NIST SP 800-26

Whereas the NIST SP 800-14 framework discusses the various security principles used to secure information and IT assets, NIST SP 800-26 provides guidelines for managing IT security. Implementing security policies alone cannot enable a company to realize optimum cyber security since they require frequent assessments and evaluations. For example, the publication contains descriptions for conducting risk assessments and practices for managing identified risks. It is a highly useful framework that ensures organizations maintain effective cyber security policies. A combination of different NIST publications can ensure businesses maintain adequate cyber security programs.

**https://csrc.nist.gov/publications/detail/sp/800-26/archive/2001-11-01**

## 4.14 CYBER GLOSSARY

**"Access control"** is selective limiting of the ability and means to communicate with or otherwise interact with a system, to use system resources to handle information, to gain knowledge of the information the system contains or to control system components and functions.

**"Back door"** is a secret method of bypassing normal authentication and verification when accessing a system. A back door is sometimes created in hidden parts of the system itself or established by separate software.

**"Bring your own device (BYOD)"** allows employees to bring personally owned devices (laptops, tablets, and smart phones) to the ship and to use those devices to access privileged information and applications for business use.

**"Cyberattack"** is any type of offensive manoeuvre that targets IT and OT systems, computer networks, and/or personal computer devices and attempts to compromise, destroy or access company and ship systems and data.

**"Cyber incident"** is an occurrence, which actually or potentially results in adverse consequences to an onboard system, network and computer or to the information that they process, store or transmit, and which may require a response action to mitigate the consequences.

**"Cyber risk management"** means the process of identifying, analysing, assessing, and communicating a cyber-related risk and accepting, avoiding, transferring, or mitigating it to an acceptable level by taking into consideration the costs and benefits of actions taken by stakeholders.

**"Cyber system"** is any combination of facilities, equipment, personnel, procedures and communications integrated to provide cyber services; examples include business systems, control systems and access control systems.

**"Defence in breadth"** is a planned, systematic set of activities that seek to identify, manage, and reduce exploitable vulnerabilities in IT and OT systems, networks and equipment at every stage of the system, network, or sub-component life cycle. Onboard ships, this approach will generally focus on network design, system integration, operations and maintenance.

**"Defence in depth"** is an approach which uses layers of independent technical and procedural measures to protect IT and OT on board.

**"Executable software"** includes instructions for a computer to perform specified tasks according to encoded instructions.

**"Firewall"** is a logical or physical break designed to prevent unauthorised access to IT infrastructure and information.

**"Firmware"** is software imbedded in electronic devices that provides control, monitoring and data manipulation of engineered products and systems. These are normally self-contained and not accessible to user manipulation.

**"Flaw"** is unintended functionality in software.

**"Intrusion Detection System (IDS)"** is a device or software application that monitors network or system activities for malicious activities or policy violations and produces reports to a management station.

**"Intrusion Prevention System (IPS"**, also known as Intrusion Detection and Prevention Systems (IDPSs), are network security appliances that monitor network and/or system activities for malicious activity.

**"Local Area Network (LAN)"** is a computer network that interconnects computers within a limited area such as a home, ship or office building, using network media.

**"Malware"** is a generic term for a variety of malicious software, which can infect computer systems and impact on their performance.

**"Operational technology (OT)"** includes devices, sensors, software and associated networking that monitor and control onboard systems.

**"Patches"** are software designed to update software or supporting data to improve the software or address security vulnerabilities and other bugs in operating systems or applications.

**"Phishing"** refers to the process of deceiving recipients into sharing sensitive information with a third party.

**"Principle of least privilege"** refers to the restriction of user account privileges only to those with privileges that are essential to function.

**"Producer"** is the entity that manufactures the shipboard equipment and associated software.

**"Recovery"** refers to the activities after an incident required to restore essential services and operations in the short and medium term and fully restore all capabilities in the longer term.

**"Removable media"** is a collective term for all methods of storing and transferring data between computers. This includes laptops, USB memory sticks, CDs, DVDs and diskettes.

**"Risk assessment"** is the process which collects information and assigns values to risks as a base on which to make decision on priorities and developing or comparing courses of action.

**"Risk management"** is the process of identifying, analysing, assessing and communicating risk and accepting, avoiding, transferring or controlling it to an acceptable level considering associated costs and benefits of any actions taken.

**"Sandbox"** is an isolated environment, in which a program may be executed without affecting the underlying system (computer or operating system) and any other applications. A sandbox is often used when executing untrusted software.

**"Service provider"** is a company or person, who provides and performs software maintenance.

**"Social engineering"** is a method used to gain access to systems by tricking a person into revealing confidential information.

**"Software whitelisting"** means specifying the software, which is present and active on an IT or OT system.

**"Virtual Local Area Network (VLAN)"** is the logical grouping of network nodes. A virtual LAN allows geographically dispersed network nodes to communicate as if they were physically on the same network.

**"Virtual Private Network (VPN)"** enables users to send and receive data across shared or public networks as if their computing devices were directly connected to the private network, thereby benefiting from the functionality, security and management policies of the private network.

**"Virus"** is a hidden, self-replicating section of computer software that maliciously infects and manipulates the operation of a computer program or system.

**"Wi-Fi"** is all short-range communications that use some type of electromagnetic spectrum to send and/ or receive information without wires.

# 5 Safety Management

## 5.1 OBJECTIVE

**The objective of this Chapter is to provide guidance on the requirements for Safety Management systems for MASS operations to meet the provisions of the IMO instruments.**

## 5.2 SCOPE

**5.2.1** The objectives of this Code are to ensure safety at sea, prevention of human injury or loss of life, and avoidance of damage to the environment, in particular to the marine environment and to property. This can be successfully implemented by the use of a Safety Management System (SMS) as part of the management and operation of MASS.

**5.2.2** The purpose of this Chapter is to provide guidance on how to develop and implement an effective SMS for MASS.

## 5.3 GENERAL

**5.3.1** Safety management objectives of the Operator should provide for:

- *Safe practices in MASS operation and a safe working environment;*
- *Assess all identified risks to the MASS, personnel and the environment and establish appropriate safeguards; and*
- *Continuously improve safety management skills of personnel ashore and aboard MASS, including preparing for emergencies related both to safety and environmental protection.*

**5.3.2** The safety management system should ensure:

- *Compliance with rules and regulations; and*
- *That applicable Codes, guidelines and standards mandated or recommended by the International Maritime Organization, administrations (e.g. The MCA), Classification Societies (e.g. Lloyds Register) and maritime industry organizations are taken into account..*

**5.3.3** Every Operator should develop, implement and maintain a safety management system, which includes the following functional requirements:

- *A safety and environmental-protection policy;*
- *Instructions and procedures to ensure safe operation of MASS and protection of the environment in compliance with relevant international and Flag State legislation;*
- *Defined levels of authority and lines of communication between, and amongst, shore and MASS personnel;*
- *Procedures for reporting accidents and non-conformities with the provisions of this Code;*
- *Procedures to prepare for and respond to emergency situations; and*

- *Procedures for internal audits and management reviews;*
- *A voyage data recorder may be required to record mission data for further analysis.*
- *A pro-active safety management system incorporating vessel data analysis for safety and compliance purposes is suggested..*

**5.3.4** The following paragraphs explain in more detail how the Operator can fulfil the functional requirements.

## 5.4 SAFETY AND ENVIRONMENTAL PROTECTION POLICY

**5.4.1** All issues of health, safety and the environment that can affect the Operator, its staff and those third parties affected by its business, both ashore and afloat, should be considered and recorded in an effective policy statement.

**5.4.2** The policy should describe how the objectives of ensuring safety at sea, prevention of human injury or loss of life and avoidance of damage to the environment are to be achieved.

**5.4.3** Such a policy might read along the following lines:

- *"The policy of **[name of Owner/Operator]** is to conduct its activities taking full account of the health and safety of its employees and of all persons using or connected with the Operator and with due regard for the protection of the environment.*
- *In implementing this policy, **[name of Owner/Operator]** will ensure that the MASS is, at all times, properly maintained and operated by qualified personnel in compliance with relevant legislation.*
- *In particular, **[name of Owner/Operator]** will carry out an assessment of the risks to the health and safety of workers and others affected by [the operation] and will take the necessary measures to minimise the risks identified."*

**5.4.4** The Operator should ensure that the policy is implemented and maintained at all levels of the organisation, both onboard and ashore.

## 5.5 OPERATOR RESPONSIBILITIES AND AUTHORITY DOCUMENTATION

**5.5.1** The Operator should have authority at all times to make decisions with regard to the safety of the MASS and any persons on board.

**5.5.2** To ensure that there is no ambiguity regarding the authority of the Operator, there should be a simple written statement to this effect.

**5.5.3** For all personnel who manage, perform and verify work associated with safety and pollution prevention, their respective responsibilities, authority and relationship with affected personnel should be demarcated and documented.

**5.5.4** Suitable and sufficient resources and shore support are to be provided to enable the designated person/persons to fulfil their duties.

**5.5.5** A form of quality system should be established where procedures to control all documents and data which are relevant to the SMS are recorded, maintained and kept current.

**5.5.6** The Operator should ensure that:

- *Current in date and MASS specific documentation is available as required at all relevant locations;*
- *Changes to documents are reviewed and approved by authorised personnel; and*
- *Obsolete documents are promptly removed/destroyed/archived, and change management controlled effectively.*

**5.5.7** The system and form of documentation adopted by the Operator should suit their own policy and be effective to meet the requirements of the Operator.

**5.5.8** The documents used to describe and implement the SMS may be referred to as the Safety Management Manual. Each MASS should retain on board all relevant documentation to that platform, but this will depend on the size of the MASS. Where a MASS does not have the size or capacity to retain the applicable records a suitable alternative arrangement of document retention should be provided by the Operator.

## 5.6 GENERAL HEALTH & SAFETY PROTECTION POLICY

**5.6.1** One or more competent person(s) should be delegated to take responsibility for health and safety, and these personnel should be clearly identified. It is the responsibility of the Operator to ensure that the policy is complied with, and that the responsibilities are understood.

**5.6.2** The Operator should develop a policy on the prevention of alcohol and drug abuse for all its staff.

**5.6.3** All personnel, both ashore and afloat, have a duty to take care of themselves and other persons who may be affected by their acts or omissions.

## 5.7 ISM CODE CERTIFICATION

**5.7.1** The International Safety Management Code (ISM Code), under Regulation 3 and 4, may have a requirement for MASS to have a level of certification for safety. These may include:

- *Document of Compliance;*
- *Safety Management Certificate.*

**5.7.2** The provisions of this Code (Chapter 13) and the development and use of an SMS will assist the Operator in showing compliance to the ISM Code certification requirements when appropriate.

## 5.8 RISK ASSESSMENT

**5.8.1** Hazard identification and risk assessment are key tools in identifying those potential hazards that the operation and maintenance of the MASS may impart and the associated realisation of those hazards occurring.

**5.8.2** The process for the risk assessment should be based on the techniques available in the following documents:

- *ISO/IEC 31010. Risk Management – Risk Assessment techniques*
- *ISO/IEC 27005. Information Technology – Security techniques. Information security risk management.*

**5.8.3** Therefore, a key duty of the Operator is to develop an effective Risk Assessment system. This will, through a logical approach, systematically identify risks to personnel and the environment that the MASS could potentially influence.

**5.8.4** Risk assessment system outputs will assist in the production of the MASS safe systems of work and operational procedures.

**5.8.5** Any Risk Assessment system should be simple to understand and implement such that Operators can carry out effective risk assessments, taking into account any deviations from the perceived 'normal' operating envelope.

**5.8.6** Further guidance can be sought in Chapter 1 of the Code of Safe Working Practices for Merchant Seafarers.

**5.8.7** Where a MASS uses, transfers or holds bulk quantities of substances, materials or liquids that, in the event of a spillage could constitute an environmental impact then the Operator is recommended to develop and implement a MASS Oil Pollution Emergency Plan (MASSOPEP).

## 5.9 PROCEDURES TO ENSURE SAFE OPERATION OF MASS

**5.9.1** The regulations and rules, not addressed by this Code, which apply to all MASS include, but are not limited to:

- *The IMO Instruments;*
- *Local navigation rules;*
- *National health and safety regulations;*
- *The Code of Safe Working Practices for Merchant Seamen;*
- *All relevant national shipping or guidance notices.*

**5.9.2** The Operator should pay due adherence to the many and varied statutes, legislations, rules, regulations and Codes of practice that apply to seafaring. Although the autonomous nature of the MASS operation may seem to negate some requirements, it is the crewless aspect that should demand increased awareness. Any procedures produced should pay particular attention to this detail, especially those systems and equipment procedures that are required to avoid collision.

**5.9.3** The Operator should formulate and document procedures to ensure that safe working practices are carried out in the operation of the MASS. These may be in the form of checklists, which can be followed by all personnel irrespective of their location.

**5.9.4** Simple procedures should be developed for the operation of the MASS. These should include, but not be limited to:

- *Testing of equipment, including propulsion and steering gear, prior to commencing a passage;*
- *Navigation and handling of the MASS;*
- *Maintenance routines;*
- *Bunkering operations;*
- *Watertight/weathertight integrity;*
- *Stability of the MASS;*
- *Conduct of passengers and crew if utilised on board.*

**5.9.5** Due to the autonomous nature of MASS operation the following areas should be considered on top of traditional vessel operating procedures:

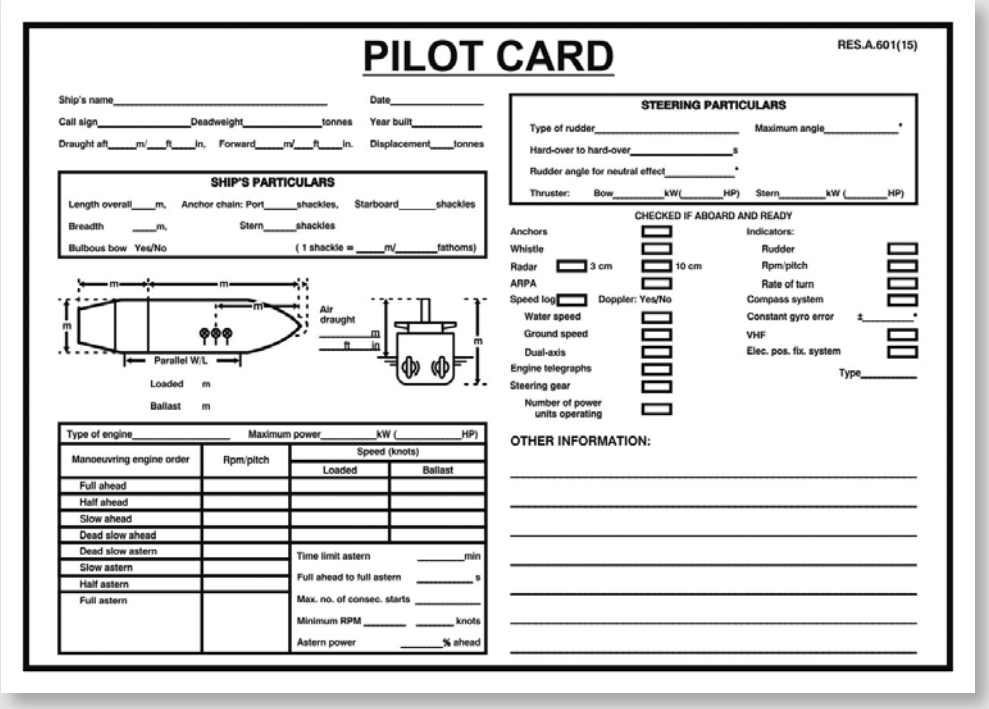
- *Anti-Collision, crewless MASS and the ability to detect and avoid collision;*
- *Cyber Security, anti-hacking and vessel hijacking for remote operated MASS;*

- *Anti-Piracy, close protection, remote control etc;*
- *SOLAS Reg 14, Considerations pertaining to evidence of minimum manning level requirements;*
- *SOLAS Reg 33, Distress situations and how the Operator meets its obligations and responsibilities to other mariners in distress.*

## 5.10 CREWING REQUIREMENTS FOR LARGER SHIPS WHEN PILOTAGE IS REQUIRED

**5.10.1** For some MASS, it might be appropriate to have permanently exhibited information for pilots and port authorities, e.g. at the RCC for navigational items in the event of platform manning and the need to take local control. An example of the ICS Vessel Pilot Card is at Figure 5-1.

**Figure 5-1 - Pilot Card**



PILOT CARD

RES.A.601(15)

Ship's name_____ Date_____

Call sign_____ Deadweight_____tonnes Year built_____

Draught aft____m/___ft___in. Forward____m/___ft___in. Displacement____tonnes

SHIP'S PARTICULARS

Length overall____m, Anchor chain: Port_____shackles, Starboard_____shackles

Breadth ____m, Stern_____shackles

Bulbous bow Yes/No ( 1 shackle = ____m/_____fathoms)

STEERING PARTICULARS

Type of rudder_____ Maximum angle_____°

Hard-over to hard-over_____s

Rudder angle for neutral effect_____°

Thruster: Bow_____kW(_____HP) Stern_____kW (_____HP)

CHECKED IF ABOARD AND READY

Anchors
Whistle
Radar 3 cm 10 cm
ARPA
Speed log Doppler: Yes/No
Water speed
Ground speed
Dual-axis
Engine telegraphs
Steering gear
Number of power units operating

Indicators:
Rudder
Rpm/pitch
Rate of turn
Compass system
Constant gyro error ±____°
VHF
Elec. pos. fix. system
Type_____

Parallel W/L
Loaded m
Ballast m

Air draught
m
ft in

Type of engine_____ Maximum power_____kW (_____HP)

| Manoeuvring engine order | Rpm/pitch | Speed (knots) Loaded | Ballast |
|---|---|---|---|
| Full ahead | | | |
| Half ahead | | | |
| Slow ahead | | | |
| Dead slow ahead | | | |
| Dead slow astern | | | |
| Slow astern | | | |
| Half astern | | | |
| Full astern | | | |

Time limit astern _____min
Full ahead to full astern _____s
Max. no. of consec. starts _____
Minimum RPM _____ _____knots
Astern power _____% ahead

OTHER INFORMATION:

**5.10.2** Alternatively, in a smaller MASS, the record could take any suitable form. These could include a diary, as distinct from a specially printed logbook, or a shore/remote pick up data-logger.

**5.10.3** Whatever form the record takes, such entries should be accepted as evidence of compliance with the Shore-Side, On Board, Remote Procedural requirements.

**5.10.4** The various tasks, once defined, should only be assigned to qualified personnel.

## 5.11 LINES OF COMMUNICATION BETWEEN PERSONNEL, ASHORE AND AFLOAT

**5.11.1** Clear lines of communication detailing reporting routes and lines of authority should be established. This can be produced as a simple line diagram but should, as part of the system, be documented and kept up to date.

**5.11.2** The responsibilities and authority of each employee should be clear. The communications policy should contain the means of communication both in normal and emergency situations and for crewless MASS should incorporate the means and methods of communication to third parties and stakeholders that may be affected by the MASS.

## 5.12 PROCEDURES FOR REPORTING ACCIDENTS

**5.12.1** All accidents and near misses/dangerous occurrences should be reported to the management regardless of the incident size and its severity. The method for reporting of accidents should be well understood by all personnel. This in turn will improve the safety culture practised through the Operator.

**5.12.2** MASS operating under this Code should report any accidents to the RO and the Operator should therefore have a procedure in place to achieve this requirement.

**5.12.3** The accident reporting system should be well documented, with all records retained as per Operator policy for the retention of records.

**5.12.4** The system should include procedures ensuring that accidents and hazardous situations are reported to the Operator. After initial actions are completed to safeguard individuals or equipment, an investigation should be conducted. The incident results are to be analysed and recorded, with the appropriate measures subsequently implemented to improve safety and pollution prevention.

**5.12.5** This procedure should also include any identified non-conformities to the standards followed after audit or through general observation.

**5.12.6** The Operator should establish procedures for the implementation of corrective action, including measures intended to prevent recurrence.

## 5.13 PROCEDURES FOR RESPONDING TO EMERGENCY SITUATIONS

**5.13.1** The risk assessment and hazard identification system process should identify potential emergency MASS situations. Safe systems of work and procedures should then be developed to respond to them. An Emergency Situation should be considered to have occurred when a signal has not been received by the MASS for a critical time period. This critical time period will be related to, but not dependent upon, the MASS last confirmed location, its risk level and cargo. The appropriate authorities should be informed as soon as it is recognised by the Master and operators that the Emergency Situation exists.

**5.13.2** Procedures for responding to emergency situations should be clearly established. These may include but are not limited to:

- *Loss of Control of MASS for a critical time period;*
- *Fire;*
- *Collision;*
- *Grounding;*
- *Flood;*
- *Violent act;*
- *Main propulsion or steering failure;*
- *Man overboard (if vessel manned);*
- *Abandon MASS procedure (if vessel manned).*

**5.13.3** Checklists/Aide Memoires may be useful in this regard onboard the MASS and at control stations.

**5.13.4** The roles and responsibilities of all personnel in an emergency situation should be defined and recorded.

**5.13.5** The safety management system should provide for measures ensuring that the Operator's organization can respond at any time to hazards, accidents and emergency situations involving its MASS. This is particularly important during crewless periods of operation.

**5.13.6** It is essential that there is the ability to communicate with the emergency services via the MASS or RCC.

**5.13.7** Preparation for emergency situations requires careful consideration and planning. All new and existing personnel should undertake suitable and sufficient training for each of the emergency scenarios. A programme of drills and exercises to react for emergency actions should be incorporated into any vessel management plan.

**5.13.8** Any exercises conducted should be recorded. This record should include the names of those who participated.

## 5.14 PERSONNEL AND TRAINING

**5.14.1** All personnel should receive training appropriate to the tasks they undertake. It is the responsibility of the Operator to ensure that this training is given, and that the personnel have an understanding of the relevant regulations and rules. This training should be recorded in the MASS Operators Training Record Book (see Chapter 13).

**5.14.2** As a minimum, this means:

- *For the Operator, the relevant qualifications;*
- *For the crew, relevant qualifications and any additional training appropriate to their designated duties.*

**5.14.3** Training needs analysis should be conducted regularly for identifying any training, which may be required in support of the SMS and ensure that such training is provided for all personnel concerned.

**5.14.4** Relevant information on the SMS should be distributed to all personnel in a clear, concise manner, which should include considerations of language.

**5.14.5** The SMS should also incorporate an effective feedback procedure such that the MASS's personnel are able to communicate effectively in the execution of their duties related to the SMS.

**5.14.6** Prior to the first occasion of working on the MASS, each employee should receive appropriate familiarisation training and proper instruction in onshore and on board procedures. This should include, but is not necessarily limited to:

- *Control of areas around a MASS, on the support vessel whether docked alongside or rafted, or whilst at sea;*
- *Manoeuvring in all modes at sea;*
- *Operations in restricted and restricted/busy navigational areas;*
- *Launching and recovery operations;*
- *Evacuation from all areas of the MASS;*
- *Use and handling of emergency equipment/systems.*

**5.14.7** This training should be recorded in the MASS Operators Training Record Book and signed off as completed by the appropriate authority or responsible person.

## 5.15 MAINTENANCE OF THE MASS AND EQUIPMENT

**5.15.1** A Maintenance Management System (MMS) is another important integral part of the MASS safety management regime.

**5.15.2** Procedures need to be established to ensure that the MASS is maintained to conform with the provisions of the relevant rules and regulations and with any additional requirements which may be established by the Operator.

**5.15.3** To ensure conformity to these requirements the Operator should ensure that:

- *Inspections are held at appropriate intervals;*
- *Any non-conformity is reported, with its possible cause, if known;*
- *Appropriate corrective action is taken; and*
- *Records of these activities are maintained.*

**5.15.4** The equipment should be checked and tested in accordance with defined schedules produced by the Original Equipment Manufacturer (OEM) and operator procedures when in use. This is in addition to the tests referred to in the procedures to ensure safe operation of MASS in compliance with the Regulations and Rules of the ISM Code.

**5.15.5** There should be procedures for a more detailed inspection and maintenance programme of the MASS and equipment, which may be conducted by an outside authority/classification society. The frequency of the inspections should be determined by the Operator in conjunction with the OEM Schedule and Classification Society/Professional Bodies requirements, but every event should be planned and recorded..

**5.15.6** A checklist could be employed as an aide-memoire for the inspection of equipment.

**5.15.7** The Operator should identify equipment and technical systems, which, if subject to sudden operational failure, may result in hazardous situations. The SMS should provide for specific measures aimed at promoting the reliability of such equipment or systems. These measures should include the regular testing of stand-by/ reversionary arrangements and equipment or technical systems that are not in continuous use.

**5.15.8** The inspections mentioned, as well as the measures referred to, should be integrated into the MASS operational MMS.

## 5.16 REVIEW

**5.16.1** Every management system has a cyclic approach and one of the key stages is review. This enables the Operator to undertake a review of the MMS and SMS and determine its effectiveness and to develop areas for continuous improvement and assurance that it is 'fit for purpose' and current in accordance with the latest legislation.

**5.16.2** The ISM Code regulates and requires a review period for the safety system and award/retention of its certification. The details of review are as follows:

- *Document of Compliance - External audit of system every five years from date of initial issue and an Internal Verification to be conducted by the Operator on an annual basis;*
- *Safety Management Certificate - External audit of system every five years from date of initial issue and an Internal Verification to be conducted by the Operator between two to three years;*
- *The Operator should periodically evaluate the effectiveness of the SMS in accordance with procedures*

*established by the Company. The audits and possible corrective actions should be carried out in accordance with documented procedures;*

- *Therefore, the Operator should carry out internal safety audits on board and ashore at intervals not exceeding 12 months to verify whether safety and pollution-prevention activities comply with the SMS;*
- *In exceptional circumstances, this interval may be exceeded by not more than 3 months, as agreed with the Authority;*
- *Personnel carrying out audits should be independent of the areas being audited unless this is impracticable due to the size and the nature of the Company;*
- *The results of the audits and reviews should be brought to the attention of all personnel having responsibility in the area involved;*
- *The management personnel responsible for the area involved should take timely corrective action on deficiencies found;*
- *All records and actions from audit should be retained within the organisations document management system.*

## 5.17 MASS VESSEL DATA RECORDING (VDR)

**5.17.1** With the increasing numbers of MASS vessels in commercial use and the consequential need to maintain acceptable safety standards and regulatory oversight, the capture and storage of vessel data and the development of MASS vessel monitoring programmes needs to be considered.

**5.17.2** Carriage of a VDR is not currently mandatory and due to the nature of remote and autonomous operations, off-board data recording may also be appropriate to fully capture vessel command and control data.

**5.17.3** For accident investigation purposes, MASS vessels present new challenges and so data should be recorded and be made available in order to aid investigations.

**5.17.4** It is suggested that operators of MASS vessels also look to incorporate vessel data monitoring programmes as part of a proactive Safety Management System. Establishment of a "Just" safety culture[2] within MASS operations and the development of pan-industry data sharing initiatives on safety related issues is to be encouraged, as this will aid the development of the critical safety standards in this emerging industry.

**5.17.5** Annexe A provides further guidance on the recording of vessel data.

[2] *A Just Culture is a prerequisite to a Reporting Culture where people feel they will be treated fairly, are encouraged to and therefore readily report hazards, safety concerns, errors and near misses which provide the organisation with vital safety-related information.*

*SEA-KIT International Maxlimer with Hugin AUV*

## ANNEX A TO CHAPTER 5 – VESSEL DATA RECORDING

Establishing base-line standards for data recording and the subsequent playback of data to aid both internal and external incident and accident investigation is seen as an essential step to developing safe and sustainable MASS operations. Manufacturers and operators of MASS vessels and control systems can assist in this by adopting common standards in relation to vessel data management and its incorporation into the development of safety processes and procedures.

### Data to be recorded

It is suggested that the following minimum level of parameters are recorded (where appropriate and applicable):

| Parameters | Details | On Vessel | At RCC |
|---|---|---|---|
| Date and time | From an external source | Y | Y |
| Ship's position | GPS or other satellite derived position | Y | Y* |
| Speed | Over Water and Over Ground | Y | Y* |
| Heading | Must match Ship's heading source | Y | Y* |
| RCC status | Which Remote Control Centre is in control of the vessel and recording of any handover | Y | Y |
| Vessel/RCC audio | For RCC responsible for the vessel. | Y (Noises onboard and in the surrounding area) | Y (Discussions related to operation of the MASS) |
| Vessel Visual recording | Situational awareness images as displayed to vessel operators | Y | Y |
| RCC Visual recording | General View of RCC and Operator control station | N | Y |
| Communication audio | One channel each for external, internal and VHF recording | Y | Y |
| Radar data | Main display of all radar installations incl. settings | Y | Y (Available to the RCC) |
| ECDIS data | Main display Incl. Configuration Settings, Safety Depth, Safety Contour, Look ahead and Alarm Setting, passage | Y | Y (Where available) |
| Echo sounder | Depth information | Y | Y* |
| All Vessel Alarms | All alarms, warnings, cautions and advisory message information | Y | Y |
| Rudder order and response | Signals sent, signal received, signal ordered, equipment / signal response and response order sent and received back to remote command | Y | Y |
| Propulsion and thruster order and response | Signals sent, signal received, signal ordered, equipment / signal response and response order sent and received back to remote command | Y | Y |
| Hull opening (doors) status | | Y | Y* |
| Payload equipment deployment/ recovery | Command initiation and response | Y | Y* |
| Acceleration | If fitted | Y | Y* |
| Hull stresses | If fitted | Y | Y* |
| Wind speed and direction | Regular sample | Y | Y* |
| Rolling Motion | Inclinometer | Y | Y* |
| AIS | All AIS data to be recorded | Y | Y (Available to the RCC) |
| **As Reported by the Vessel* | | | |

## Data to be recorded – General Principles

MASS vessels by their very nature produce large volumes of data of many differing types and in most cases will pass this data back to a Remote Control Centre (RCC), this annexe suggests the type of data that should be recorded and how it can be made available in the event of accident investigation being required. Vessel data in respect to MASS vessels is complicated by the remote nature of the designated operator, which means that command data that is necessary for accident investigation maybe generated offboard and therefore operators should look to record operator command data and vessel response data as well as recording vessel data parameters.

## Data Security and Access

The vessel owner will, in all circumstances and at all times, own the data produced. However, it is expected that owners/operators will make all vessel onboard and offboard data available to accident investigators[3] as required.

**Duration of storage:** The minimum duration for stored data should be 30 days standard, captured internally and 48 hours for both fixed and float free Final Recording Medium (FRM.) Offboard storage should be maintained for a similar period and it is suggested that operators and owners look to maintain a full history of operational data to aid the development of incident reporting and accident investigation procedures as they pertain to MASS vessels.

**Securing and provision of data:** In the event of an accident or incident, operators should have defined procedures for securing onboard and offboard data and providing it to the relevant authority as required and within 48hrs to the Flag State of operation and registration (if different) that the vessel was operating, for any marine casualty as defined under the IMO Casualty Investigation Code MSC.255(84).

**Post Incident data downloading:** In all circumstances the responsibility to arrange down-loading and read-out of the data from the recovered memory in whatever form should, in the first instance, be undertaken by the investigator who should keep the ship owner fully informed. Additionally, and specifically in the case of a catastrophic accident, where the memory may have sustained damage, the assistance of specialist expertise may be required to ensure the best chance of success.

## Data Format

If the data format used on-board a vessel is proprietary to the manufacturer or vessel type then a conversion tool to convert to Commercial Off The Shelf (COTS) formats should be made available to the relevant investigating authority. Replay software should be supplied license free to the relevant authority.

## System testing

Daily Performance testing of recording equipment is recommended, as is performance testing following any maintenance or repair to equipment that supplies data to be recorded.

*[3] The term investigator refers to the Marine Casualty Investigator of the flag State or, where it has been agreed, under the terms of the Code for Investigation of Marine Casualties and Incidents, that another State will lead the investigation, the Marine Casualty Investigator of that State*

# 6 Automation on Inland Waterways

**The objective of this Chapter is to summarise the current position (2019) for automation on Inland Waterways in Europe and is included as a reference to reflect the increasing interdependence of vessels operating between inland waterways and other sea areas.**

## 6.1 SUMMARY

**6.1.1** The Working Party on Inland Water Transport (IWT) (SC.3) of the Inland Transport Committee (ITC) of the United Nations Economic Commission for Europe (UNECE) and its subsidiary body (the Working Party on the Standardization of Technical and Safety Requirements in Inland Navigation (SC.3/WP.3), act within the framework of the policies, and under the general supervision of, ITC and operate in accordance with the UNECE Guidelines for the establishment and functioning of Working Parties within UNECE.

**6.1.2** In line with the objective of the UNECE transport subprogramme to facilitate the international movement of persons and goods by inland transport modes and improve safety, environmental protection, energy efficiency and security in the transport sector to levels that contribute effectively to sustainable transport, SC.3, assisted, where appropriate, by SC.3/WP.3, carries out the following activities:

- *Organize a pan-European policy dialogue on the inland water transport issues*
- *Promote a coordinated development of inland waterway infrastructure*
- *Address safety and operational requirements in inland navigation*
- *Promote integration of IWT in multimodal transport chains*
- *Prevention of pollution from vessels and resilience to climate changes*
- *Contribute to the harmonization of the legal framework for international IWT*

**6.1.3** Automation on inland waterways and smart shipping have been introduced in the agenda of SC.3 and SC.3/WP.3 since February 2018 (the fifty-second session of SC.3/WP.3), following the request of its member States that work actively in this sphere. At its fifty-fourth session, the Working Party on the Standardization of Technical and Safety Requirements in Inland Navigation (SC.3/WP.3) noted the working document on automation in inland navigation submitted for the eighty-first session of ITC (ECE/TRANS/2019/16) that contained the definition of automation levels in inland navigation adopted by the Central Commission for the Navigation of the Rhine (CCNR), and decided to include automation in the agenda of its fifty-fifth session (ECE/TRANS/SC.3/WP.3/108, para. 70). At its eighty-first session, ITC welcomed the actions taken by SC.3 and SC.3/WP.3 and considered this issue in relation to its work on Intelligent Transport Systems.

**6.1.4** This chapter reproduces the annex to resolution 2018-II-16 adopted by CCNR at its plenary meeting in December 2018, transmitted to the secretariat, and contains proposals for follow-up actions that may be undertaken by the Working Party on Inland Water Transport (SC.3).

## 6.2 INTERNATIONAL DEFINITION OF AUTOMATION LEVELS IN INLAND NAVIGATION

**6.2.1** Automated navigation covers a wide range of technical solutions and addresses cases ranging from a simple navigation assistance to a fully automated navigation. Although technology synergies are expected with the maritime sector, CCNR has emphasized the specificities of inland water transport that should be taken into account, such as:

- *The composition of crews*
- *Navigation in enclosed and restricted conditions*
- *The passage of locks*
- *The height of the water level and under bridges*
- *The manoeuvrability of vessels.*

**6.2.2** During its plenary meeting in December 2018, CCNR adopted a first international definition of levels of automation in inland navigation by its resolution 2018-II-16 in order to ensure a clear understanding of automated navigation as a whole and support further work, including the analysis of the regulatory needs. It was aimed at improving safety and functionality of navigation of the Rhine and European inland navigation in whole, promoting innovation and ensuring the uniformity and consistency of the legal framework and technical standards applicable on the Rhine. This definition is valid till 31 December 2020, given that it may be subject to modifications based on the experience and knowledge acquired.

**6.2.3** CCNR invited the European Commission, the Economic Commission for Europe (ECE), the Danube Commission, the Mosel Commission, the International Sava River Basin Commission, CCNR observer States, the European Committee for the development of standards in the field of inland navigation (CESNI) and associations recognized by CCNR to apply this definition in the context of relevant initiatives or work, in particular, in the regulatory activities.

**6.2.4** The definition of automation levels in inland navigation is given below. For this purpose, the following terms and definitions are applied:

- *"Dynamic navigation tasks": the set of tactical vessel operations, such as operation of the rudder apparatus, propulsion, anchor winches or elevating wheelhouse. The complexity of these tasks depends upon the context considered (for example, the manipulation of anchor winches can be excluded, where the use of anchors is forbidden anyway).*

- *"Context-specific": confined navigational conditions such as navigation on specific waterway sections or lock crossing, as well as vessel arrangements with convoys or platooning. The context includes the infrastructure relevant for automation, for example, the type and capacity of radio transmission networks.*

- *"Navigational environment": fixed and dynamic conditions affecting navigation, such as the shape of a waterway, the water level, weather conditions, visibility, vessel crossing and other factors. The navigation automation system is able to use only a part of the available information (for example, under level 1, rate-of-turn indicators do not use information on vessel crossing). The response to the navigational environment includes the radiocommunication with boatmasters of other vessels.*

- *"Collision avoidance": the critical task in responding to the environmental conditions (other vessels, bridges, etc.).*

| | Level | Designation | Vessel command (steering, propulsion, wheel-house, etc) | Monitoring of and responding to navigational environment | Fall-back performance of dynamic navigation tasks | Remote control |
|---|---|---|---|---|---|---|
| Boatmaster performs part or all of the dynamic navigation tasks | 0 | **No automation**<br>the full-time performance by the human boatmaster of all aspects of the dynamic navigation tasks, even when enhanced by warning or intervention systems<br>*Example: navigation with the support of the radar installation* |  |  |  | No |
| | 1 | **Steering assistance**<br>the context-specific performance by a steering automation system using certain information about the navigational environment and with the expectation that the human boatmaster performs all remaining aspects of the dynamic navigation tasks<br>*Examples : rate-of-turn regulator ; track pilot (track-keeping system for inland vessels along pre-defined guiding lines)* |  |  |  | |
| | 2 | **Partial automation**<br>the context-specific performance by a navigation automation system of both steering and propulsion using certain information about the navigational environment and with the expectation that the human boatmaster performs all remaining aspects of the dynamic navigation tasks |  |  |  | |
| System performs the entire dynamic navigation tasks (when engaged) | 3 | **Conditional automation**<br>the sustained context-specific performance by a navigation automation system of all dynamic navigation tasks, including collision avoidance, with the expectation that the human boatmaster will be receptive to requests to intervene and to system failures and will respond appropriately |  |  |  | Subject to context specific execution, remote control is possible (vessel command, monitoring of and response to the environ-ment or fall-back performance). It may have an influence on the number or qualification of crews |
| | 4 | **High automation**<br>the sustained context-specific performance by a navigation automation system of all dynamic navigation tasks and fall-back operation, without expecting a human boatmaster responding to a request to intervene[1]<br>*Example : Vessel operating on a canal section between two successive locks (environment well known), but the automation system is not able to manage alone the passage through the lock (requiring human intervention)* |  |  |  | |
| | 5 | **Autonomous = Full automation**<br>the sustained and unconditional performance by a navigation automation system of all dynamic navigation tasks and fall-back operation, without expecting a human boatmaster will respond to a request to intervene |  |  |  | |

[1] *This level introduces two different functionalities: the ability of "normal" operation without expecting human intervention and the exhaustive fall-back. Two sub-levels could be envisaged.*

# 7 Ship Design and Manufacturing Standards for MASS

## 7.1 OBJECTIVE

**The objective of this Chapter is to provide a process to ensure that the design, manufacture, through life survey, maintenance and disposal requirements of MASS are appropriately considered. This Chapter is written as a goal based requirement to permit the maximum scope to introduce innovative ideas into the design.**

## 7.2 SCOPE

**7.2.1** The scope of this Chapter is to cover the design, manufacture and through life survey, maintenance requirements and disposal requirements of MASS. The MASS in this context is taken as the structure, equipment and systems (including software), afloat and ashore, which constitute all the key elements of the MASS.

**7.2.2** The MASS should be designed, constructed and maintained with reasonable care and, in particular, in compliance with the requirements of a classification society which is recognised by the Flag State Administration; or in accordance with applicable national standards of the Flag Administration which provide an equivalent level of safety, for example UK MCA Workboat Code.

**7.2.3** For the defined operational life of the MASS it should be designed and constructed to:

- *Enable the MASS to operate in all Reasonably Foreseeable Operating Conditions (RFOC);*
- *Carry and respond to all foreseen loads in a predictable manner, with a level of integrity commensurate with operational and safety requirements;*
- *Ensure the watertight and weathertight integrity, to meet buoyancy and stability requirements;*
- *Minimise the risk of initiating fire and explosion;*
- *Minimise the spread of fire;*
- *Enable the maintenance and repair in accordance with the maintenance philosophy.*

**7.2.4** Operators should be provided with adequate access, information and instructions for the safe operation and maintenance of the MASS.

## 7.3 SELECTION OF DESIGN BUILD AND SURVEY REQUIREMENTS

**7.3.1** MASS shall be certified to demonstrate compliance with the requirements of the Code. Certification requirements are covered in Chapter 13.

**7.3.2** The MASS supplier is to provide evidence and justification to the RO (or MCA approved Certifying Authority for Workboats) to demonstrate that the MASS is fit for the intended role and meets the goals of this Chapter. This evidence is to include the following information:

- *Concept of Operations (ConOps): To include details of the vessel's role, operating area, operating profile, environmental limits, maintenance and survey plans. The ConOps should also include any other information required by the administration to enable a certifying officer to determine if appropriate standards have been used. (Note: a good example of this is provided in the Lloyds Register Crewless Marine Systems Code or similar guidance from other ROs);*
- *The Design Standards, Codes or Rules used for the vessel;*
- *Periodic maintenance, trials and survey requirements necessary to demonstrate that the design intent is maintained through life;*
- *A design justification as to why the particular standard is suitable for the vessel and intended use.*

**7.3.3** Typically, the design justification would be achieved by demonstrating that the performance requirements of the structure, equipment or system under consideration is the same as would be required for an equivalent manned vessel. (e.g. a 100m ship would require the same longitudinal stiffness and same propulsive power whether it is manned or crewless).

**7.3.4** Where the MASS design departs from the equivalent manned standard the justification shall demonstrate that either:

- *the change is acceptable because the manned vessel requirement is redundant in the MASS (e.g. Removal of crew habitability requirements or lifesaving equipment); or*
- *an alternative solution is required to maintain the same level of performance (e.g. replacing a manual firefighting system with automatic systems).*

**7.3.5** In either case the justification should demonstrate that the change does not result in an increased risk to other vessels, third parties or the environment.

## 7.4 STRUCTURE

**7.4.1** The structure should be designed, constructed and maintained with a level of integrity sufficient to enable the MASS to be operated and maintained safely as and when required within its design or imposed limitations in all RFOC.

**7.4.2** Any penetrations in the structure of the MASS should not affect the watertight and weathertight boundaries.

## 7.5 STABILITY

**7.5.1** The buoyancy, stability, watertight and weathertight integrity should be sufficient to enable the MASS to be operated and maintained safely as and when required within its design or imposed limitations in all RFOC.

## 7.6 PROPULSION AND MANOEUVRING

**7.6.1** The propulsion and manoeuvring systems should be designed with a level of integrity sufficient to enable the MASS to be operated and maintained safely as and when required within its design or imposed limitations in all RFOC.

**7.6.2** The propulsion and manoeuvring systems should enable the MASS to manoeuvre as and when required by the Operator but still remain within the designed or imposed limitations.

## 7.7 ELECTRICAL SYSTEMS

**7.7.1** The electrical system should be designed with a level of integrity sufficient to enable the MASS to be operated and maintained safely as and when required within its design or imposed limitations in all RFOC.

**7.7.2** Sufficient electrical power should be provided to supply the required services of the MASS during all RFOC.

**7.7.3** Sufficient power should be provided to supply for MASS to conduct its mission with an appropriate level of redundancy. It is acknowledged that for some smaller Classes of MASS there may be little, or no redundancy required.

## 7.8 FIRE SAFETY

**7.8.1** Where fire safety systems are required, they should be designed to detect and extinguish a fire with a level of integrity sufficient to enable the MASS to be operated and maintained safely and to protect the MASS in all RFOC.

## 7.9 AUXILIARY SYSTEMS

**7.9.1** The auxiliary systems should be designed to support mission equipment and mission functions.

**7.9.2** If the MASS is to have a payload or carry cargo, it is not to have a detrimental effect on the MASS for the duration of its mission.

**7.9.3** The MASS is to have sufficient systems to support the embarkation of cargo and equipment for the duration of its mission.

**7.9.4** If seamanship systems are fitted to the MASS, they are to ensure that the MASS can be recovered safely and undertake any seamanship operations as required (e.g. anchoring, mooring, towing etc).

## 7.10 SOFTWARE INTEGRITY

**7.10.1** Functional Objective. For any activity that relies on the integrated use of equipment or sub-systems that include software, the risks associated with software and its integration into the equipment or sub-system are properly managed and that the software is safe to use. A failure or unspecified behaviour of the software shall not result in:

- *an event that escalates to a hazard; or*
- *impairment of the mitigation of a hazard; and*
- *impairment of recovery from a hazard.*

**7.10.2** Performance Requirements. The way software could be a stimulus event to a hazard, or impair the mitigation of a hazard, or impair recovery following such a hazardous event, shall be communicated to the appropriate parties.

**7.10.3** The production of software shall be managed so that the safety risks arising from the software production are reduced to an acceptable level.

**7.10.4** Provision shall be made to protect systems against:

- *intentional or unintentional viruses or unauthorised Code (Cyber Security is covered in more detail at paragraph 11.6);*
- *unauthorised installation, change, or deletion of software or associated data;*
- *the installation or use of unauthorised software, (e.g. running games or office applications);*
- *modification of the software function by additional or modified physical devices.*

**7.10.5** The system safety justification shall be developed to include the risks posed by the use of software both afloat and ashore and how those risks are reduced to an acceptable level. Consideration should be given to conducting a Failure Mode Effects and Criticality Analysis (FMECA) to identify risks or safety Critical Software elements. Any function of a MASS should be adequately validated in accordance with its consequence to safety and performance of the MASS, and any software implementation of this function adequately verified.

**7.10.6** The configuration status of the software on each platform shall be captured and recorded, and the record maintained up-to-date for the life of the platform.

**7.10.7** The development and testing of changes to the software and data, including specific arrangements for on-board testing, shall be managed so that the safety of the system, sub-system or equipment is not compromised.

**7.10.8** The retention and release of earlier versions of software shall be managed to enable restoration of a previous known and trusted state when necessary.

**7.10.9** The release and installation of software to each platform shall be appropriately and actively managed so that changes to software are controlled. The installation process shall include a strategy for managing a failed installation.

## 7.11 IN-SERVICE REQUIREMENTS

**7.11.1** Independent verification should be undertaken to provide assurance that the MASS complies in all respects with the provisions of this Code and remains compliant throughout its life.

**7.11.2** Construction surveys should be conducted at a periodicity and scope appropriate to the design and build and may include:

- *A review of the capability, organisation and facilities of the manufacturer to confirm that acceptable standards can be achieved for the construction, and fit out of the hull structure, systems and equipment;*
- *Certification of software, equipment and components;*
- *Survey of the material state during build to confirm compliance with the appraised design;*
- *Witness of tests and trials to demonstrate functionality;*
- *Details of software integrity testing and cyber-security compliance audits.*

**7.11.3** Through life survey activities should be conducted at a periodicity appropriate to the design, construction, material state and operation of the MASS.

*RNMB Hussar engaged in operational duties with the Royal Navy.*
*This is a development of ATLAS ELEKTRONIK UK's ARCIMS USV.*


## 7.12 MASS DISPOSAL

**7.12.1** MASS, for the purposes of this Code, will follow the existing legal policies and practices already in place for manned ships when an owner decides to dispose of its MASS.

**7.12.2** Disposal will take two forms. These are:

- *Disposal by sale to new owner;*
- *Disposal by sale to a ship breaker as a MASS end of life activity, which is known as Recycling..*

**7.12.3** Disposal by Sale. MASS owners will follow the existing maritime ship sale processes as agreed in maritime law. This may include the use of a ship broker to facilitate the sale to a third party. The selling process usually involves three stages. These are:

- *Negotiations and Contracts Stage;*
- *Inspection Stage;*
- *Completion Stage.*

**7.12.4** Memorandum of Agreement (MOA) will be drawn up by the shipbroker on behalf of the MASS owner. The MOA is the formal contract of sale of the MASS. MASS owners will, where possible, take advantage of the existing standard forms of MOA contract, one example being the Norwegian Sale Form (NSF).

**7.12.5** Disposal by Recycling. MASS owners will follow the current recycling process and procedures as laid out in National, Regional and International law.

**7.12.6** MASS ship builders will ensure that each vessel is supplied with an Inventory of Hazardous Materials (IHM).

**7.12.7** MASS owners will ensure that the IHM is maintained during the period that they own the MASS platform.

**7.12.8** MASS owners when disposing of a MASS platform for recycling will ensure that the IHM is up to date.

**7.12.9** There are a number of guides on the recycling of ships that are applicable for application to the recycling of redundant MASS. The following is one example.
**http://www.lr.org/en/_images/229-77058_ShipRecycling_040711_tcm155-223320.pdf**

# 8 Navigation Lights, Shapes and Sound Signals

## 8.1 OBJECTIVE

**The objective of this Chapter is to provide guidance on the lights, shapes and sound signals required by MASS.**

## 8.2 SCOPE

**8.2.1** If it can be demonstrated that, for a particular MASS, full compliance with the regulations is impracticable, then application can be made to the Administration where considered necessary, via the RO, for consideration of exemptions and equivalent arrangements, taking into account the class and nature of the operation of the MASS concerned.

## 8.3 LIGHTS & SIGNALS

**8.3.1** A MASS should comply with the requirements of the International Regulations for Preventing Collisions at Sea, 1972, as amended (COLREG). With regard to Part C, a MASS which operates only between sunrise and sunset, and in favourable weather, is not required to carry navigation lights where it can be demonstrated that the MASS will not be caught in or near an area of restricted visibility.

**8.3.2** Table 8-1 is a summary table of navigation lights appliances for MASS. This Table is for guidance only and does not cover all possible operations. Reference should be made to the regulations stated in Paragraph 8.3.1 for all operations not covered.

***Thales USV Apollo with a towed minehunting sonar.*** *© Thales 2019*

| Table 8-1: Navigation Lights | | | | |
|---|---|---|---|---|
| **Overall length** | **Power driven vessels when underway** | **At Anchor** | **Not under command** | **Aground** |
| **<7m** | All round white, 1 mile + side-lights, 1mile (Note 1) | Required | Not required | Not required (Note 2) |
| **≥7m- <12m** | All round white + sidelights<br>*OR*<br>a masthead light, 2 miles;<br>a sidelight, 1 mile;<br>a stern light, 2 miles;<br>a towing light, 2 miles<br>a white, red, green or yellow all-round light, 2 miles.<br>*OR*<br>(if lights have to be offset from centreline) combined lantern sidelights plus either all round white or masthead and stern light. | Required | two all-round red lights in a vertical line where they can best be seen; | Not required |
| **≥12m- <50m** | a masthead light, 5 miles;<br>a sidelight, 2 miles;<br>a stern light, 2 miles;<br>a towing light, 2 miles;<br>a white, red, green or yellow all-round light, 2 miles. | Required | two all-round red lights in a vertical line where they can best be seen; | Required (Note 3) |
| **Although vessels of 50 metres or more are not covered by this Code, this category has been included below for reference and guidance only.** | | | | |
| **≥50m** | a masthead light, 6 miles;<br>a sidelight, 3 miles;<br>a stern light, 3 miles;<br>a towing light, 3 miles;<br>a white, red, green or yellow all-round light, 3 miles. | Required | two all-round red lights in a vertical line where they can best be seen; | Required (Note 4) |

**Notes**

**1.** Vessels not exceeding 7 knots maximum speed should show sidelights if practicable.

**2.** A vessel of less than 7 metres in length, when at anchor, not in or near a narrow channel, fairway or anchorage, or where other vessels normally navigate, should not be required to exhibit lights or shapes.

**3.** A vessel of less than 12 metres in length, when aground, should not be required to exhibit the lights or shapes.

**4.** A vessel at anchor may, and a vessel of 100 metres and more in length should, also use the available working or equivalent lights to illuminate their decks.

## 8.4 SOUND SIGNALS

**8.4.1** Sound signalling equipment should comply with the requirements of COLREG, Part D, as amended. A vessel of less than 12 metres in length is not obliged to carry the sound signalling equipment, provided that some other means of making an efficient sound signal is provided where feasible and practicable.

**8.4.2** Table 8-2 is a summary table of sound appliances for vessels. This Table is for guidance only and does not cover all possible operations. Reference should be made to the regulations stated in Chapter 8.1 for all operations not covered.

| Table 8-2: Sound Appliances | |
|---|---|
| **Overall length** | **Power driven vessels when underway** |
| **<12m** | A vessel of less than 12 metres in length should not be obliged to carry sound signalling appliances prescribed in Part D, Rule 32 (a), but if she does not, she should be provided with some other means of making an efficient sound signal where feasible and practicable. |
| **≥12m & <20m** | A vessel of 12 metres or more in length should be provided with a whistle. |
| **≥20m & <100m** | A vessel of 20 metres or more in length should be provided with a bell in addition to a whistle |
| **Although vessels of 50 metres or more are not covered by this Code, this category has been included below for reference and guidance only.** | |
| **≥100m** | A vessel of 100 metres or more in length should, in addition to a whistle and bell, be provided with a gong, the tone and sound of which cannot be confused with that of the bell. |

*Dstl's MAST 13 designed and built by L3Harris*

# 9 Situational Awareness and Control

## 9.1 OBJECTIVE

**The objective of this Chapter is to outline the main requirements and considerations that should be included in a process to design and manufacture a Situational Awareness and Control System for a MASS.**

## 9.2 SCOPE

**9.2.1** A situational awareness and control system for a MASS can include the onboard sensors and offboard information sources (Audio and Visual), communications links and control logic that allow the MASS to operate safely.

## 9.3 FUNCTIONAL OBJECTIVES

**9.3.1** The goal of Situational Awareness and Control is to ensure that the MASS, and RCC when appropriate, have sufficient information, interpretation and control of its position and systems, to enable it to be as safe as a manned counterpart operating in similar circumstances. Any decision making that impacts safety and is performed by the MASS (i.e. independent of a human operator) should have been adequately demonstrated to be commensurate with that which a competent seafarer would correctly perform in the same circumstances.

**9.3.2** A Risk Assessment shall be undertaken using an appropriate method, e.g. Failure Mode Effects Analysis (FMEA), in order to identify the risk levels associated with the MASS and its operation. The analysis should be supported by appropriate trials.

**9.3.3** Internal and External sensors may be used to monitor the state of the platform and the external environment.

**9.3.4** It is necessary to have the ability to interpret sensor data in terms of its immediate or impending impact on MASS performance, and its direct or indirect effect on the safety of the MASS, surrounding structures and vessels, humans and the environment.

**9.3.5** The control system shall be designed and constructed to:

- *Enable its operation in all RFOC;*
- *Operate in a predictable manner with a level of integrity commensurate with operational and safety requirements;*
- *Ensure the watertight and weathertight integrity, to meet buoyancy and stability requirements;*
- *Minimise the risk of initiating fire and explosion;*
- *Enable the maintenance and repair in accordance with the maintenance philosophy.*

**9.3.6** Operators shall be provided with adequate access, information and instructions for the safe operation and maintenance of the control system.

**9.3.7** It may be necessary to exert command and control over the MASS, in order to ensure its safe operation. In the case of a propelled and steered craft, this includes the ability to direct the MASS along a safe route at a safe speed. It also includes the ability to ensure that on-board systems are deployed in a safe manner – e.g. switching off or diminishing high power transmissions when they could cause harm to vulnerable systems or personnel nearby.

## 9.4 RISK ASSESSMENT

**9.4.1** A Risk Assessment shall be performed for the MASS to identify potential failures which could impact on safety through:

- *Collision with fixed or floating objects;*
- *Grounding;*
- *Becoming a significant obstruction or hazard to other traffic;*
- *Leakage of noxious substances or other forms of pollution;*
- *Other potentially hazardous events or situations, which may depend on the type of MASS and how it is deployed and operated.*

**9.4.2** The Risk Assessment shall consider MASS systems, sub-systems, and components, and shall take into account:

- *The probability of a failure occurring, in measurable units, e.g. probability per 10,000 hours of operation, and the direct and indirect effects of the failure;*
- *Whether the MASS is capable of inflicting significant damage in a collision, by reason of its kinetic energy or its mass. Even at zero hull speed, a significant mass may cause damage by drifting onto, being blown by wind or thrown by waves onto another object or vessel.*
- *Whether the MASS is liable to become a significant obstruction to other traffic, if left to drift without propulsion or steering. This is governed by size and weight and operating area.*
- *Whether the MASS carries significant quantities of hazardous or pollutant substances.*

**9.4.3** If the consequence of failure identified in the Risk Assessment are deemed acceptable then the single point failure modes need not be analysed further for the purpose of the Code.

**9.4.4** Failure modes to be considered in the Risk Assessment shall encompass, but not necessarily be limited to, the following:

- *Power generation, control, distribution;*
- *Propulsion systems including the control of thrust and its direction;*
- *Steering systems including actuators and their control;*
- *Propulsion;*
- *Electrical connectors;*
- *Fuel and hydraulic systems (potential fire, pollution, loss of control);*
- *Individual sensors and their power supplies;*
- *Individual actuators and their power supplies;*
- *Communication systems;*
- *The platform control system (including autopilots and Collision Avoidance systems);*
- *The autonomy processor(s), i.e. the interpretation and decision-making system which takes in sensor data and takes decisions on what control actions to take. This may be done on board, off-board, or as a combination of these;*
  - *Signalling and lighting;*
  - *Data quality or inconsistency.*

**9.4.5** The Risk Assessment shall be able to show that the MASS is able to be operated to a tolerably safe level, ideally proven to be as safe as an equivalent manned counterpart (i.e. similar size and carrying similar payload / cargo).

**9.4.6** The protection measures afforded on a manned MASS, e.g. emergency engine stop in the case of fire, often rely on a human operator to detect the fault and to trigger the stop mechanism. On MASS, these measures must be fully automated unless the attendant risk can be otherwise reduced to an acceptable level (e.g. using electric propulsion, no fuel aboard; nobody on board put at direct risk; etc).

**9.4.7** The Risk Assessment shall highlight all potentially critical failure modes which are mitigated using failure sensors and/or "defence in depth", dual or multiple redundant safety features, as these need to be identified for the purpose of test and accreditation of the MASS.

## 9.5 SITUATIONAL AWARENESS SENSORS

**9.5.1** Most of the sensors considered in Paragraphs 9.6 and 9.7 may be regarded as optional, but some may be considered essential on some MASS under certain circumstances; or they may represent the best way to ensure the necessary levels of safety equivalent to a manned counterpart.

**9.5.2** The overall need for monitoring shall depend on the considerations above, being guided specifically by the outcome of the Risk Assessment.

## 9.6 INTERNAL SENSORS (PLATFORM MONITORING)

**9.6.1** Internal sensors may be fitted for monitoring the platforms' vital functions and safety. This may include a monitoring capability which would normally be provided by crew onboard.

**9.6.2** Examples include:

- *Health status of command datalinks, in particular those with the ability to receive an Emergency Stop command (this may be considered essential);*
- *Operability and health status of sensors that are identified as vital;*
- *Operability and health status of on-board systems which govern the ability to control the direction and speed of movement of the MASS (Heading or COG and STW or SOG);*
- *Operability and health status of on-board systems such as propulsors, platform control systems, collision avoidance systems, autopilots, Navigational Systems, servos, communications datalinks, and other internal sensors which may be needed to maintain platform and mission integrity;*
- *Onboard audio facilities:*
- *Remaining fuel;*
- *Watertight integrity;*
- *Integrity of the hull (or hulls);*
- *Structural damage to the overall MASS or its components;*
- *Entanglement;*
- *Pitch, roll and heave;*
- *Vibration;*
- *Shock.*

**9.6.3** The level at which these may be considered essential depends on the type of MASS and operational conditions, as indicated in Table 9.1 below. The need should be driven by the necessity to reach equivalent safety levels for all MASS with their manned counterparts.

**Table 9-1: Platform Monitoring**

| Factor | Impact on need for monitoring |
|---|---|
| **MKE** (Mass/Kinetic Energy) | High MKE - > greater need |
| **HAZCHEM** (Hazardous substances on board) | Payload integrity / fuel leaks: greater need |
| **OP-RANGE** (Operating range) | Outside LOS, greater need for monitoring |
| **Level of Control** (See definitions at Ch 2) | Appropriate monitoring required for the level of control in operation |
| **Area of Operation** (See definitions at Ch 2) | Close to shore and busy seaways, greater need for monitoring, rapid response. Offshore/Open Ocean, reduced need, slower response may be acceptable |

**9.6.4** The MASS shall respond to a simultaneous failure (or deliberate interruption) of all critical data links, i.e. those which can deliver an Emergency Stop command, by applying an Emergency Stop command (i.e. Fail Safe). This may be considered essential on all MASS.

## 9.7 EXTERNAL SENSORS AND SOURCES OF DATA

**9.7.1** External sensors may be fitted to sense and/or measure the environment, surroundings, navigational data, and other platforms and systems, which may include, but not be limited to, the following:

- *GNSS (Lat/Long), with position integrity provided by Satellite Based Augmentation Systems (SBAS, i.e. EGNOS in Europe) and/or terrestrial DGNSS beacons, and with the inclusion of a complementary backup system for resilience against GNSS interference, jamming and spoofing;*
- *Heading (may be considered essential, unless operated at a range of less than 300m from a manned ground control station within LOS and capable of commanding Emergency Stop);*
- *Sea state (may be measured using pitch and roll sensors);*
- *Wind speed and direction;*
- *Depth below keel;*
- *Radar targets, and automatic target tracking;*
- *Sound signals;*
- *Visual signals, such as shapes, carried by other vessels or navigational marks;*
- *VHF capability to receive and transmit messages;*
- *Relatively small floating objects that may reasonably be expected to be found in the area of operation.*

**9.7.2** Third party data feeds, including Notices to Mariners and other bulletins, may also be required, subject to their limitations, including:

- *AIS data;*
- *Weather forecast data;*
- *Tidal almanac data.*
- *ENCs*
- *High resolution bathymetry*
- *Environmental Protected Areas*
- *Wrecks*
- *Cables*
- *Anchorage areas*
- *Vessel manoeuvring restrictions and constraints*

This data, which can largely be obtained from the UK Hydrographic Office, may be used in the planning, and execution and monitoring stages of an operation."

The exact number of, and performance requirements for, these sensors will be dependent on the MASS category, level of control and the operating area as defined in the risk assessment. The Global Navigation Satellite (GNSS) system deployed must comply with any best practice guidance for GNSS issued by UK authorities.

**9.7.3** GNSS and, in particular, the US Global Positioning System (GPS), is pervasive across our increasingly digital infrastructure, enabling positioning, navigation and timing (PNT) applications. The ease of implementation of GPS receivers, particularly for timing and synchronisation, has led to unknown dependencies across critical national infrastructure. GNSS are very vulnerable to interferences, such as jamming, spoofing and solar storms, potentially costing the UK £5.2b over a five-day outage. The recent Blackett Report on satellite dependencies for position and timing highlights these vulnerabilities and the lack of awareness of the dependency across sectors.

**9.7.4** The National Physical Laboratory (NPL) contributes to the formulation of the global time scale, UTC (Coordinated Universal Time), and manages the UK's real time implementation, UTC(NPL). Direct access to this UTC reference offers the UK a source of time, independent to GNSS and not susceptible to the same vulnerabilities. NPL are leading the development of a resilient national timing infrastructure, providing GNSS independence, and access to sovereign capability (UTC(NPL)). This National Timing Centre will offer a resilient core UTC(NPL), distributed across secure hosting facilities in the UK.

**9.7.5** In addition, the NTC will begin addressing the UK skills gap in timing and will be provisioning access nodes to engage industry and academia, disseminating reference time and frequency signals, toward supporting the development of a UK supply chain for timing products and services. This capability, covering infrastructure and processes, products and services, could be exported globally, maintaining our heritage and leadership in time and time dissemination.

## 9.8 DATA INTERPRETATION

**9.8.1** The MASS shall have at least one of the following:

- *The ability to interpret sensor data on board in a timely manner with regard to its impact on MASS safety and performance and to execute its responsibilities in accordance with COLREG and international law;*
- *The ability to transmit sensor data in a timely manner to an off-board system or human operator who can interpret the data with regard to its impact on MASS safety and performance; and to receive appropriate commands in response, in a timely manner.*

**9.8.2** Sufficient data from the sensors (internal and/or external) shall be made available in a timely manner to a System which is capable of exerting control over the MASS, bringing it to a safe haven or away from a danger area when deemed necessary. The System, in this context, must include at least one of:

- *A human operator working in an RCC (LoC L1-L3);*
- *An on-board or remote automatic system (LoC L3-L5);*
- *A distributed system comprising on-board and off-board elements, which may or may not include a human operator or supervisor, with appropriate communication links between them.*

**9.8.3** In order to interpret sensor data in regard to its impact on MASS performance, the System shall be capable of determining or forecasting, by means of algorithms or data, as necessary to ensure safe operation:

- *Safe operating limits for sensor data where applicable;*
- *Permitted geographic area(s) and time window(s) for MASS operation;*
- *Expected water depth in relation to geographic position and time;*
- *Expected water current or tidal stream speed and direction in relation to geographic position and time.*

**9.8.4** Where applicable and deemed necessary the MASS is to be capable of de-conflicting the data presented by different sources (e.g. navigational data and sensor data).

**9.8.5** The System shall be capable of taking operational decisions in accordance with the sensor data interpretation, in order to maintain the safety and integrity of the MASS, surrounding objects and personnel, and to pursue its mission subject to those safety considerations.

## 9.9 CONTROL

**9.9.1** The MASS shall have the ability to be controlled by a Control System which may be an on-board, off-board system or human operator, or a distributed system involving one or more of these elements.

Control is typically a combination of high level and low-level functions and behaviours, which may be implemented in separate modules, such as the following examples:

- *Sub-second control of a rudder actuator, with a feedback loop in order to control heading in response to Heading and Rate of Turn (ROT) set points;*
- *Following a sequence of waypoints by issuing Heading and ROT set points;*
- *Generating or selecting waypoints, and selecting which route to follow;*
- *Enabling waypoint-following, or superseding the mission controller with heading and speed set points calculated by a collision avoidance algorithm.*

**9.9.2** It should be noted that the MASS's ability to transmit situational awareness data to an off-board controller has been covered in the previous Chapter. This, and the ability to receive appropriate and timely commands from the controller, should be borne in mind in cases where some of these functions are performed remotely.

**9.9.3** The control functions, (on-board, remote, or distributed) shall be capable of exerting timely and accurate control in such a manner as to maintain safety of (1) the platform; (2) surrounding persons, structures, ships; and (3) the environment.

## 9.10 EMERGENCY STOP

**9.10.1** The MASS should have a defined condition of Emergency Stop, which must be fail safe under conditions where normal control of the MASS is lost. Under Emergency Stop, propulsion is reduced to a safe level in a timely manner. In this context:

- *"a safe level" means a level at which it is not likely to cause damage either directly or indirectly. It should be noted that some MASS (e.g. wave propelled) may not have any means of cutting propulsion power to zero. But in a harbour or sheltered waters the wave propulsive power may reasonably be expected to be a safely low level;*
- *"in a timely manner" means within a time that is short enough to ensure that the risk from uncontrolled propulsive power can be contained before it is likely to cause damage. In open ocean conditions this may be relaxed, whereas in a docking situation the propulsion may need to be cut more quickly, within seconds or less.*

**9.10.2** The MASS shall have the ability to be placed in an Emergency Stop condition by a human or automatic controller or supervisor with access to sufficient Situational Awareness data to be able to determine when an Emergency Stop command is necessary.

**9.10.3** In the case of an automatic operator, the design of that controller or supervisor shall be fail safe, in that it shall recognise all known unsafe operating conditions with no false negatives and shall react to unknown or indeterminate safety conditions by invoking Emergency Stop in a timely manner.

**9.10.4** On sensing a failure (or disabling, whether deliberate or not) of all data-links which may carry an emergency stop command, the MASS shall enter a 'render-safe' procedure. This should culminate in Emergency Stop. The first action should be that, if situational awareness has been, and continues to be, fully operational, the MASS should immediately shape a safe course and adopt a 'safe speed' (making appropriate sound and visual signals when feasible) commensurate with weather conditions, COLREGS and safe navigation at the time of loss of data-link. This should minimise hazards to the MASS and other vessels, whilst the MASS and the control station resolve the situation. If the data-link is not re-established after an appropriate grace time, and/or the MASS's own situational awareness deems it safe/necessary, the MASS should enter Emergency Stop. Consideration may be made of including 'dropping anchor' as part of the render-safe procedure, commensurate with accepted safe navigation practices.

**9.10.5** In the event that the MASS experiences loss or compromise of Situational Awareness as well as loss of data-link, then Emergency Stop should be immediately initiated (making appropriate sound and visual signals when appropriate).

## 9.11 PROPULSION CONTROL

**9.11.1** MASS should have propulsion control as far as necessary to be capable of ensuring that safe operating speeds appropriate to its situation are not exceeded.

## 9.12 STEERING CONTROL

**9.12.1** The MASS should have steering control as may be necessary to maintain a safe heading. Note that 'passive' MASS, such as drifting sensor buoys, do not have steering control, but the risk is mitigated by deploying in safe areas and monitoring their position, and maintaining the ability to recover the MASS when necessary.

**9.12.2** Note on Heading vs Course Over ground (COG). Marine craft may have control of heading but limited control of Course Over Ground (COG) because of environmental influences such as surface currents, waves, or wind, combined with low Speed Through the Water (STW). The risk posed by potential loss of control over COG shall be addressed by means of situational awareness, using sensor and almanac data or calculations as necessary to anticipate environmental influences, so as to avoid bringing the MASS into a situation where it is predictably carried in an unsafe direction by overwhelming environmental influences.

## 9.13 COLREG – COMPLIANT BEHAVIOURS AND FAIL-SAFES

**9.13.1** The Control System shall be capable of operating to a level of compliance with COLREGS appropriate to the MASS class.

**9.13.2** The Control System may include a system or systems designed to sense and avoid obstacles. These obstacles may be fixed (e.g. coastline) or moving (drifting or other craft).

**9.13.3** Sense and Avoid systems may be deemed necessary:

- *When operating within Line of Sight (LOS), as directed by area control authorities;*
- *When operating outside LOS.*

**9.13.4** The performance of Sense and Avoid systems may be categorised using the following criteria and the ability to:

- *Accept externally defined fixed exclusion zones (e.g. based on geographical data);*
- *Accept externally directed control (third party) (e.g. VTS);*
- *Accept dynamic data on both fixed and moving obstacles via automatic electronic sensors (such as AIS, Radar with automatic target tracking (ATT);*
- *Take control of the MASS heading;*
- *Take control of the MASS propulsion;*
- *Interpret Situational Awareness sensor data automatically to provide the following information regarding any other object within range:*
  - *a. its position;*
  - *b. whether it is a vessel according to COLREGs;*
  - *c. if so, the aspect of the vessel in terms of its heading;*
  - *d. its course and speed, either absolute or relative to the MASS;*
  - *e. its classification according to COLREG (not under command, restricted in her ability to manoeuvre, sailing, fishing, constrained by her draft);*
- *Calculate and apply manoeuvring commands where practicable in such a manner as to comply with an appropriate interpretation of COLREGs where applicable;*
- *Calculate and apply manoeuvring commands in such a manner as to avoid collisions under all circumstances in which it is practicably feasible to do so.*

**9.13.5** A classification matrix may be used to summarize the performance level of a Collision Avoidance System. The CA Category required for the MASS should be determined by the vessel category, Level of Control and operating area. An illustrative matrix is given at Table 9-2 (overleaf).

| Table 9-2: Illustrative Classification Matrix | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Criterion in accordance with Para 9.13.4 | | | | | | | |
| **CA Class** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| **0** | Yes | Yes | | Yes | Yes | | | |
| **1** | Yes | Yes | Yes | Yes | Yes | | | Yes |
| **2** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |


*BAE Systems Pacific 950*

# 10 Communications Systems

## 10.1 OBJECTIVE

**The objective of this Chapter is to outline the requirements for communications systems to be carried by MASS, as required for compliance with IMO instruments and for command and control of the MASS.**

## 10.2 SCOPE

**10.2.1** MASS will be heavily dependent on communications systems for control and monitoring of the MASS, irrespective of any existing regulatory requirements for carrying radio-communications systems.

**10.2.2** RF communications requirements for MASS will include the following:

- *GMDSS compatibility;*
- *Communications for Control System Monitoring and Input.*

## 10.3 GMDSS REQUIREMENTS

**10.3.1** The application of SOLAS Chapter IV (Radiocommunications) is to cargo ships of 300 gross tonnage and upwards on international voyages. These SOLAS requirements are therefore not generally applicable to the majority of MASS within the application of this Code.

**10.3.2** The Merchant Shipping (Radio Installations) Regulations (SI 1998 No. 2070) require cargo ships of 300 gross tonnage and upwards on domestic voyages to carry a GMDSS radio installation as described in the regulations. MASS of 300 gross tonnage and upwards should therefore comply with these regulations.

**10.3.3** There are no requirements for ships under 300 gross tonnage, although any ship using the frequencies of the GMDSS are bound by the requirements of the ITU Radio Regulations. Guidance can be found in the Code for the construction, machinery, equipment, stability, operation, manning, examination, certification and maintenance of MASS of less than 24 metres load line length which are in commercial use for the carriage of cargo and/or not more than 12 passengers or neither cargo nor passengers; and pilot boats (MGN 280).

**10.3.4** The radio equipment to be carried depends on the capabilities of the MASS and the area of operation. The minimum and recommended radio equipment is given in Table 10-1.

**10.3.5** The controller of the MASS while operating should, when practicable, be capable of receiving, interpreting and acting upon information transmitted via the following communications channels:

- *Where practicable on VHF channel 16;*
- *On VHF DSC channel 70;*
- *If fitted with an MF installation, on DSC 2187.5 kHz;*

- *If fitted with a satellite installation, with enhanced group calling;*
- *For broadcasts of Maritime Safety Information e.g. by NAVTEX.*

**10.3.6** The controller of the MASS should hold a certificate of competence for distress and safety radiocommunications (e.g. GMDSS Short Range Certificate or Long Range Certificate as appropriate).

**Table 10-1: Telecommunication Equipment requirements for MASS**

| Area Category | 6 (up to 3 nm) | 3,4,5 (up to 20 nm) | 2 (up to 60 nm) | 1 (up to 150 nm) |
|---|---|---|---|---|
| Satellite Communications | R | R | R | R |
| VHF radio installation with DSC | R | R | R | R |
| MF radio installation with DSC or a satellite installation | R | R | R | R |
| NAVTEX receiver | | | R | R |
| EPIRB | | | R | M |
| Search and Rescue locating device | | R | R | M |
| Hand-held waterproof VHF radio (if vessel is manned) | M | M | M | M |

M = Minimum R = Recommended

## 10.4 COMMUNICATIONS FOR CONTROL SYSTEM MONITORING AND INPUT

**10.4.1** RF Communications systems that are required to exercise the required Level of Control (as outlined in Chapter 1 of Part 2), or are necessary to enable the Emergency Stop functionality, should be provided with reversionary modes and backup energy supplies, the scope of which will depend on both the MASS Classification (see Table 2-1) and the Area of Operation (See Table 1-1).

**10.4.2** These reversionary modes and energy supplies should be considered in the Risk Assessment, such that the risk of loss of control communications and ability to execute the emergency stop function is reduced to a level As Low As Reasonably Practical (ALARP).

**10.4.3** The communication suite is assumed to reflect the holistic coding requirements or registration certification of the MASS. Any reduction in system fit should be formally recorded, with each new mission/task requirement being reviewed and documented as 'fit for task' prior to operation.

**10.4.4** If alternative communication systems are adopted as the primary method, the appropriate minimum level of RF communication capability should be fitted relative to the specific operation cycle.

**10.4.5** In the case of a wider system failure, an adequate failsafe communication system to support COLREG compliance should be fitted. This system should have suitable range and endurance capabilities as to enable the operator to effect appropriate safe management of the uncontrolled MASS.

## 10.5 RF COMMUNICATIONS INSTALLATION

**10.5.1** All radio communication equipment should be of a type which is approved by the relevant authority.

**10.5.2** VHF transmission and reception ranges are reliable only within the line of sight ranges of the aerials.

**10.5.3** Aerials should be mounted as high as is practicable to maximise performance. When the main aerial is fitted to a mast, which is equipped to carry sails, an emergency aerial should be provided.

**10.5.4** Masters, Owners and Operators should be aware of VHF coverage in the intended area of operation. Where the certainty of good VHF coverage in the UK coastal area is in doubt, Masters, Owners and Operators should seek advice from the Administration on whether Medium Frequency (MF) or other equipment with long range transmission capability should be carried. (i.e. Mobile Satellite Communications Systems, etc.).

**10.5.5** All radio installations should be:

- *Located to ensure the greatest possible degree of safety and operational availability;*
- *Protected against the harmful effects of water, extremes of temperature and other adverse environmental conditions.*

**10.5.6** Notwithstanding the provisions of Paragraph 10.4, when the electrical supply to radio equipment is from a battery, charging facilities (which are capable of recharging batteries to minimum capacity requirements within 10 hours) or a duplicate battery of capacity sufficient for the voyage should be provided.

**10.5.7** The battery electrical supply to radio equipment should be protected against flooding/swamping as far as practicable and arranged so that radio communications are not interrupted in adverse conditions. When the efficiency of the required protection against flooding/swamping cannot be guaranteed with batteries located below the freeboard deck, an efficiently protected battery electrical supply to the radio equipment should be provided above the freeboard deck.

**10.5.8** When fully charged, the batteries should provide at least the minimum required hours of operation to ensure effective use of the GMDSS installation.

*QinetiQ operations*

# 11 Remote Control Centre – Operation

## 11.1 OBJECTIVE

**The objective of this Chapter is to define the architecture and potential responsibilities of a Remote Control Centre and to provide outline requirements for their functions.**

## 11.2 SCOPE

**11.2.1** The Remote Control Centre (RCC) is the set or system of equipment and control units that are needed at the site or sites where safe and effective remote command, control and/or monitoring of the MASS, or several MASS, is conducted.

**11.2.2** The RCC enables the command and control of the MASS. The RCC may be located afloat on a separate ship or ashore. The RCC may also interface with other RCCs that are separately located; the risk assessment will indicate which RCC has responsibility for a MASS at a specific time.

**11.2.3** The RCC may be a fixed stationary installation, or fitted within a highly modular and portable unit, either of which may be controlling MASS from an RCC in a separate country to the location of the ship. This raises complicated questions as to the effective enforcement of maritime regulation. These include practical issues about the limitations on a port or coastal State's ability to satisfy itself as to the safety of the operation and maintenance of a MASS when the control centre is located in another country. Questions of jurisdiction and responsibility pertaining to the regulation of RCCs is an important matter for the international community and owners/operators should take this into account in the development of their operational procedures.

## 11.3 SUB-SYSTEM ARCHITECTURE

**11.3.1** The RCC architecture will vary from system to system, but enables the following tasks to be undertaken to a level appropriate for the mission, in accordance with the risk assessment:

- *Operation Planning;*
- *Operation Control;*
- *Post Operation Analysis.*

## 11.4 TASKING CYCLE OF THE MASS

**11.4.1** The MASS tasking cycle is a sub-set of the overarching system life cycle and includes a number of tasks that involve the operation of the RCC. It is necessary to clearly define the concept of use and tasking cycle of the MASS and the roles, responsibilities and boundaries of those involved in these tasks. An example of a MASS tasking cycle is presented in Table 11-1.

| Table 11-1: Tasking Cycle of a MASS<br>PHASE 1 MISSION APPRAISAL | |
|---|---|
| **Task** | **Description** |
| Operation Planning | Can be conducted ahead of actual operation and includes:<br>■ Determine operational area;<br>■ Notification and permissions from port/sea authorities, joint force, other organisations;<br>■ Notice to Mariners;<br>■ Environmental assessment;<br>■ RF licences;<br>■ Route planning;<br>■ Infrastructure;<br>■ Description of incident handling processes and procedures. |
| **Activities** | **Considerations** |
| Has a launch site visit and familiarisation been conducted YES/NO. | If no, has this been briefed to all those involved in the operation? |
| Are there any restrictions?<br>Is a support vessel required? | Establish restrictions and provide support vessel if required. |
| Personnel planning | Determine number of personnel required for the operation (consider country of operation requirements for qualifications). |
| Is the RCC mobile / is the RCC location fixed? | RCC set up and tested? |
| Vessel/s transit to launch site | Transit Duration?<br>ETA?<br>How – Air/sea/road?<br>Parties involved?<br>Can the vessel and support team conduct necessary procedures or maintenance shoreside? |
| Visas/permits - Overseas travel or permits to work needed? | Conduct necessary liaison with relevant authorities, obtain relevant permissions. |
| Inoculations for any overseas tasks. | Medical advice should be sought |
| Country Liaison | Determine level of regulation in planned launch country.<br>Seek permission for operations.<br>Determine required level of qualification required for operators.<br>If vessel will operate between nations, ensure both authorities are aware.<br>Seek acceptance for control centre location.<br>Determine best location for support team. |
| Country brief | Local Maritime regs/Personnel conduct/Cultural sensitivities/Laws/ Driving/Weather/security etc. |
| Weather check and report for all phases where possible. | How will this be monitored and what is the plan for inclement weather?<br>Consider vessel construction and weather suitability. |
| Sea states | As above. |
| Nearest facilities: Medical, Fuel etc. | If operating abroad, what standards are they? Are the necessary medical insurances in place? |
| Security: People/ Equipment/ Data | Is a secure location available?<br>If not do the team need to protect data? (24/7 presence) |
| Real-life support | Food, water, washing facilities. |
| Are the team all Suitably Qualified and Experienced Persons, (SQEP) for the task? | Check and record |

| PHASE 2. MISSION PLANNING | |
|---|---|
| **Task** | **Description** |
| Pre-deployment | Mobilisation and configuration of equipment |
| Pre-launch | Detailed operation planning and system |
| **Activities** | **Remarks** |
| What is the method of launch? | Crane operation? Is there a vessel specific launch and recovery system? |
| Names of personnel involved including names to tasks/responsibilities | Are they SQEP?<br>Are they in a fit state, (any illnesses)?<br>Drug and alcohol policy? |
| Operation planning | Vessel route planned, transit areas identified, watch routine established<br>Timings of key phases for the pre-launch<br>Give a summary of the pre-launch to the team<br>Necessary liaison complete?<br>External support in place? |
| Remote control centre set up and all comms/systems check complete? | |
| Communications check between main RCC and mobile support control centre? *(if applicable)* | |
| Who has control during the launch? | Support team or main control? Establish handover procedures |
| Payload checks | Checklist/SOPs Pre Sea Checks in accordance with approved check list; Check data/control links, communications, sensors, propulsion, and steering, etc |
| Necessary liaison complete? | |

| PHASE 3. MISSION EXECUTION – VESSEL DEPLOYMENT, LAUNCH AND TRANSIT | |
|---|---|
| **Task** | **Description** |
| Deployment | Deploy equipment to operational area by rail, road, air, sea |
| Launch / cast off | In water launch or cast off of MASS from mother ship or from shore side, including lifting operations. |
| Post Launch | ■ In water equipment checks prior to transit including:<br>■ Propulsion and steering;<br>■ Communications links;<br>■ MASS Health / BITE status;<br>■ Emergency procedures and functionality of fail-safe equipment. |
| Operation Conduct | Operation phase which will continue until the planned operation end time is reached or the operation is aborted. The operation may consist of one or several tasks and is highly dependent on the application. The operation may include re-planning, that is modification of the pre-launch operation plan, either automatically or commanded by the RCC. The operation may include deployment of other vehicles that perform their own operation. Will include handling of incidents (via the RCC) that occur during the operation. |
| **Activities** | **Remarks** |
| Establish Mission distance and duration | |
| Determine departure timing | |
| Ascertain Transit WPs | |
| Determine ETA's | |
| Establish Team numbers/skills requirement | |
| External Support? | |
| Forecast Expected weather and sea states | |
| Identify any handover Lat/Long | |
| Establish the handover procedures to main control if escorted or manned transit. | |
| Brief all involved regarding actions for Abnormal or Emergency operations | |

| PHASE 4. VESSEL MONITORING | |
|---|---|
| **Task** | **Description** |
| Pilotage | Transit in confined waters and/or areas of high traffic density where a conventionally manned vessel would normally require a specialist pilot or navigator |
| Transit | Transit to operation start point |
| Replenish | Replenishment such as re-fuelling may occur within an operation or at its margins. This could also include changing or replacement of various operation equipment |
| Transit | Transit to point of berthing |
| Berthing | Berthing of MASS to mother ship, shore side or jetty/mooring. This could include lifting operations when recovering to mother ship or land. |
| **Activities** | **Remarks** |
| Establish Mission distance and duration | |
| Crew rotation schedule | |
| Any external support needed (vessel/crew) | |
| Crew rest periods | |
| Comms schedule to main control | |
| External support required? Including contact details | |
| Actions on abnormal activity or emergency | Loss of Control Signal; Loss of Propulsion; Loss of Steering; Sensor Failure; Heading; Speed; Detection etc<br>Special Conditions: Constrained by Draft; Restricted in Ability to Manoeuvre; Not under Command; Grounding; Towing; Anchoring; Operating in restricted visibility<br>Sounds and Shapes required by COLREGs; Collision; Navigational Incident/Near miss; Fire; Grounding; Flood; Unauthorised Boarding/ Interference; Piracy; Cyberattack; Salvage<br>Distress: Issuing a Distress call, Detecting a Distress Call; Assistance to vessel/seafarers in Distress; MOB |

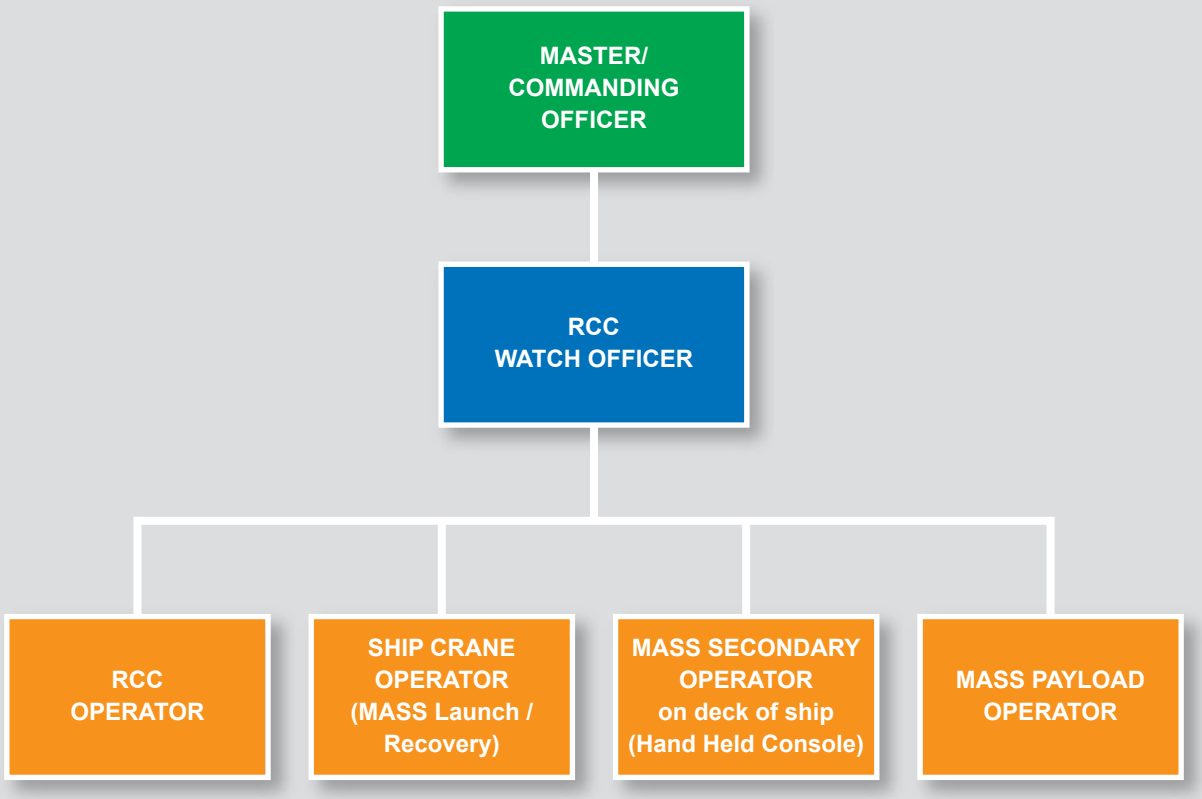
| PHASE 5. VESSEL RECOVERY AND POST OPERATION EVALUATION & ANALYSIS | |
|---|---|
| **Task** | **Description** |
| Shut Down | Shut down in accordance with check list procedures. This could also occur prior to, or as part of, the recovery procedure. |
| Post Operation Evaluation & Analysis | Post operation analysis could include: Analysis of operation data capture.; Evaluation and reporting of errors, faults, safety related issues; Evaluation of the success of the operation; Reporting of events to authorities, environmental monitoring agencies etc. as required. |
| **Activities** | **Remarks** |
| Method of recovery: | Crane operation? Is there a vessel specific launch and recovery system? |
| Timings | |
| Names of personnel involved including names to tasks/responsibilities | Are they SQEP? Are they in a fit state, (any illnesses)?<br>Drug and alcohol policy? |
| Remote control centre set up and comms check complete? | |
| Communications check between main RCC and mobile support control centre? | |
| Who has control during the recovery? | Support team or main control? |
| Payload checks | Checklist/SOPs |
| Necessary liaison complete? | |
| External support in place? | |
| Handover of control | |
| Actions on – Insert from checklist | Handover of control |
| Give a summary of the recovery to the team including key phases and timings. | |

## 11.5 RESPONSIBILITY OF THE RCC OPERATOR WITHIN AN OPERATIONAL HIERARCHY

**11.5.1** In most cases, there will be several personnel involved in the operation of the MASS with different types and levels of responsibility. The titles given to these personnel will differ depending on the type of commercial or military application. It is necessary to have a clear understanding of the responsibilities of all involved in the operation, particularly the RCC operator.

**11.5.2** An example of a responsibility diagram is provided at Figure 11-1 below. In this example, the MASS is launched and operated from the mother ship. The RCC is located in the ship operations room with a second MASS operator on deck to conduct short range remote operations using a hand-held console during launch and recovery of the MASS.

**Figure 11-1: Illustrative Responsibility Diagram**




In this example, the following roles and responsibilities are applied:

- ***Master/Commanding Officer***
  - *– Overall responsibility for the ship and her crew and all operations including those involving off board systems (MASS);*
  - *– Authorises the mission plan.*
- ***RCC Watch Officer***
  - *– Manages and commands the complete MASS mission;*
  - *– Manages the interaction between MASS RCC operator, crane operator, payload operators etc;*
  - *– Involved in mission planning, execution and post mission evaluation;*
  - *– Direct communication with equipment operators;*
  - *– If the MASS Watch Officer (MWO) is located in the Operations Room, then the oversight of crane/deck operations will pass to the commanding officer on the bridge.*

- ***RCC Operator***
  - *– Receives commands from the Watch Officer;*
  - *– Responsible for the MASS command and control when operated by the RCC;*
  - *– Responsible for mission planning, execution and post mission evaluation;*
  - *– Could be fully or partially responsible (shared by payload operator) for launch and recovery of vehicle payloads (ROVs, AUVs, towed systems and UAS);*
  - *– Communicates with other operators, e.g. crane operator, secondary operator on deck and payload operators.*
- ***Ship Crane Operator***
  - *– Receives commands from the Watch Officer;*
  - *– Responsible for lifting and lowering MASS to/from water;*
  - *– Will require to have communication with the MASS RCC and MASS secondary operator on deck as appropriate.*
- ***MASS Payload Operator***
  - *– Receives commands from the Watch Officer;*
  - *– Could receive commands directly from the MASS RCC Operator;*
  - *– Responsible for operation of payload;*
  - *– Could be fully or partially responsible (shared by RCC operator) for launch and recovery of vehicle payload (ROVs, AUVs, towed systems and UAS);*
  - *– Will have communication with MASS RCC Operator;*
  - *– This role could be conducted by the RCC Operator.*

## 11.6 DYNAMIC POSITIONING STATION KEEPING SYSTEMS FOR MASS AND REMOTE OPERATIONS

**11.6.1** The emergence of Remote Operation and the growth of the MASS towards 2025 and beyond has seen the number of MASS Remote Control Centres (RCC) expanding rapidly as companies are beginning to transition into a remote way of working. Currently there is no mandatory requirement for a ship's officer to complete dynamic positioning equipment training for the operation of MASS as part of STCW training.

**11.6.2** As MASS increase in size and complexity, seafarers qualifying as USV Masters and USV Watch supervisors will be required to hold DP certification in order to operate DP classed vessels. As a result, The Nautical Institute is exploring the changing needs around DP Certification for USV and MASS operations (Oct 2020). These will be issued in due course by The Nautical Institute.

## 11.7 TRANSFER OF MASS CONTROL

**11.7.1** The person responsible for the operation of the MASS is normally the Primary RCC operator, however, in certain circumstances, this responsibility may be transferred to another person within the operation. Any hand-over of control of the MASS, whether internally or externally, should be formally planned and strict procedures developed and adhered to such that the full and itemised responsibility is always clearly allocated and promulgated both in terms of personnel and jurisdiction.

**11.7.2** Control of the MASS could be transferred from the Primary RCC operator to one of the following operators:

- *RCC (Secondary) Operator - Where a network of two or more RCCs are used at different locations;*
- *Remote control using portable / handheld console - for example, during launch and recovery to/from mother ship or shore side;*
- *Manual operation - For optionally manned MASS, a qualified coxswain may take control of the MASS from the helm, for example, during transit, test scenarios, launch and recovery to/from mother ship or shore side;*
- *Fully autonomous operations – it is conceivable that in some circumstances full automated control could be given to the MASS. In this event, an RCC must be nominated as the immediate fall back if required;*

- *Pilotage – where port or other regulations require that a pilot is "embarked", suitable provision must be made to allow the pilot (embarked on the MASS or using other arrangements) to discharge his duties, (including taking Legal Conduct of the navigation of the vessel within stipulated pilotage waters where applicable), with due regard to any communications latency issues.*

**11.7.3** It may be necessary for the RCC operator to interact with other operators and consideration should be given to the level of interaction required, methods of communication and any interdependencies. For example:

- *MASS Payload Operation:*
  - *MASS payloads such as hull mounted sensors, towed sonars, may be controlled by a separate operator. This may form part of the MASS system and associated RCC or configured as a stand-alone system with its own dedicated RCC.*
- *MASS Launch and Recovery System:*
  - *Launch and recovery of the MASS may involve the operation of a davit, crane or similar device. During these events, the davit/crane operator will have control of the MASS for a period of time;*
- *MASS start-up / shut down and transfer of control between the RCC operator and lifting device operator needs to be coordinated:*
  - *External support e.g. chases boats, port/harbour control, with the responsibility of controlling other vessels within the operational Waterspace.*

## 11.8 CONTROLLING MASS FROM AN RCC

**11.8.1** The RCC should enable the operator to effectively monitor the behaviour of the MASS at all times, with a sufficient level of data to assess and react to requests including the following examples:

- *Health Status of MASS, including warnings and alerts:*
  - *Built in Test Equipment (BITE) data presented to RCC;*
  - *Battery status;*
  - *Fuel level;*
  - *Engine or equipment condition and performance warnings;*
  - *Fire on-board.*
- *MASS navigational data:*
  - *Actual position, Heading, CoG, SoG;*
  - *Planned course.*
- *MASS requests:*
  - *Request to perform some form of action that requires RCC authorisation.*
- *Situational Awareness data within vicinity of MASS; For example:*
  - *Target/obstacle Track Data;*
  - *Camera data;*
  - *Radar data;*
  - *In water sensor data (e.g. obstacle avoidance sonar);*
  - *Sound data (e.g. warnings from other vessels).*
- *Collision Avoidance:*
  - *Warnings of potential obstacles.*
  - *MASS intended action (autonomy level dependent)*
- *Attack or interference with the MASS or its subsystems.*
- *Chart overlays, including land mass, shipping lanes, charted obstacles, seabed topography (if required).*

**11.8.2** When designing the RCC, the type and quality of data presented at the RCC should be assessed to ensure that a sufficient level of safety and incident management is provided. This will depend on several factors; for example:

- *Type of MASS:*
  - *Small MASS will be limited in their ability to support situational awareness and collision avoidance sensors.*
- *Operation:*
  - *What other measures are available, if any, to provide situational awareness and communication with other vessels?*
  - *Where is the MASS operating, e.g. confined waters with high density traffic or blue waters?*
- *Level of control available (see definitions in Chapter 1 of Part 2):*
  - *Data latency and ageing;*
  - *Reliability of Communications Link;*
  - *Weather;*
  - *Geographic location.*

## 11.9 RELATIONSHIP BETWEEN AUTONOMY LEVELS OF CONTROL AND RCC

**11.9.1** There are several levels of control defined in Chapter 1 of Part 2. Irrespective of the LoC, the RCC should be designed to enable the operator to take control of the MASS at any time, including the ability to change the level of control or shut down the MASS completely.

## 11.10 SUGGESTED RCC OPERATIONAL REQUIREMENTS

**11.10.1** The following operational requirements are provided as illustrations for guidance:

- *The RCC should enable the operator to plan the MASS mission;*
- *The RCC should enable the operator to execute a MASS mission;*
- *The RCC should enable the operator to evaluate the MASS mission;*
- *The RCC should provide the operator with a sufficient level of situational awareness information both for the safe navigation and control of the MASS;*
- *The RCC should provide the ability for the operator to re-programme the required activities and responses of the MASS in timescales appropriate to the MASSs configuration, location and shipping conditions;*
- *The RCC should enable the operator to take direct control of the MASS at any time:*
- *In cases where the RCC is unable to assert direct control of the MASS, e.g. when MASS is operating in Level of Control 5, special provisions and control measures should be required to ensure safe operation.*
- *The RCC should alert the operator of any emergency warnings or a change in condition such as risk of collision, fire on board MASS, MASS equipment or functional failure/defect or 3rd party attack/interference;*
- *The RCC should alert the operator of any changes to the planned mission, such as change in speed, heading, collision avoidance manoeuvres;*
- *The RCC should be arranged such that the transfer of control from one base station to another or from one MASS to another may be undertaken safely;*
- *The RCC should be compatible with the communications link;*
- *The RCC should store data:*
- *This could include log data for fault diagnosis, scenario reconstruction, (e.g. collision event), last known coordinates following communications loss etc;*
- *Sufficient to meet international/local regulations;*
- *Two or more RCCs could be used to control one MASS from different locations. Only one RCC should provide control at any one time. Transfer of control from one RCC to another should be a simple seamless transition;*

- *It is possible that certain MASS functions (e.g. payload – instruments and their data) may be controlled from separate RCCs;*
- *The RCC should clearly indicate the control status of the RCC and any other RCC that form part of a networked control;*
- *The RCC should provide a sufficient level of security to prevent unauthorised access. This may include separate account access levels for Operator, Maintainer and Supervisor purposes;*
- *The RCC should be easy to use. The type of information displayed should be based on the priority of importance. Safety related warnings, graphical or audible, should be displayed on the Graphical User Interface (GUI), regardless of the GUI configuration.*

## 11.11 WORKING WITHIN PILOTAGE WATERS

**11.11.1** Working within the jurisdiction of a Harbour Authority and other Marine organisations can present specific challenges. Factors such as traffic density, local Port operations, including pilotage, VTS, and liaising with other stake holders, may subject the vessel to compulsory pilotage.

**11.11.2** Prior to entry of a Harbour or Marine facility, an RCC operator may be required to demonstrate they have sufficient skill, experience, and local knowledge to operate within the area.

**11.11.3** Prior to entry of a Harbour or Marine facility, an RCC operator may be required to demonstrate they have sufficient skill, experience, and local knowledge to operate within the area.

- *Knowledge of the 1987 Pilotage Act*
- *Knowledge of the 2013 Marine Navigation Act*
- *Local Pilotage Regulations*
- *Local Emergency plan and procedures - e.g. Fire, Pollution, Mooring failure etc.*
- *Local Bye-laws*
- *Local VTS traffic management regulations, protocols, and restrictions*
- *National occupational standards for Marine Pilots*
- *Obligatory additional technology required by the port authority - e.g. RCC operator equipped with something akin to a heavyweight pilot's PPU for overall situational awareness of port moments etc.*
- *Achieving a Pilotage Exemption certificate, which may require: -*

  *– Local experience gained under supervision of experienced pilots.*

  *– Additional training requirements (e.g. use of tugs in event of equipment malfunction)*

  *– Assessment process and standards*

  *– Examination syllabus, procedure, and standards*

# 12 System Integrity Certification and Test Procedures

## 12.1 OBJECTIVE

**The objective of this Chapter is to outline the certification and test procedures required for the situational awareness, control and other mission-critical systems within a MASS.**

## 12.2 SCOPE

**12.2.1** Verification shall be undertaken to provide assurance that the Situational Awareness and Control System complies with the provisions of this Code and remains compliant throughout its operational life.

**12.2.2** The Risk Assessment for the MASS should be reviewed in detail, to check that no critical single point failures have been overlooked. The Risk Assessment should be confirmed as being thorough and conservative in its safety assessment.

## 12.3 SYSTEM TEST BASED ON RISK ASSESSMENT

**12.3.1** All safety critical items covered by failure sensing and remedial action, or by dual or multiple redundancy, having been highlighted in the Risk Assessment, should be individually tested by simulating each failure mode of each sub-system or component and verifying that the backup measures are effective in mitigating any critical consequences.

**12.3.2** The effects of power failures should be checked, to ensure that simultaneous power failures on several sub-systems do not invalidate critical safety measures that rely on dual redundant systems.

**12.3.3** System integrity testing should be performed in a hierarchical manner in such a way as to ensure that each submodule functions in accordance with performance requirements. Integration testing should be performed to test the interfaces and the performance of the combined systems.

**12.3.4** Electronic systems should be installed in the same manner as for conventionally manned ships. This includes EMC compliance, use of enclosures and connectors with suitable marine grade IP ratings, communications standards EIA-422, EIA-232, NMEA 0183 and NMEA 2000 and others as appropriate.

**12.3.5** Simulators may be used to verify levels of performance of some but not all systems. This includes autopilot performance, collision avoidance algorithms, though not the systems whose performance is critically dependent on real-world stimuli, such as optical and inertial sensors.

## 12.4 SENSOR TESTS

**12.4.1** Any sensor whose performance is critical to MASS safety should be tested and certified to give reliable results. As far as possible, this may be done for each sensor type; in some cases, the sensor performance is largely independent of the platform on which it is mounted.

**12.4.2** Where indicated by the Risk Assessment, and where sensor performance is to some degree influenced by the platform on which it is mounted, sea trials should be performed using the sensor/MASS combination, to test external and internal sensors in a real maritime environment that meets or exceeds the most demanding environments for which the MASS is to be certified.

**12.4.3** In some cases, the dependence of sensor performance on the host platform is such that the tests may be performed using a representative platform, i.e. one where the sensor performance is expected to be equivalent or worse than on the MASS itself. This means that the sensor may be certified, on the basis of one set of trials, for many MASS platforms. In such cases, the critical parameters of the test and MASS platforms in question shall be recorded for comparison and justification. For example, if sensor performance depends positively upon antenna height above sea level, the test may be performed on a trials vessel using a lower antenna height, to provide accreditation for use on all MASS with higher antenna mountings.

## 12.5 EMERGENCY STOP TEST

**12.5.1** The Emergency Stop systems should be tested, using all defined methods of triggering Emergency Stop, singly and in combination, and under datalink failure conditions, to demonstrate that the Emergency Stop system is fail safe.

## 12.6 CYBER SECURITY

**12.6.1** Cyber security is covered in Chapter 4 and is defined as the protection of information systems from theft or damage to the hardware, the software, and to the information on them, as well as from disruption or manipulation of the data for the services they provide..

**12.6.2** MASS should have cyber security measures to protect sensors and control systems as far as practicable and necessary.

**12.6.3** Key risks are identified as (but not limited to):

- *Backdoors;*
- *Denial of Service;*
- *Direct Access;*
- *Eavesdropping;*
- *Tampering.*

**12.6.4** Key systems to be protected are those concerned with vital situational awareness and the display thereof (e.g. position sensors, heading sensors), control (steering, waypoint generation), operator override (including Emergency Stop provisions)..

**12.6.5** Security measures include:

- *Security by design, using best practice principles;*
- *Use of safe operating system (or no operating system at all), as many cyber-attacks exploit the operating system itself;*
- *Air-gapping (denial of communications so that the firmware, once programmed, is safe). This eliminates back-door attacks and is effectively applied to many sensors such as GPS, heading and depth sensors;*
- *Command link encryption;*
- *Use of multiple command links, effectively providing command link backup.*
- *BIT testing to verify the integrity of firmware and mission and configuration data at run time.*

**12.6.6** A Cyber Security Analysis should be conducted to identify possible security vulnerabilities and their effects on the vital systems and the performance of the craft or vessel, including but not limited to the command link, the generation and dissemination of waypoints, steering, and the ability to initiate Emergency Stop..

**12.6.7** The Cyber Security Analysis should be interpreted and acted upon in a manner similar to the Risk Assessment, in terms of identifying the need to apply corrective measures to reduce risk to an acceptably low level.

*Fugro FAS900*

# 13 Operator Standards of Training, Qualifications, Competence and Watchkeeping

## 13.1 OBJECTIVE

**The objective of this Chapter is to provide guidance on the required training and qualifications for identified roles within a MASS operating organisation, including RCC, for the various classes of MASS and operating Levels of Control.**

## 13.2 SCOPE

**13.2.1** The aim of this Chapter of the Code is to establish pan industry agreement on skill and competency requirements for MASS operation in advance of and alongside the establishment of governing regulations. However, operators should demonstrate a clear understanding of the relevant extant IMO instruments (COLREGs, SOLAS, MARPOL and STCW).

**13.2.2** This Chapter sets out to identify the principles and considerations to be given to the skills and competencies required to operate MASS safely.

**13.2.3** Skill and competency levels, and team size for specific MASS operations, should be defined in a Safe Operating Plan equivalent to the IMO Resolution A.1047(27) - Principles of Minimum Safe Manning. Paragraph 1.4 of Annex 2 (Guidelines for Determination of Minimum Safe Manning) states that, in determining the minimum safe manning of a ship, consideration should also be given to the number of qualified and other personnel required to meet peak workload situations and conditions, with due regard to the number of hours of shipboard duties and rest periods assigned to seafarers.

**13.2.4** It is recommended that the owner or operating organisation should produce a "Safe Manning Guide" similar to that required in the MCA Publication "A Master's Guide to the UK Flag".

## 13.3 GENERAL PRINCIPLES

**13.3.1** Part 1 of this Code sets out a clear Industry Principle for Training and Development:

- *Users of this Code should ensure the appropriate level of training and certification for all MASS operational staff to meet their Safe Operating Plan. They should enable staff development and the sharing of best practice through professional maritime bodies;*
- *MASS operational Staff should be trained and certified to at least the same recognised Flag State Authority or national equivalent standards, to a level equivalent to that appropriate for a similar manned vessel;*
- *Companies within the Industry should have staff development processes in place to capture and progress skill generation.*
- *Training should be underpinned internally and externally through quality auditing. MASS Training course recognition or accreditation must only be carried out by external organisations, bodies, or authorities with the competence to do so.*

## 13.4 APPLICABILITY

**13.4.1** In identifying the required skills for MASS operators, the organisation should consider:

- *The size of the MASS, e.g. MASS less than 24m in length, as defined by the Workboat Code; or by*
- *The Class of the Vessel - see MCA Guidance on Vessel classification and certification at* **https://www.gov.uk/guidance/vessel-classification-and-certification;**
- *The types of operation: Line of sight or beyond the horizon; 500m zone; bathymetric survey; mine clearance; pipeline survey; cargo operations; firefighting etc.*
- *The areas of operations: The MCA/NWA Workboat Code for Vessels defines a range of areas of operation as included in Chapter 1 of Part 2 of this Code;*
- *The Nature of the Cargo: appropriate training for the carriage and care of Dangerous Cargoes (see Chapter 17).*

## 13.5 OWNER/OPERATOR RESPONSIBILITIES

**13.5.1** As a responsible industry, it is essential that companies also implement a training, development and appraisal system for their MASS Operators and related personnel. Training needs should be identified and facilitated such that an appraisal system and competence scheme operate in an integrated manner.

**13.5.2** It is the responsibility of the Owner/Operator to ensure that all MASS operators and related personnel are adequately trained, developed and where appropriate certified to undertake their roles and responsibilities.

**13.5.3** All companies operating and/or owning MASS of any size must:

- *Provide for safe practices in MASS operations and a safe working environment;*
- *Continuously improve safety management skills of personnel operating MASS vessels, including preparing for emergencies related to both safety and environmental protection;*
- *Comply with all mandatory rules and regulations;*
- *Ensure that applicable Code, guidelines and standards recommended by IMO, Flag States, Classification Societies and Recognised Organisations are taken into account.*

**13.5.4** Therefore, for MASS, the vessel operator, whether owner or charterer, must ensure that their personnel undertake the required initial training and that the operator(s) are completely familiar with the equipment installed on the MASS, both for normal operations and emergency situations.

## 13.6 ENTRY REQUIREMENTS

**13.6.1** All MASS Operators should have an appropriate Seafarer certificate of competence applicable to the area category and vessel size. Details and information on appropriate certification can be found below:

- *RYA Certificates for powerboats at all appropriate levels;*
  - *MSN 1856 (M+F) UK requirements for Master and deck officers*
  - *MSN 1857 (M+F) UK requirements for engineer officers and operators*
- *MSN 1858 (M+F) Certificates of Competency: Yacht Deck Officers Training and Certification Guidance;*
- *The Safety of Small Workboats and Pilot Boats – a Code of Practice applicable to small workboats operating in commercial use to sea and all pilot boats. (The Merchant Shipping (Small Workboats and Pilot Boats) Regulations 1998 (SI 1998/1609), as amended);*

- *MSN 1853 The Merchant Shipping (Boatmasters' Qualifications, Crew and Hours of Work) Regulations 2015. Structure and Requirements;*
- *MGN 280 Small Vessels in Commercial Use for Sport or Pleasure, Workboats and Pilot Boats Appendix 3 – The Manning of Small Vessels;*
- *MGN 411 (M+F) – "Training and Certification Requirements for the Crew of Fishing Vessels and their Applicability to Small Commercial Vessels and Large Yachts";*
- *Nautical Institute Dynamic Positioning Certificate.*

**13.6.2** Vessels greater than 24M LOA and/or 500 GT may need to make reference to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 and Manila 2010 Amendments.

**13.6.3** All MASS Operators should complete a generic MASS operator's training course. This training should include, but not be limited to the requirements outlined in paragraph 13.8.1. Additional training should be undertaken for type and mission specific skills. The level of the skills required for each mission should be assessed, agreed and audited by an independent party.

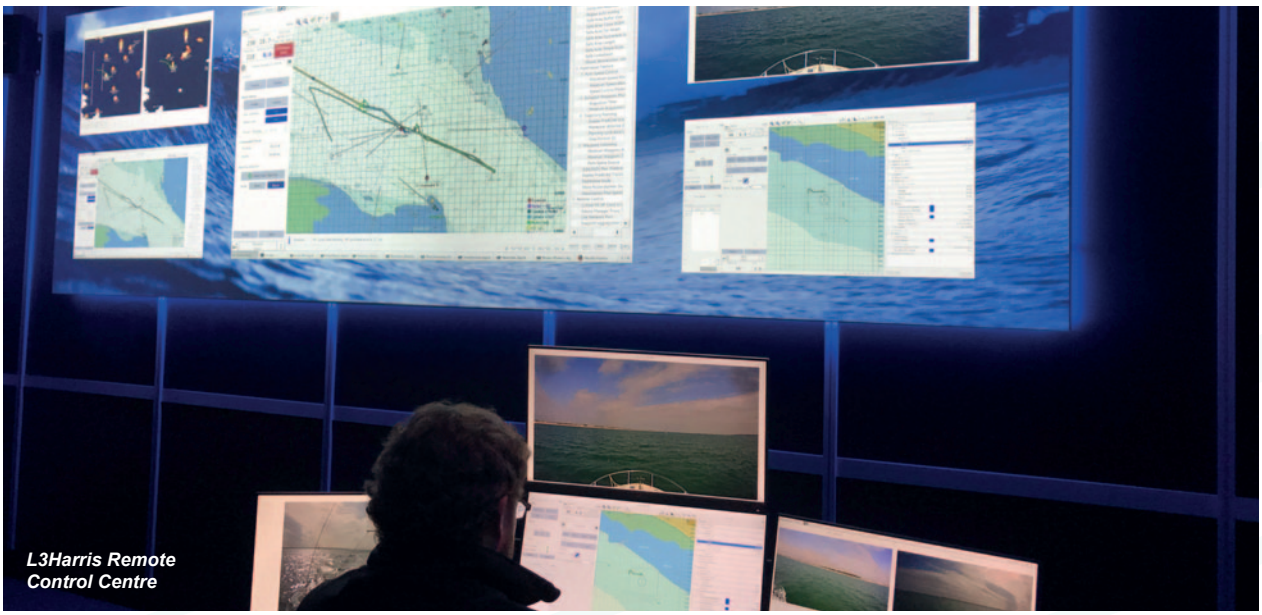
**13.6.4** All training undertaken, and all subsequent operational experience should be recorded by the operator. All training should be endorsed by the training provider. Operational experience should be endorsed by an appropriate company representative. Evidence should include dates, operational hours, operational area, as well as where and when any training took place.

## 13.7 EXPERIENCE

**13.7.1** It is recognised that MASS are an emerging technology. The approach adopted for this Code recommends starting with current seafarer skills; specific training needs will develop as solutions emerge. Your attention is drawn to industry Principle 9 and the sharing of best practice and experience.

## 13.8 TRAINING NEEDS

**13.8.1** The following MASS specific training needs, shown at Table 13-1, have been identified. Where possible an equivalent MNTB National Occupational Standard has been identified to provide guidance. A Generic Training Matrix is at Annex B to Chapter 13.



*L3Harris Remote Control Centre*

| Table 13-1: MASS Training Needs | | |
|---|---|---|
| **Key Training areas** | **Explanation** | **MNTB Occupational Standard** (if applicable) |
| **Principles of Autonomous Systems** | Understanding of the levels of automation and specifically the level of operator's interaction with the MASS | N/A |
| **MASS Regulations, permissions, notifications, requirements** | Understand and produce the required notifications, permissions and requirements for the operation of MASS in the given area | MNTB NOS Series A: A35 |
| **MASS Safety Principles including Machine Application of Regulations** | Understand the safe operation of the MASS and any limitations in the application of regulations within the system | |
| **MASS Command Control and Communications to include Security** | Operate and control communications with the MASS, awareness of security aspects (e.g. cyber) and responses when communications are lost | MNTB NOS Series C:C12, C13, C14, C23, C45 |
| **MASS Deployment and Recovery** | Control the launch and Recovery of vessels from land or other vessels | |
| **MASS Responsibilities (Owner, operator, insurer, accreditor, certifier)** | Understand the responsibilities of all parties involved with a MASS operation | |
| **MASS Operations Risk Assessment** | Conduct Risk assessment for MASS operations including deployment and recovery | |
| **MASS Vessel Specifics** | Control the specific MASS and understand all operational requirements according to the MASS vessel in operation. | |
| **System Maintenance & Checks** | Training on the servicing, repair to (including fault finding), maintenance, pre-launch checks & overhaul of all appropriate components of the whole system | |
| **Operator Facilities and interactions** | Understand all vessel controls and interactions available to the operator and awareness of the specifics of operating a vessel at distance | |
| **Limits of Operation** | Understand the limitations of the vessel | |
| **Sea Awareness and Handling** | Demonstrate awareness of the performance of the MASS under different conditions and any specific handling limitations | |
| **Operations** | Control all MASS system operations, maintaining safety at all times and meeting regulatory requirements | MNTB Series B: B02, B04, B13, B14 |
| **Emergencies, Contingencies and Faults** | Control the vessel or take appropriate action in the event of emergencies including loss of communications with the MASS | MNTB Series B: B11, B12, Series C C42, C43, C44, C45 |
| **Mission Planning** | Conduct mission planning for the MASS Operation according to the area, type and vessel solutions | MNTB Series B: B03, B15 |

## 13.9 MASS OPERATORS TRAINING REQUIREMENTS ASSESSMENT

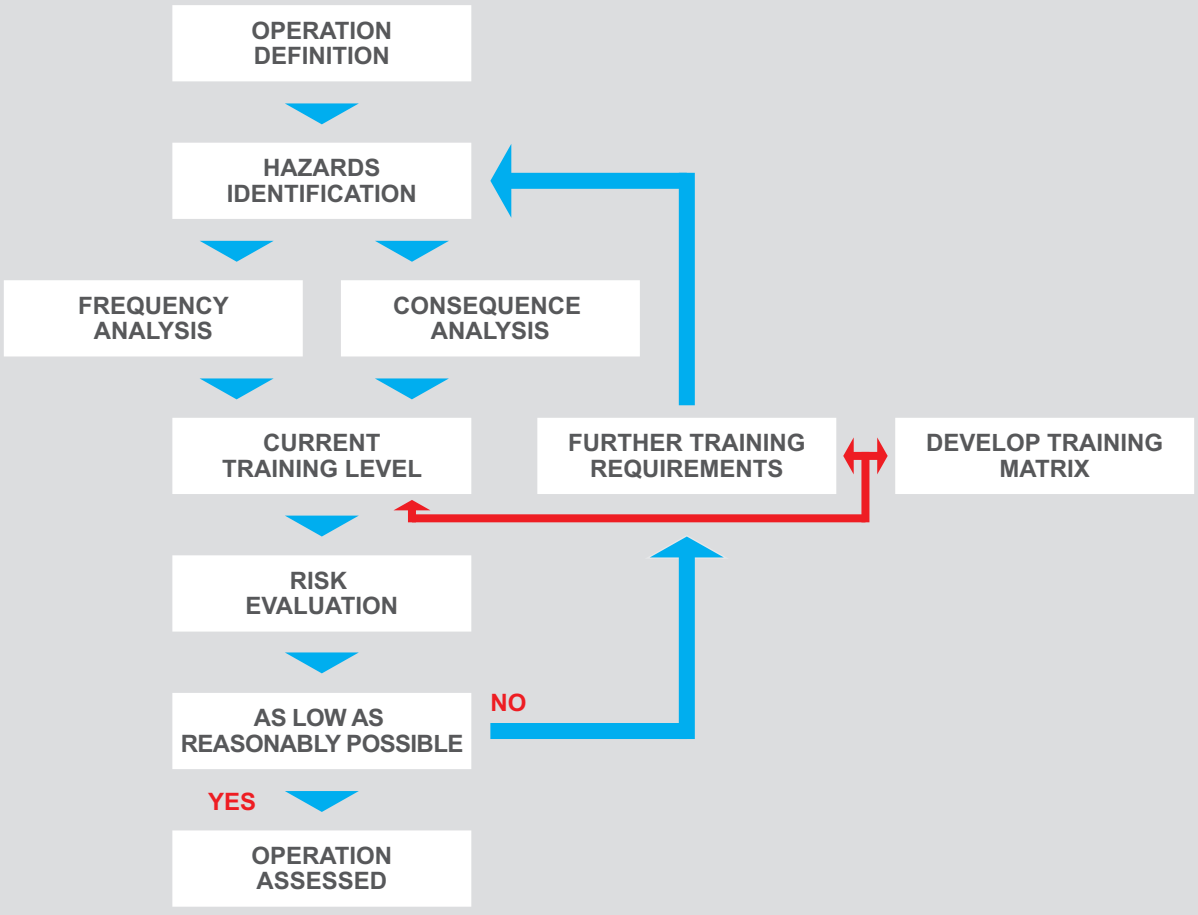
**13.9.1** There are multiple operations that MASS can conduct. As such the requirements for the operators of such MASS should be carefully assessed to see if their knowledge and training is acceptable to the tasks being conducted by the vessel. If not, then a gap analysis should be performed to see where any operator training shortfalls exist, and how such shortfalls maybe bridged through training.

**13.9.2** It is recommended therefore that a hazard and operability study (HAZOP) is completed for each MASS and its expected operations against the knowledge and training of the unit's operators. Such an exercise shows due diligence has been exercised by the MASS operators in the event of any official requirements that may be sought in the future.

**13.9.3** To complete a HAZOP the operations of the MASS unit must be broken down into individual sections or nodes and each node evaluated for potential issues and as such this should highlight the personnel skills required to deal with such operations.

**13.9.4** Figure 12-1 below shows an outline of the suggested procedure to conduct the HAZOP for each node. It is recommended that this is conducted in a multidiscipline workshop environment with input from all departments to ensure that all aspects of the MASS operations are considered. Using a multidiscipline team will also allow the operating company to outline how many of each operator can be expected to be required in the control room. The HAZOP results may form a component of the due diligence towards the makeup and manning of the operations team as a whole.

**Figure 13-1: Flow diagram to determine level of Operators Training Level**



## 13.10 OPERATION DEFINITION

**13.10.1** A clearly defined outline for the expected operations of the MASS should be agreed to establish the nodes, examples include:

- *What will the MASS be doing whilst in operation?*
- *Where will the operation be conducted?*
- *Consider the MASS design and control room requirements and all associated equipment.*
- *What are the requirements of each discipline to allow safe and efficient operations?*
- *What are the potential issues and hazards that could be encountered whilst on operations, including operational limitations for the vessel and a review of weather and sea state?*
- *Does the MASS use Dynamic Position Station Keeping Systems?*

**13.10.2** All disciplines should be considered at this phase from launch to return. Each element should be listed prior to moving on to the next phase.

**13.10.3** Hazards Identification. The hazards, issues and difficulties of each of the operational elements outlined in paragraph 13.9 should then be considered. Once again, this must be approached from a multi-disciplinary viewpoint.

**13.10.4** Where possible, data and statistics from previous operations should be considered on a lessons identified basis and presented in the report. As such MASS operators should be encouraged to report all near misses and incidents.

**13.10.5** Frequency Analysis. The Hazards and difficulties should then be assessed on two levels; firstly, by frequency. Again, where possible, this can be greatly assisted by data or statistics. Otherwise it must be done on an expected frequency basis given the operation and ship design as outlined in paragraph 13.9. This can be re-assessed as a part of the continuous development as outlined in paragraph 13.12.4.

**13.10.6** Consequence Analysis. As well as the frequency, the expected outcome must be noted. This must be considered to indicate how strong any mitigation measures must be; less frequent issues with a low consequences may need less action than others and sit in a tolerable region as outlined in the ALARP principle.

**13.10.7** Current Training Level. The current training level of the chosen MASS operators must be known to establish if they meet all the requirements already to enable them to mitigate the expected issues and difficulties.

**13.10.8** Risk Evaluation. Does the current training level mitigate all the expected hazards and issues to a level considered as low as reasonably possible or ALARP?

**13.10.9** Incident Reporting. Operators should capture and log information pertaining to all incidents, accidents and “near misses” in order to improve crew training, operational efficiency and safety management. This information should be used to continually improve vessel design, operational procedures and personnel training.

**13.10.10** Operators of MASS should also encourage the use of external reporting systems such CHIRP Maritime.

**13.10.11** Operators should also establish internal confidential safety reporting systems to capture relevant information from all involved with MASS operations, if these do not already exist under their current SMS.

## 13.11 AS LOW AS REASONABLY POSSIBLE (ALARP)

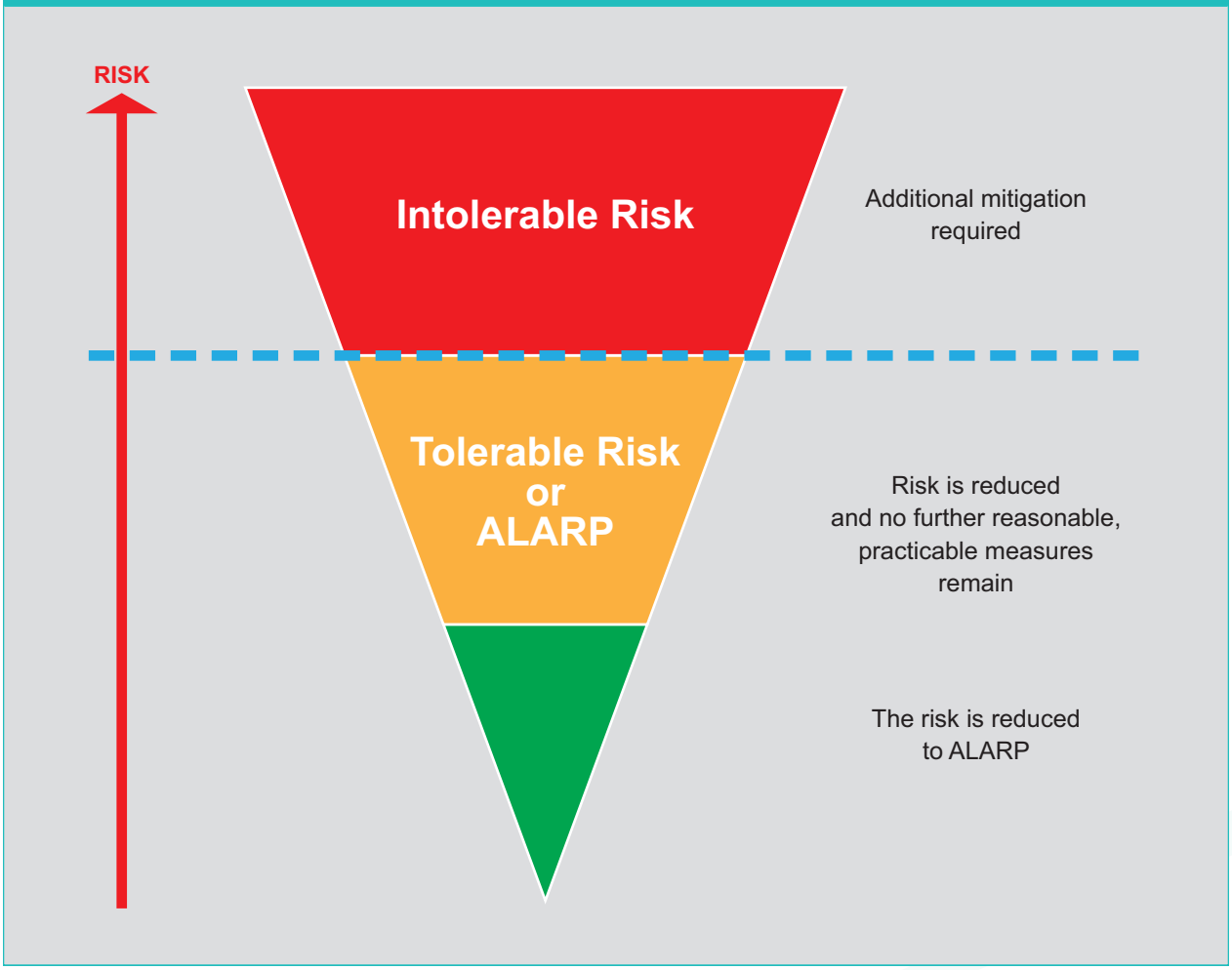
**13.11.1** All items listed will carry a certain risk. The aim of this exercise is to reduce these to as low as reasonably possible, by putting in place a required training level for the MASS operators.

**13.11.2** The ALARP principle relies on the risk levels being deemed appropriate with either the existing framework in place, or with some additional mitigation (in this case training for the operators) in place.

**13.11.3** If the results of the analysis show that the risk remains intolerable then further mitigation must be put in place. There is of course always risk present even after adequate risk mitigation measures are in place, and some residual risks are greater than others. At this level, mitigation may be considered acceptable on the basis that the no further practicable measures can be put in place for this situation.

**13.11.4** The ALARP principle is shown below in Figure 13-2.

**Figure 13-2: The ALARP Principle**




## 13.12 OPERATIONAL ASSESSMENT AND CONTINUOUS IMPROVEMENT

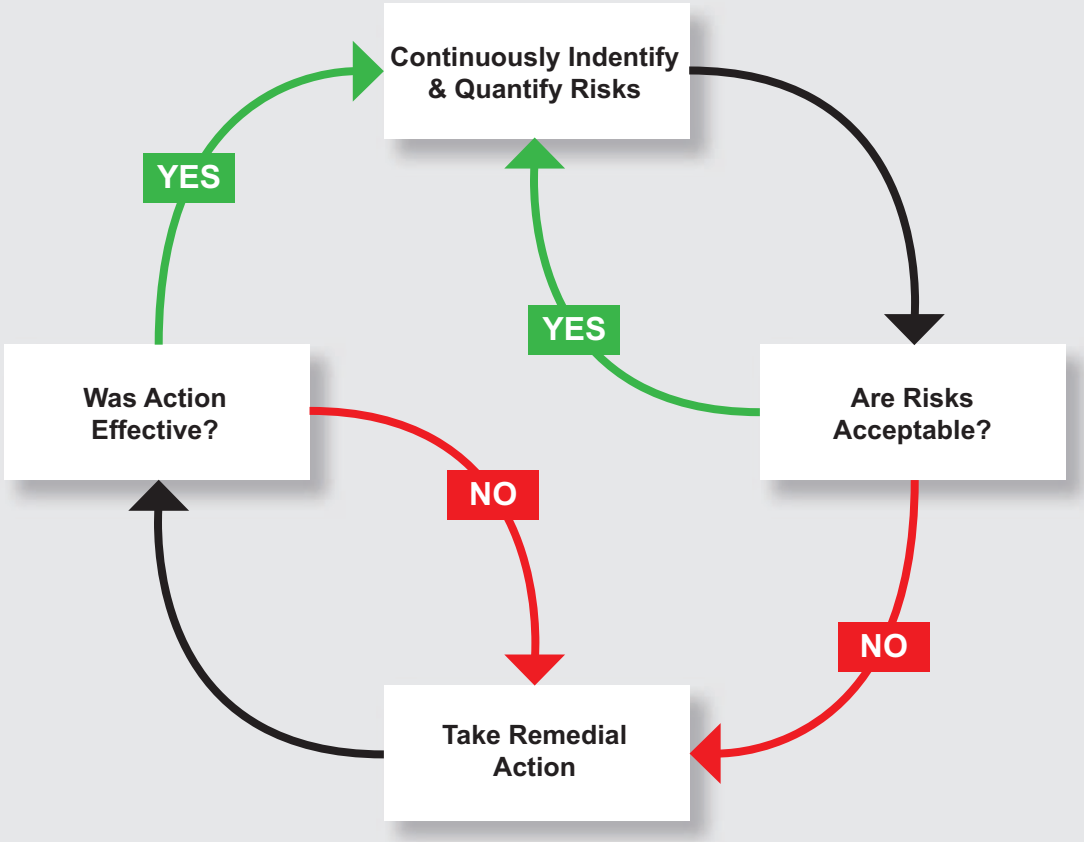
**13.12.1** In order to perform the gap analysis, the results from the above analysis must be compared to the chosen MASS operators current training and knowledge. From here, gaps in the requirements based on the MASS operations can be identified.

**13.12.2** Operation Assessed. Once all risks are reduced to a tolerable ALARP level, then the MASS operation can be considered as assessed. Gaps should then be known, and mitigation actions listed for completion, which should consist of outstanding training requirements.

**13.12.3** Training Matrix. The items listed on the potential operators current training levels, and any training identified to fill operational gaps identified during the process, can make up the operators' training matrix and used in future for similar operations.

**13.12.4** Continuous Development. As outlined earlier, the use of data and statistics of similar operations can help produce the most accurate risk assessment. However, data may be initially limited. Therefore, the assessment must be continuously monitored for its effectiveness. It is recommended that a full review is conducted at an appropriate interval to ensure that the training requirements remain relevant to the operation, and the risks remain ALARP. A Closed Loop Safety Assessment flow diagram is shown at Figure 13-3.

**Figure 13-3: Closed Loop Safety Assessment**




## 13.13 OPERATIONAL AND TRAINING RECORDS

**13.13.1** Formal proof of service and training records for operational staff should be developed and maintained to include:

- *Proof of Service and Training Records;*
- *Portfolio of evidence with ongoing experience log (e.g. date, location, vessel, software, operation, days, miles, notes etc);*

- *Assessment Records;*
- *Regular Competence Appraisals;*
- *Evidence of continuing professional development and type specific training, including Nautical Institute DP training and log books;*
- *Witness Testimonies;*
- *History of lessons identified and learned.*

## 13.14 MARITIME AUTONOMOUS INFRASTRUCTURE

**13.14.1** As the levels of the MASS autonomy change within the mission, the location of the MASS operator may well change from one RCC to another RCC. Operators operating or monitoring from any RCC should have complete understanding of the mission, as well as any specific tasks that may be required from them.

**13.14.2** Emergency scenarios and test procedure drills should be devised and practiced at regular intervals. These drills are to be recorded in the Operators Record Book. (See Annex B to Chapter 13). It is recommended that, where appropriate, cloud based or digital systems should be adopted.

**13.14.3** New MASS operator skill sets will evolve and need to be assessed and, where appropriate incorporated into the training requirements of MASS operators.

## 13.15 OPERATORS RECORD BOOK

**13.15.1** MASS operators should record and reflect on each mission. This record is to include any learning opportunities, dangerous occurrences and good practice observed during the mission. This portfolio of experience should be available for inspection, if required, by interested parties.

**13.15.2** Outline requirements for a MASS Operators Record Book are at Annex B to Chapter 13.

## 13.16 DYNAMIC POSITIONING OPERATORS/OPERATORS RECORD BOOK

**13.16.1** The Nautical Institute (NI) Certification and Accreditation standard for Dynamic Positioning (DP) will in future include a Section on a Training Scheme for DP Station Keeping Systems for Remote Operations. By completing a Training Scheme for DP Station Keeping Systems for Remote Operations, the DP Operator will receive an NI DP Certificate endorsed: 'Restricted to Dynamic Positioning Station Keeping Systems for Remote Operations'. This type of certification is restricted to DPOs who have completed the required amount of DP training on remote DP Systems. A Dynamic Positioning Operators Record Book must still be used to record DP operations and experience.

## ANNEX A TO CHAPTER 13

The blank Proforma is available on the Maritime UK web at **www.maritimeuk.org**, through the Media Centre and Resources tabs.

| MASS Generic Training Matrix | | | | |
|---|---|---|---|---|
| **Topic** | **Course Contents** | **Information Provider** | **Date** | **Instructor Signature/Name** |
| **Principles of Autonomous Systems** | | | | |
| **Safety Principles**<br><br>Operational equivalency and competency.<br><br>Use of Permit to work. | | | | |
| **Responsibilities**<br><br>Owner, operator, accreditor, auditor certifier. | | | | |
| **Regulations**<br><br>Permissions, notifications, requirements. | | | | |
| **Risk Assessment**<br><br>Operations, Mission Planning and Location. | | | | |
| **Communications**<br><br>Cyber Security and Command and Control. | | | | |
| **Deployment**<br><br>Recovery systems. | | | | |
| **Emergencies**<br><br>Contingency Checklists and Fault diagnosis flow charts.<br><br>Emergency notification requirements. | | | | |

## ANNEX B TO CHAPTER 13

The blank Proforma is available on the Maritime UK web at **www.maritimeuk.org**, through the Media Centre and Resources tabs.

| MASS Operators Record Book | | |
|---|---|---|
| | **Details** | **Comments** |
| **Date/time** | | |
| **Location/position** | | |
| **Weather** | | |
| **MASS type** | | |
| **Operator/Owner** | | |
| **Type of Operation** | | |
| **Deployment/Recovery** | | |
| **Duration** | | |
| **Control System** | | |
| **Learning Outcomes** | | |
| **Comments/Reflection** | | |
| **Signature and name of competent person** | | |
| **Other factors** | | |

# 14 Identification, Registration, Certification, Examination, Maintainance and Record-Keeping

## 14.1 OBJECTIVE

**The objective of this Chapter is to provide guidance on the areas covered in the title of this Chapter for the various Classes of MASS.**

## 14.2 IDENTIFICATION

**14.2.1** Identification is the provision of a discrete identifier for MASS; for which a number of schemes exist. However, the most widely used and understood is the IMO identification scheme, administered by IHS Markit. Currently it is only mandatory for cargo ships of 300GT and above and passenger ships of 100GT and above. An IMO number in these categories may be issued to any vessel for which a confirmed order has been awarded.

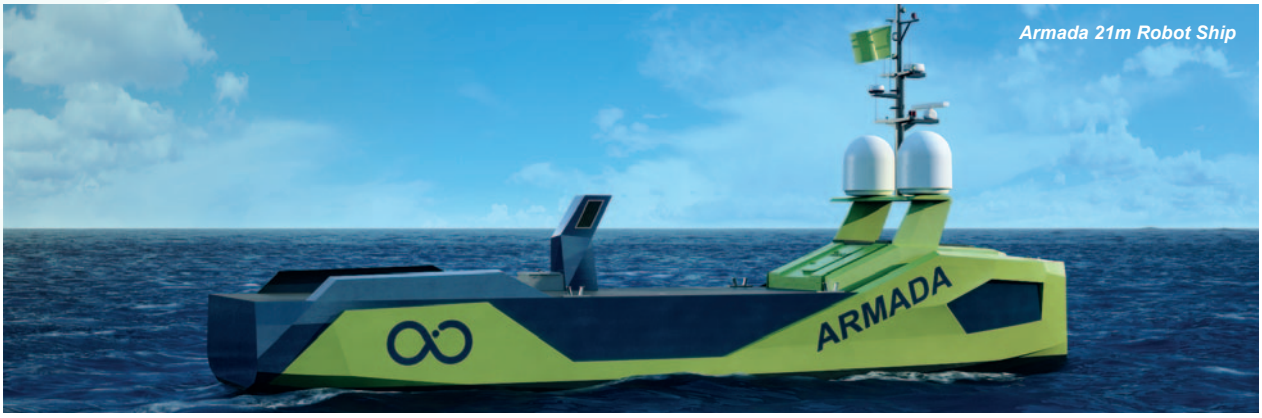
**14.2.2** The use of an identification number allows a MASS to be uniquely identified and is intrinsically linked to certification and documentation issued in respect of it, for example Registration or legal documentation. It also allows the MASS to be readily identified by a third party.

**14.2.3** An alternative identification scheme is outlined in EN ISO 10087:2006; which is intended to provide an identification scheme for small ship and all waterborne craft less than 24m in length and meets the requirements of the Merchant Shipping Act, 1995 Chapter 1(2). This WaterCraft Identification Number (WIN, previously CIN and HIN) may be applied directly by the Builder without any reference to a third party.

**14.2.4** It is recommended that identification be as shown at Table 14-1. Large MASS are included for reference only.

**14.2.5** Ships on the UK Ship Register will also be provided with an Official Number which should be marked on the MASS, together with the MASS name and port of registry as directed by the Registrar. The Official Number appears on the Registry Certificate and is distinct from the IMO number which remains with the MASS throughout its life and irrespective of any ownership or change of Flag state registry.

**14.2.6** It is recommended that identification of a MASS should indicate, when feasible, the level of control as defined in chapter 1 of Part 2 of this Code, irrespective of its size.



*Armada 21m Robot Ship*

| Table 14-1: Identification Requirements for Classes of MASS | | |
|---|---|---|
| **MASS Type** | **Description** | **Requirement** |
| **Large MASS** | Merchant ships > 100GT<br>Generally, length >24m | IMO number<br>"IMO" followed by a unique 7-digit number, which is managed by IHS Markit |
| **Light / Small / High-Speed MASS** | MASS should have either an IMO identification number or a Watercraft Identification Number (WIN) which should be marked by the boat builder in accordance with EN ISO 10087:2006 (to be replaced in due course by ISO/FDIS 10087<br>As a minimum a MASS of these classes should obtain a WIN. | "IMO" followed by a unique 7-digit number<br>Managed by IHS Markit<br>Watercraft Identification Number<br>14-digit alphanumeric identifier |
| **Ultralight MASS** | Ultralight MASS should ideally obtain a WIN. As a minimum, Ultralight MASS should, display a label identifying the owner and contact details. | |

## 14.3 REGISTRATION

**14.3.1** Registration is the formal process of establishing a genuine link between a Flag State and a MASS flying its flag in order to exercise its jurisdiction effectively and control over such a ship with regard to identification and accountability of shipowner(s), operator(s) or those responsible for the technical management of it. For British ships, registry is done though the UK Ship Register or one of the Red Ensign registries. The UK Ship Register process for obtaining registration is outlined in "UK Ship Register – A Guide to Registration", accessible at the following link: **www.ukshipregister.co.uk.**

**14.3.2** Registration of MASS of less than 24 metres LOA is not required to conduct commercial activities in the inland and territorial waters in the UK. However, for all international voyages and to conduct commercial activities in the waters of another Flag state, it may be a requirement to demonstrate appropriate Flag state registration. Flag States entitle those ships to comply with the applicable international and national rules, regulations and standards.

**14.3.3** The UK Ship Register process for obtaining registration is currently outlined in "UK Ship Register – A Guide to Registration", accessible at the following link: **www.ukshipregister.co.uk.** Regardless of their size, all MASS which fall within the level of control (LoC) categories 3-5 are required to be registered and have unique identification as set out in paragraph 14.2.

**14.3.4** The registration process requires a number of documents and certificates to be made available as explained in the Guide to Registration.

**14.3.5** In addition, the following requirements also need to be considered, regardless of registration. These include:

- *Safe Manning*
- *Certification of Competency and Medical Fitness*
- *Maritime Security*
- *Radio Communications*
- *Safety Management Documentation*
- *Employment Agreements and Accommodation*
- *Construction Surveys and Stability*
- *Civil Liability Certification*

**14.3.6** For MASS this will require discussion with the Flag State Administration to demonstrate that the proposed arrangements provide equivalence to the requirements. The requirements outlined in this Code of Practice will support these discussions.

**14.3.7** Details of Ports of Registry and/or Operations should be held with other records.

**14.3.8** Subject to provisions of UK Laws the UK Ship Registry may grant registration and right to fly its flag to a MASS bareboat chartered-in by a charterer in the UK for that specific period. The UK Ship Registry shall ensure that a MASS bareboat chartered in, will be subject to its full jurisdiction and control.

## 14.4 SURVEY & CERTIFICATION

**14.4.1** The different classes of MASS, which are outlined in Chapter 1 of Part 2 require different certification requirements.

**14.4.2** Each and every MASS, whether a new-build or transferring from another Flag, must be surveyed before it can be registered on the UK Ship Register. These surveys can be undertaken by either MCA or MCA approved Class surveyors, depending on certain criteria. If the survey is delegated to a Classification Society (or other RO), the name and contact details of the attending surveyor will need to be provided. On receipt, UK Ship Register will arrange the issue of the appropriate Instrument of Appointment.

**14.4.3** If the survey is carried out by the MCA, the survey application should be made using Form MSF 5100. If, on completion of survey, the surveyor is satisfied that the MASS meets international standards and UK regulations, where relevant, of safety and pollution prevention, short-term certification can be issued immediately. Full term certification would then follow in due course.

**14.4.4** Where mandatory requirements do not apply, the factors in Table 14-2 overleaf should be considered, particularly when undertaking any risk assessment. This table is not a definitive list: other relevant certification, e.g. safe manning, ISPS, ISM, RCC certification, may also need to be considered.

| Table 14-2: Certification Considerations for Classes of MASS | | | | | |
|---|---|---|---|---|---|
| | MASS Category | | | | |
| **R = Recommended M = Mandatory** | **Ultralight MASS** | **Light MASS** | **Small MASS** | **High-Speed MASS** | **Large MASS** |
| **Vessel construction & arrangements Certification** | **R** Approved Design Code or standard iaw Ch.6 | **R** Approved Design Code e.g. MGN280 or Workboat Code | **R** Approved Design Code e.g. MGN280 or Workboat Code | **R** Approved Design Code e.g. IMO HSC Code | **M** Approved Design Code or Class Rules |
| **Vessel certificate issued by** | RO | Class Society / Flag State | Class Society / Flag State | Class Society / Flag State | Class Society / Flag State |
| **Vessel Control System certificate** | **R** Approved Design Code or standard iaw Ch. 9 | **R** Approved Design Code or standard iaw Ch. 9 | **R** Approved Design Code or standard iaw Ch. 9 | **R** Approved Design Code or standard iaw Ch. 9 | **M** Approved Design Code or standard iaw Ch. 9 |
| **Certificate Issued by** | Appropriate authority | RO | RO | Flag State or RO | Flag State or RO |
| **Software Survey and Configuration Certification and Clearance for Use** (See note 2) | | | | | |
| **Crew Certification** | As per Ch. 12 | As per Ch. 12 | As per Ch. 12 | As per Ch. 12 | As per Ch. 12 |
| Note 1. For the purposes of this table 'ROs' may include a UK Approved Certifying Authority.<br>Note 2. Details will be added in a later version, but appropriate Software Certifications should be considered by Owners/Operators. | | | | | |

## 14.5 SURVEY & CERTIFICATION PROCEDURE

**14.5.1** The owner or operator will apply as appropriate to the Flag State (or RO or Certifying Authority, as deemed suitable by the National Maritime Administration) for any mandatory survey & certification. Copies of the certificates should be held in the company and/or owner offices and should be available in hardcopy or electronically on demand.

## 14.6 SURVEY PROCEDURES

**14.6.1** Examination of the MASS for certification purposes will, as far as possible, follow the regime adopted for ships of similar type, in terms of periodicity and content of survey.

**14.6.2** Surveys will be conducted by ROs or Certifying Authorities as approved by the Flag State administration.

## 14.7 MAINTENANCE PROCEDURES AND RECORDS

**14.7.1** All MASS should be provided with a recommended maintenance schedule from the designer/manufacturer.

**14.7.2** Configuration control of maintenance procedures and maintenance records should be assured as part of the Safety Management System and procedures for the operator.

## 14.8 RESPONSIBILITIES FOR RECORD KEEPING

**14.8.1** Survey & maintenance records should be kept up to date by the operator and be readily accessible for inspection.

# 15 Security

## 15.1 OBJECTIVE

**The objective of this Chapter is to provide guidance on the considerations and requirements necessary to meet the provisions of the IMO ISPS Code.**

## 15.2 SCOPE

**15.2.1** The scope of this Chapter is to ensure security in the operation of MASS by, inter alia:

- *Ensuring the performance of all MASS security duties;*
- *Controlling access to the MASS itself and to its control station;*
- *Reducing the risk of third-party cyber interception of MASS communications;*
- *Controlling the embarkation of persons on the MASS;*
- *Monitoring restricted areas of the MASS control station to ensure that only authorised persons have access;*
- *Monitoring both the MASS and the control station;*
- *Ensuring that security communication is readily available.*

**15.2.2** The regulation of ship security may be found in a number of sources including in the Annex to the International Convention for the Safety of Life at Sea, 1974 (as amended), SOLAS Chapter XI-2, as well as the International Ship & Port Facility Security Code, 2003 and SOLAS amendments (the ISPS Code).

**15.2.3** Both SOLAS Chapter XI-2 and the mandatory obligations found in Part A of the ISPS Code apply to “ships” of 500 gross tonnage and upwards. Such obligations would only find application to those MASS which are registered as “ships” under international law and meet this tonnage threshold.

**15.2.4** The Administration may allow a particular ship, or group of ships, to implement other security measures equivalent to those prescribed under both SOLAS Chapter XI-2 and in Part A of the ISPS Code, provided those measures are at least as effective in ensuring security.

**15.2.5** Even outside the direct applicability of SOLAS Chapter XI-2 and the ISPS Code measures should be taken by MASS Operating Companies to ensure security in the operation of MASS.

**15.2.6** MASS Owners and Operators are responsible for security in the operation of their MASS. Ensuring MASS security will require technical requirements for the MASS itself as well as procedures to be observed by the MASS operating company and the employment of qualified security personnel.

## 15.3 MASS TECHNICAL REQUIREMENTS

**15.3.1** MASS shall be designed so as to ensure appropriate compliance with the objectives of this Chapter.

**15.3.2** The MASS should be provided with a MASS Security Alert System.

**15.3.3** The MASS Security Alert System, when activated, should transmit a MASS-to-shore security alert to a competent authority designated by the Administration, identifying the MASS, its location and indicating that the security of the MASS has been compromised.

**15.3.4** The MASS Security Alert System should be capable of being activated from the control station immediately by personnel charged with the MASS's navigation or supervision.

**15.3.5** There should be protection from third-party interference with MASS communications.

**15.3.6** There should be a mechanism by which, in the event of third party communications interception, either the command of the MASS's shore-based personnel may reassume communications or, alternatively, shut down the MASS's operations, where it is thought safe to do so by the Master.

**15.3.7** There should also be a mechanism for safely shutting MASS communications down when the security of the control station centre has been compromised.

**15.3.8** The MASS hull/chassis must have a means of indicating:

- *That it is certified as compliant with the security requirements of the issuing authority;*
- *The means by which the MASS's Remote Control Centre may be contacted;*
- *Any other practical security-related information.*

**15.3.9** The MASS Remote Control Station should be secure. Reference should be made to the relevant guidance and regulations of ensuring the security of land facilities.

## 15.4 MASS OWNER/OPERATOR OBLIGATIONS

**15.4.1** The MASS Owner/Operator should undertake a MASS security assessment. The MASS security assessment should include a security survey of both the MASS hull itself but also the MASS Control Station. It must include:

- *Identification of existing security measures, procedures and operations in respect of both physical and cyber intrusion;*
- *Identification and evaluation of critical MASS and shore-based operations that it is important to protect;*
- *Identification of possible threats, both physical and cyber, to the key MASS operations and the likelihood of the occurrence in order to prioritise security measures;*
- *Identification of weakness, including human factors, in the infrastructure, policies and procedures.*

**15.4.2** The MASS security assessment should be documented, reviewed, accepted and retained by the MASS Owner/Operating Company.

## 15.5 MASS SECURITY PLAN

**15.5.1** The MASS Owner/Operator should ensure that each vessel has a MASS Security Plan approved by the Administration.

**15.5.2** The submission of the MASS Security Plan for approval should be accompanied by the MASS Security Assessment on the basis of which the plan has been developed.

**15.5.3** The plan should be in the working language of the MASS RCC and should include the following:

- *Measures to prevent dangerous substances being taken on board the MASS or into its RCC;*
- *Identification of the restricted areas and measures for the prevention of unauthorised access to those areas, both on the vessel and in the MASS control station;*
- *Measures to reduce the risk of compromise of MASS cyber-security;*
- *Measures to prevent unauthorised access to restricted areas on the vessel or at the control station;*
- *Procedures for responding to threats of security breaches, including provisions for maintaining critical operations of the MASS or, as the case may be, shutting them down;*
- *Procedures for responding to any security instructions made by port authorities;*
- *Duties of shore-based personnel assigned security responsibilities;*
- *Procedures for auditing the MASS security activity;*
- *Procedures for training, drills and exercises associated with the plan;*
- *Procedures for the interfacing with port facility security activities;*
- *Procedures for periodic review of the plan;*
- *Procedures for reporting security incidents;*
- *Identification of the MASS security officer;*
- *Identification of the Company security officer, including 24-hour contact details;*
- *Procedure for ensuring, testing, calibration and maintenance of security equipment on the MASS and that located in the control station;*
- *Frequency for testing, calibration and maintenance of security equipment on the MASS and that located in the control station;*
- *Procedures, instructions and guidance on the use of the ship security alert system, including the testing, activation, deactivation and resetting of that system.*

## 15.6 RECORDS

**15.6.1** Records of the following activities should be maintained at the control station as follows:

- *Training drills and exercises;*
- *Security threats and incidents;*
- *Breaches of security;*
- *Changes in security level set by the Administration;*
- *Communications relating to the direct security of the MASS such as the specific threats to the MASS or its RCC;*
- *Internal audits and reviews of security activities;*
- *Periodic review of the ship's security activities;*
- *Periodic review of the ship security assessment;*
- *Periodic review of the ship security plan;*
- *Implementation of any amendments to the plan;*

- *Maintenance, calibration and testing of any security equipment provided on board, including testing the MASS security alert system.*

**15.6.2** Records should be protected from unauthorised access or disclosure.

**15.6.3** The MASS Owner/Operator should ensure that the MASS Master has available, at all times, information through which it may be ascertained who is responsible for appointing members of the MASS Remote Control Centre and who is responsible for making decisions as to the employment of the MASS.

**15.6.4** The MASS Operator should employ both a Company Security officer and a MASS Security Officer.

## 15.7 COMPANY SECURITY OFFICER

**15.7.1** The MASS Owner/Operator should ensure that each of its MASS is assigned to the responsibility of a Company Security Officer (CSO).

**15.7.2** The CSO's responsibilities should include, but are not limited to:

- *Advising on the level of threats (including cyber) to be encountered by the MASS and its RCC using all relevant information;*
- *Ensuring MASS security assessments are carried out;*
- *Ensuring the development and submission for approval and thereafter maintenance of the MASS security plan;*
- *Ensuring that the MASS security plan is modified as appropriate and to correct deficiencies in the security plan;*
- *Ensuring that deficiencies and non-conformities identified in internal audits are addressed and dealt with;*
- *Arranging internal audits and reviews of security activity;*
- *Arranging initial and subsequent verifications;*
- *Enhancing security awareness and vigilance;*
- *Ensuring effective communication and co-operation between the MASS Security Officer and the relevant port facility security officers;*
- *Ensuring consistency between security and safety requirements.*

## 15.8 MASS SECURITY OFFICER

**15.8.1** The RCC team must include a MASS Security Officer (MSO) who takes responsibility for the security of the MASS, from both physical and cyber intrusion.

**15.8.2** The MSO should be responsible for:

- *Undertaking regular security inspections of the MASS and RCC to ensure that appropriate security measures are maintained;*
- *Maintaining and supervising the implementation of the MASS security plan;*
- *Proposing modifications to the MASS security plan;*
- *Reporting to the MASS Company security officer any deficiencies with the existing security arrangements identified in audits;*
- *Enhancing security awareness amongst the MASS personnel at the MASS control station;*
- *Ensuring adequate training has been provided to shore-based personnel on security matters, reporting all security concerns.*

## 15.9 VERIFICATION AND CERTIFICATION

**15.9.1** The MASS should periodically undergo verifications to ensure that its equipment guarantees safety to a comparable extent to those measures prescribed in SOLAS Chapter XI-2 and Part A of the ISPS Code

**15.9.2** The verifications will be undertaken by officers of the Administration.

**15.9.3** Initial verification should be undertaken before the MASS is put into service. This should be a complete verification of the MASS security system and associated security equipment and a comparable verification must be undertaken of cyber security measures and measures to protect the MASS and its RCC.

**15.9.4** Renewal verifications should be undertaken at intervals specified by the Administration.

**15.9.5** The Administration should issue a MASS Security Certificate if content that the MASS and its Remote Control Centre conforms to the requirements of this Chapter.

**15.9.6** The details of any such certificate and the duration of its validity should be specified by the Administration.

*Dynautics SPECTRE remote controlled autopilot onboard FASTAR*

# 16 Prevention of Pollution

## 16.1 OBJECTIVE

**The objective of this Chapter is to provide guidance on the considerations and requirements necessary for MASS to meet the provisions of the IMO MARPOL Instrument and Annexes.**

## 16.2 GENERAL

**16.2.1** A MASS complying with the Code should meet international, national, regional and local requirements for the prevention of marine pollution which are applicable to the area in which the vessel is operating.

**16.2.2** Responsibility for the MASS to be properly equipped and maintained to meet the prevailing requirements rests with the Owner/Operator.

**16.2.3** It is also the responsibility of the Owner/Operator to ensure that a charterer of a MASS receives up-to-date and adequate information on prevention of pollution in the area in which the charterer intends to operate. The information may include the need to seek advice from local or harbour authorities, for which contact details should be given.

**16.2.4** The disposal of ship generated waste to port reception facilities is regulated in the UK through the Merchant Shipping and Fishing Vessels (Port Waste Reception Facilities) Regulations 2009 (MASSSI 2009 No.1776), as amended. Further guidance on the applicability of these Regulations can be found in MGN 387 (M+F) - Port Waste Reception Facilities Regulations 2003 and the “Port Waste Management Planning – A Guide to Good Practice” booklet available from Marine Offices. MASS operators should ensure they manage their waste in a sustainable manner and fulfil the applicable requirements (if any) of these Regulations.

**16.2.5** All MASS should comply with the requirements of UK Regulations implementing MARPOL and environmental protection requirements as applicable to the size and operating area of the vessel.

## 16.3 OIL POLLUTION

**16.3.1** MASS should retain on board oil or oily mixtures for discharge to shore facilities.

## 16.4 GARBAGE

**16.4.1** Being crewless, operation of the MASS should not generate substantial quantities of garbage or similar. However, any maintenance or cargo handling operations aboard which generate such arisings must comply with the provisions of the MARPOL annex as appropriate to the size of the vessel and material generated.

## 16.5 AIR POLLUTION

**16.5.1** All engines with a power output of greater than 130kW, installed on a MASS of any size, or a MASS in commercial use for sport or pleasure over 24 metres length (as measured using EC Directive 2013/53/EU), constructed after 1st January 2000, should be issued with an Engine International Air Pollution Prevention (EIAPP) Certificate and a Technical File, according to schedule 2 of MSN 1819(M+F).

**16.5.2** A MASS less than 24 metres certified as a MASS in commercial use for sport or pleasure is not required to carry an EIAPP certificate if it is compliant with EC Directive 2013/53/EU. Further guidance on air emissions regulations can be found in MSN 1819 (M+F)85 and the Merchant Shipping (Prevention of Air Pollution from Ships).

## 16.6 BALLAST WATER

**16.6.1** MASS should comply with the International Convention for the Control and Management of Ships' Ballast Water and Sediments (2004) as applicable.

## 16.7 USE OF ANTI-FOULING COATINGS AND PAINTS

**16.7.1** On the 5th October 2001, the IMO adopted the International Convention on the Control of Harmful Anti-Fouling Systems on Ships. This Convention prohibits the use of environmentally harmful organotins (for example, Tributyl Tin) in antifouling paints applied on vessels, including MASS, and prevents the possible use in the future of other harmful substances in anti-fouling systems. The Merchant Shipping (Anti-fouling Systems) Regulations 2009 (SI 2009 No. 2796)83 apply to MASS.

**16.7.2** As a result of EC Regulation EC 782/2003 on the prohibition of organotin compounds on ships, it became compulsory for all ships in the EEA not to apply or re-apply organotin compounds which act as biocides in anti-fouling systems from 1st July 2003. For vessels less than 24 metres in length it is not necessary to provide for a specific survey or declaration.


*AutoNaut USV accompanies*
*The Ocean Clean Up in the Pacific Ocean*

# 17 Carriage and Transfer of Cargo (including Dangerous Goods)

## 17.1 OBJECTIVE

**The carriage and transfer of cargoes under MASS operations should be conducted in an acceptable safe manner to maintain all practical equivalence to the prescribed regulations for conventional shipping. This Chapter of the CoP offers guidance to MASS Owners and Operators in the interpretation of their 'Duty of Care' to be considered in conjunction with the MASS Definitions, Operations and Certification within this Code.**

## 17.2 SCOPE

**17.2.1** The carriage and transfer of cargo (including dangerous goods) by sea is controlled in order to prevent injury to persons or damage to ships and their cargoes and to prevent pollution of the marine environment under normal operating conditions. Dangerous goods are cargoes classified in the International Maritime Dangerous Goods (IMDG) Code which is given force of law through the Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997 (SI 1997 No. 2367), as amended and applies to all vessels irrespective of size in UK (navigable) waters. MASS operations will be dictated by the operational requirements of the MASS and carriage of all cargoes should be subject to a risk based safety assessment.

**17.2.2** This Chapter is divided into the following sub-sections:

- *Cargo demarcation;*
- *Ships stores;*
- *Construction and certification requirements;*
- *Operational considerations including emergency and spillage provisions;*
- *Transfer arrangements of Marine Gas Oil (MGO) and equivalents from designated tanks;*
- *Transfer arrangements from portable tanks (greater than 450 litres) or intermediate bulk containers (IRCC);*
- *Transfer arrangements for receptacles less than 200 litres;*
- *Dangerous Goods Classes (listing).*

**17.2.3** Control of dangerous goods is intended to cover all dangerous goods carried as cargo on any vessel. This includes any specialist equipment which may be classified as dangerous cargo when carried by crew or workers in the event of partial manned operations.

**17.2.4** When carrying dangerous goods identified in the IMDG Code, the vessel, including MASS, is required to have a Document of Compliance for the Carriage of Dangerous Goods issued by the Administration regardless of the quantities being shipped and held by the 'Operating' authority for all MASS operations.

**17.2.5** Dangerous goods may only be carried at the same time as personnel on MASS holding a Document of Compliance only where such workers or industrial personnel are carried on the express business of the MASS in the event of partial manned operations.

**17.2.6** For MASS engaged on international voyages, the 'Operator' of the MASS has the obligation to contact the port of arrival and/or departure Administration prior to arrival to agree that this Code standard for the carriage of dangerous goods is acceptable to them, including the additional constraints implicit and mitigating the MASS operation risk assurance assessment.

## 17.3 CARGO DEMARCATION

**17.3.1** The carriage of cargo is the process whereby a vessel, including MASS, is loaded, or intended to be loaded, with any item for delivery to, or collection from, one location and loading/unloading at another location.

**17.3.2** Cargo can be divided into:

- *General cargo – securing and other carriage requirements are Regulated through the Merchant Shipping (Carriage of Cargoes) Regulations 1999 (Statutory Instrument 1999 No. 336).*
- *Dangerous goods – cargoes which are classified as dangerous goods according to the criteria given in the IMDG Code are regulated through the Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997 (SI 1997 No. 2367). Dangerous goods are assigned, and identified by, United Nations (UN) Numbers and Proper Shipping Names according to their hazard classification. Their system of containment systems, e.g. portable tanks, IRCC, drums etc must comply with the requirements of the IMDG Code with a minimum of equivalence to achieve operating certification of MASS.*
- *Clear warnings that a MASS is carrying 'Dangerous goods' must be displayed in all appropriate spaces where personnel may board the vessel in any eventuality, and during normal ops i.e. safety checks, loading and unloading, maintenance etc.*

**17.3.3** Vessels where bulk cargo is loaded into and carried in the vessels hold or tanks which are considered to be small tankers or bulk carriers should be certified in accordance with the provisions of equivalent standards, recognising the MASS definitions and operational employment constraints thereto.

## 17.4 SHIPS' STORES

**17.4.1** The IMO definition of ships' stores (MSC.1/Circ.1216) is as follows:

- *Ships' stores, for the purposes of the carriage of dangerous goods, means materials which are on board a ship for the upkeep, maintenance, safety, operation or navigation of the ship (except for fuel and compressed air used for the ship's primary propulsion machinery or fixed auxiliary equipment) or for the safety or comfort of the ship's crew or workers in the event of partial manned operations;*
- *Materials intended for use in commercial operations by a ship are not considered as ships' stores, such as: diving, surveying and salvage operations.*

**17.4.2** For the purpose of this Code, when a total quantity of 25kg/25litres of the following dangerous goods are carried and used on board a 'light' category of MASS, of Classes 2.1, 2.2, 3, 6.1, 8 and 9, such materials can be considered as ships' stores and the MASS does not require a dangerous goods document of compliance. These materials can be specialist equipment to support the function of the MASS, in order to facilitate the specific tasks for which they are designed. Examples of such materials/specialist equipment would be compressed air bottles, portable generators/compressors etc.

## 17.5 CONSTRUCTION/CERTIFICATION REQUIREMENTS TO MAINTAIN MASS EQUIVALENCE

**17.5.1** Scuppers and Drains:

- *The scupper and drainage arrangements are to be directed overboard with no connections to internal spaces.*

**17.5.2** Electrical Equipment:

- *Electrical equipment installed in the cargo area should be of the certified safe type for the cargo being carried or be capable of being securely isolated during the carriage of packaged dangerous goods.*

**17.5.3** Structural Fire Protection:

- *Bulkheads forming boundaries containing fuel tanks, engine spaces and [in the event of partial manned operations] accommodation spaces are to be insulated to A-60 standard unless the dangerous goods are stowed three metres from such bulkheads and boundaries.*

**17.5.4** Vessel Certification. Prior to carrying dangerous goods, the vessel should be surveyed, and a dangerous goods Document of Compliance issued. A risk based assessment should be undertaken in consideration of the size categorisation (Paragraph 4.7) and level of autonomy (Table 1-4).

**17.5.5** Operators are recommended to undertake their own safety assessment before applying for a Document of Compliance for the Carriage of Dangerous Goods; this assessment procedure should be discussed with the Administration. This may consider specific requirements for the vessel including the carriage of additional safety equipment, (i.e. in MASS operations for remote sensing and reporting), additional emphasis on structural fire protection, automated fire suppression, separation between dangerous goods and control spaces. It may be necessary for the operator to submit a safety case.

**17.5.6** This survey may only be undertaken by a RO and will be valid for a determined period or specific operation. Upon successful completion of a survey, a Document of Compliance for the Carriage of Dangerous Goods will be issued to the vessel indicating the Class of goods that can be carried with a list of equipment fitted.

## 17.6 OPERATIONAL CONSIDERATIONS

**17.6.1** Operator Training as prescribed in MASS certification (See Chapter 2 of this Code)

- *The MASS operating authority should undergo training in the carriage of dangerous goods and the IMDG Code, commensurate with their responsibilities, and records kept of the training undertaken.*

**17.6.2** Stowage and Segregation requirements [in meeting MASS equivalency]:

- *Dangerous goods are only to be carried on deck or in internal MASS certified stowages;*
- *They should be secured to the vessels to prevent movement during the voyage;*
- *The stowage and segregation requirements of the IMDG Code should apply;*
- *Packaging (including portable tank and IRCC) should be commensurate with the intended MASS operations and take due cognizance of eventual 'manned' interface;*
- *Dangerous goods should be packed in accordance with the IMDG Code.*

**17.6.3** Documentation:

- *When carrying dangerous goods, a full manifest of the cargo should be retained ashore by the Vessel's owner/operator, or designated person [ashore], in case of an incident. The manifest should contain the UN Number, Proper Shipping Name, Packing Group and Quantity for each dangerous good being carried. The designated person ashore should have a list of contact numbers for the emergency services and relevant manufacturers/suppliers of the dangerous goods. The designated person should be employed by the Code vessel's owner and be aware of the details of the voyage. Prior to accepting back-loaded cargoes, the designated person should establish that their carriage will be in compliance with this Code.*

**17.6.4** Emergency and spillage procedures:

- *When dangerous goods are carried, details of the emergency firefighting equipment and First Aid medical procedures should be provided as per the risk based assessment of need, and practicalities of the MASS design and operation. The IMDG Code and its supplement may give guidance on such items, to ensure that if an emergency occurs, it can be dealt with effectively by any attending support or safety team.*

**17.6.5** Fixed and Portable Fire Fighting Equipment.:

- *The requirement should be assessed on categorisation, size, and level of autonomy. When operating MASS with 'partial manning'. fixed and portable Fire Fighting equipment must provide a minimum of manned vessels equivalence.*

**17.6.6** First Aid Kit Requirements:

- *Although the vessel is by definition to be usually crewless, the provisions of Annex 4 – "Medicines to be carried on ships carrying dangerous cargoes" to MSN 1768 (M+F), should be taken into consideration when carrying dangerous goods, to account for loading / unloading requirements, and/or any periods of manned contact.*
- *When a vessel is carrying a dangerous substance or substances, in quantities in excess of those defined in column 7 of the Dangerous Goods list of the IMDG Code, as whole or part of the cargo, the Operators must ensure the correct antidote to the substance (plus the necessary ancillary equipment e.g. syringes) is carried to account for loading/unloading requirements and or any periods of manned contact.*

## 17.7 TRANSFER ARRANGEMENTS OF MGO, UN1202, FROM DESIGNATED TANKS

**17.7.1** Careful consideration should be taken with regard to meeting MARPOL regulations and MASS equivalence of Duty of Care. Vessels which are adapted and used for the transfer of MGO from designated oil fuel tanks to other external facilities (e.g. a wind turbine) should demonstrate that they comply with MARPOL's requirements as far as practically possible taking into account that pollution of the seas is an offence. All existing manned equivalence measures must be adhered together with the requirement to demonstrate MARPOL compliance with regard to a full risk assessment carried out for the particular vessel and operation, including but not limited to, the hose not breaking free, pollution, fire safety and training of the shore based operators.

**17.7.2** Vessels should have operating procedures covering the loading, discharging and transferring of fuel, which should include safe use of the MASS equipment to minimise fire risks and pollution, and use of Safety Data Sheets (SDS).

**17.7.3** The installation should be surveyed by the RO and the vessel's Certification should be endorsed to permit this operation.

**17.7.4** The tank(s) should be of suitable design and construction, and have protection adequate for the service for which they are intended. Construction and fittings should be to an appropriate standard, to the satisfaction of the RO. Provision should be made to retain any oil leakage within the confines of the vessels hull to protect the marine environment and any workers or crew on board partial MASS manned vessels, or any to be embarked at a later date. Tanks should be tested to class standards.

**17.7.5** When considering proposals for the transport and transfer of MGO, UN1202 and other oils, in portable tanks or IRCC, the equivalency of MASS design should be satisfactorily addressed in the 'practical' context of MASS operations. This should take account of:

- *Portable tanks or IRCC should meet the requirements of the IMDG Code for the carriage of MGO, UN1202, or oils classified as dangerous goods;*
- *It should be verified that the intended stowage location is designed for the carriage of cargo and that the loads / point loads are within design limits of the deck;*
- *Stability – assessment on the impact on vessels stability should be carried out and free surface effect considered;*
- *"On board" filling of tanks - The filling and transfer arrangements including pipe work, transfer pumps, portable hoses, control of transfer, tank gauging and venting would need to be to the satisfaction of the vessel's RO taking into consideration the following:*
  - *– Utilisation of Flexible Fuel hoses;*
  - *– Filling arrangements;*
  - *– MASS design to include hi-level and remote operator emergency cut-off capability, whilst remote spillage sensing/reporting should be included in the Certified design;*
  - *– A Save-all is to be provided around the portable tanks and connections*

**17.7.6** Satisfactory securing of a portable tank or IBC in its stowage position is to be provided taking into account the forces, directions and accelerations likely to be encountered.

**17.7.7** Emergency response and contingency plans to be developed for spills, fire etc.

**17.7.8** MASS remote sensing and monitoring should form part of the design risk based assessment of fuelling design and operations.

## 17.8 TRANSFER ARRANGEMENTS FOR RECEPTACLES CONTAINING LESS THAN 200 KG OR 200 LITRES OF DANGEROUS GOODS

**17.8.1** Receptacles should be secured within save-all (bunded) structures and any lifting to be carried out should use appropriate purpose-built cages/equipment.

## 17.9 DANGEROUS GOODS CLASSES

**17.9.1** The title of the dangerous goods classes is given below. For fuller descriptions, the IMDG Code should be consulted.

- *Class 1 Explosives*
- *Class 2 Gases*
- *Class 2.1 Flammable gases*
- *Class 2.2 Non-flammable, non-toxic gases*
- *Class 2.3 Toxic gases*
- *Class 3 Flammable Liquids*
- *Class 4 Flammable solids; substances liable to spontaneous combustion; substances which, in contact with water emit flammable gases*
- *Class 4.1 Flammable solids*
- *Class 4.2 Substances liable to spontaneous combustion*
- *Class 4.3 Substances which, in contact with water, emit flammable gases*
- *Class 5 Oxidising substances and organic peroxides*
- *Class 5.1 Oxidizing substances*
- *Class 5.2 Organic peroxides*
- *Class 6 Toxic and infectious substances*
- *Class 6.1 Toxic substances*
- *Class 6.2 Infectious substances*
- *Class 7 Radioactive material*
- *Class 8 Corrosive Substances*
- *Class 9 Miscellaneous dangerous substances and articles*

*SEA-KIT International USV Maxlimer*

# 18 Rendering of Assistance to Persons in Distress at Sea

## 18.1 OBJECTIVE

**The objective of this Chapter is to identify applicable obligations on MASS and/or their operating personnel in an RCC under international law to render assistance to persons in distress at sea and to prescribe the means by which any such duty might be effectively discharged. It should be stressed that this is an area of MASS operation which will be kept under review as new classes of MASS are developed. Feedback from operators will be an essential element of this process.**

## 18.2 REQUIREMENTS OF INTERNATIONAL LAW

**18.2.1** Article 98 of the United Nations Convention on the Law of the Sea, 1982 (UNCLOS) requires flag States to enact laws to require the Master of one of its flagged ships to render assistance to any person(s) found at sea in danger, insofar as it can be done without serious danger to the ship.

**18.2.2** In particular, the Master, if informed of persons in distress, must proceed with all possible speed to the rescue of such persons insofar as such action may reasonably be expected of him.

**18.2.3** The International Convention for the Safety of Life at Sea, 1974 as amended (SOLAS) prescribes the same obligation to contracting States in Regulation 33 of Chapter V (Navigation), adding that masters who have embarked persons in distress at sea should treat them with humanity, within the capabilities and limitations of the ship.

## 18.3 APPLICABILITY TO MASS OPERATIONS

**18.3.1** The international State obligation of rendering assistance is to be practically discharged by the Master of a ship, rather than the ship itself. Therefore, the duty cannot lie with the MASS, but only potentially to persons operating it.

**18.3.2** The State obligations will only find application to MASS operators to the extent that both:

- *the MASS is itself a "ship"; and*
- *an individual operator can be regarded as its "master" at the time of becoming aware of an incident.*

**18.3.3** A "master" under s.313 of the Merchant Shipping Act 1995 is the individual with "command or charge of a ship". The Master for a MASS is as defined at Chapter 2 of this Code.

## 18.4 MASS REMOTE CONTROLLER TASK REQUIREMENTS

**18.4.1** The duty to render assistance will fall to be discharged, if at all, by the MASS Master, potentially delegated to the controller, both as defined at Chapter 1 of Part 2 of this Code.

**18.4.2** The duty is qualified by what is reasonably to be expected given the limitations and characteristics of the relevant MASS. The duty does not require, nor is it limited to, taking persons on board.

**18.4.3** The remote controller of a MASS will not breach the duty for failing to render a particular form of assistance on account of the MASS technical limitations or for the MASS' inability to take persons on board.

**18.4.4** The MASS's technical capabilities will define the nature and the requirements of the duty and not vice versa. However, situational cognisance and communications capability may be required by other international regulations, considered elsewhere.

**18.4.5** On the assumption that the MASS will have stand off and close up monitoring capability giving continuous feedback to the remote controller, as a minimum:

- *Having become aware of persons in distress, the MASS remote controller should make best endeavours to inform the appropriate search and rescue authorities through whichever means appropriate i.e. radio, camera live feed.*
- *In most circumstances, the MASS remote controller should ensure that the MASS is brought or remains in reasonable proximity with persons found in distress, to act as a visual reference point and communications point for research and rescue authorities.*

**18.4.6** Efforts should not be made to embark persons if this cannot be done safely, relative to the peril faced by persons in distress.

# 19 Salvage and Towage

## 19.1 OBJECTIVE

**The objective of this Chapter is to identify sound practices and obligations of MASS owners in circumstances where the MASS is either the subject of a salvage operation or the recipient of towage services.**

## 19.2 GENERAL

**19.2.1** As MASS capability becomes more prolific at sea, and also as they grow in size and complexity, they will be subject to the same risks as their manned counterparts. The outcome of these risks may require the MASS to be subject to either Salvage or Towage. It is assessed that the existing body of law is applicable to MASS.

## 19.3 MASS SALVAGE

**19.3.1** Existing maritime salvage law as it applies to manned ships generally applies to MASS. MASS owners should consider making use of the existing standard salvage contracts, such as the Lloyds Open Form (LOF).

**19.3.2** MASS owners should provide salvors with information about the MASS and payload (where applicable) as necessary for the safety of the salvage operation and in any event when such information is reasonably requested by the salvor.

**19.3.3** MASS owners should co-operate as fully as possible with salvors in conducting the salvage operation and permit the salvor to make reasonable use of the MASS's equipment, as appropriate.

**19.3.4** MASS owners should accept redelivery of the MASS after the salvage operation when reasonably requested to do so by the salvors.

## 19.4 MASS TOWAGE

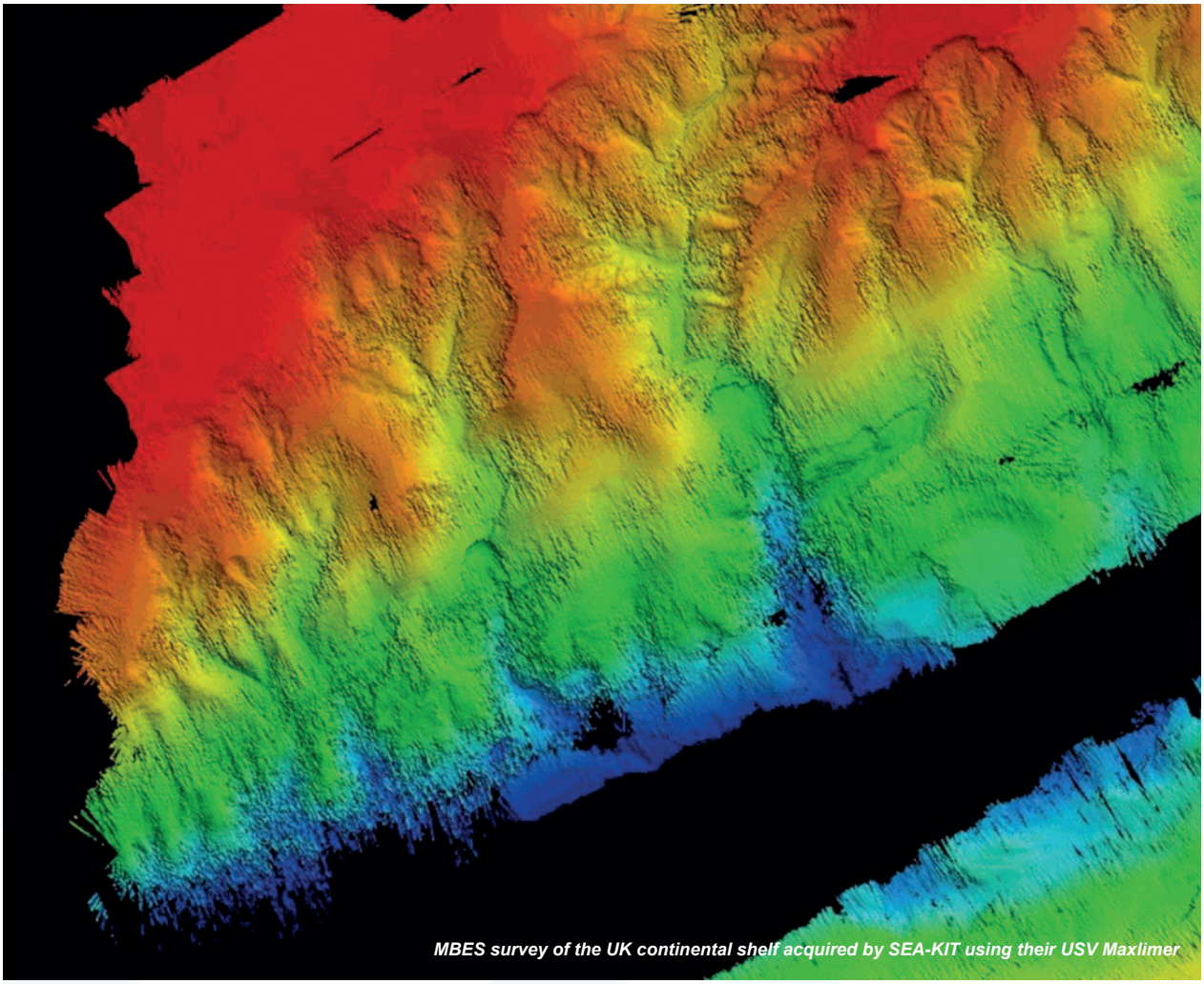
**19.4.1** Existing maritime towage law as it applies to manned ships generally applies to MASS. MASS owners should consider making use of the existing standard towage contracts such as the UK Standard Towing Conditions.

**19.4.2** MASS owners should disclose and provide to the towage service provider information reasonably necessary for the safety of the towage operation.

**19.4.3** MASS owners will ensure that all the requisite documentation for towing their MASS platform is in place and up to date; e.g. towing plans.

**19.4.4** MASS owners should exercise due diligence at the commencement of the towage to ensure that the MASS is fit to be towed and that the MASS is properly equipped therefor.

**19.4.5** MASS owners should resume control of the MASS at the agreed place of destination for the towage service.

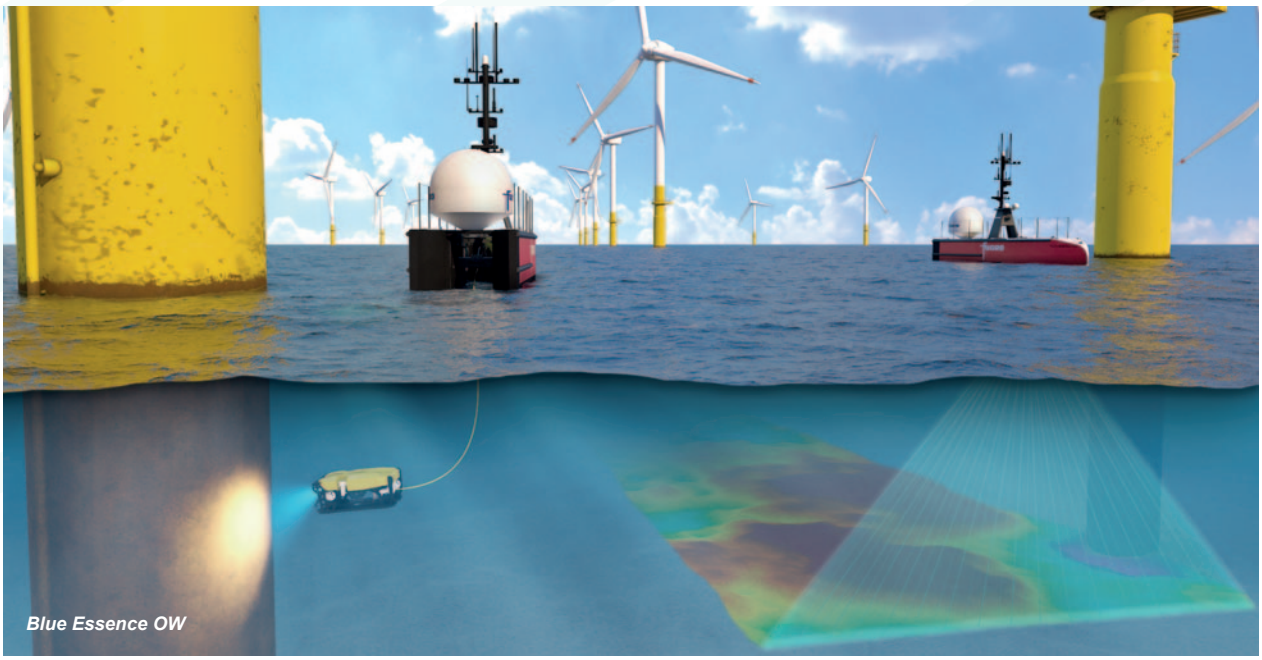


*MBES survey of the UK continental shelf acquired by SEA-KIT using their USV Maxlimer*

# 20 Glossary

| | |
|---|---|
| **AIS** | Automatic Identification System |
| **ALARP** | As Low As Reasonably Practical |
| **AUV** | Autonomous Underwater Vehicle |
| **BIT** | Built In Test |
| **BITE** | Built In Test Equipment |
| **BSI** | British Standards Institution |
| **CA** | Certifying Authorities |
| **CAS** | Crewless Air System |
| **CCNR** | Central Committee for the Navigation for the Rhone |
| **CEN** | European Committee for Standardisation |
| **COG** | ourse over Ground |
| **COLREG** | International Regulations for Preventing Collisions at Sea 1972, as amended (IMO) |
| **CSO** | Company Security Officer |
| **DGNSS** | Differential Global Navigation System Satellite |
| **EGNOS** | European Geostationary Navigation Overlay Service |
| **EMC** | Electro-Magnetic Compatibility |
| **FMEA** | Failure Mode Effects Analysis |
| **FMECA** | Failure Mode Effects and Criticality Analysis |
| **GMDSS** | Global Maritime Distress & Safety System |
| **GNSS** | Global Navigation Satellite System |
| **GPS** | Global Positioning System |
| **GUI** | Graphical User Interface |
| **HAZOP** | HAzard and OPerability Analysis |
| **IACS** | International Association of Classification Societies |
| **IMCA** | International Marine Contractors Association |
| **IMDG** | International Maritime Dangerous Goods Code |
| **IMO** | International Maritime Organization |
| **ISM** | International Safety Management Code (IMO) |
| **ISO** | International Organisation for Standardisation |
| **ISPS** | International Ship & Port Facility Security Code (IMO) |
| **ITC** | Inland Transport Committee (UNECE) |
| **IWT** | Inland Water Transport (UNECE) |
| **LEP** | Local Enterprise Partnership |
| **LoC** | Level of Control |
| **LoS** | Line of Sight |
| **MARPOL** | International Convention for the Prevention of Pollution from Ships 1973/78, as amended (IMO) |
| **MAS** | Maritime Autonomous Systems |
| **MASS** | Maritime Autonomous Surface Ship |
| **MCA** | The UK Maritime & Coastguard Agency |
| **MGN** | Marine Guidance Note |

| | |
|---|---|
| **MGO** | Marine Gas Oil |
| **MIA** | Marine Industries Alliance |
| **MMS** | Maintenance Management System |
| **MNTB** | Merchant Navy Training Board |
| **MPA** | Marine Protected Areas |
| **MSC** | Maritime Safety Committee (IMO) |
| **MSN** | Merchant Shipping Note |
| **MSO** | MASS Security Officer |
| **OEM** | Original Equipment Manufacturer |
| **RCC** | Remote Control Centre |
| **RFOC** | Reasonably Foreseeable Operating Conditions |
| **RO** | Recognised Organisation |
| **RoT** | Rate of Turn |
| **ROV** | Remotely operated vehicle |
| **RYA** | Royal Yachting Association |
| **SARUMS** | Safety and Regulations for European Crewless Maritime Systems (European Defence Agency project) |
| **SDS** | Safety Data Sheet |
| **SMS** | Safety Management System |
| **SoG** | Speed over Ground |
| **SOLAS** | Safety of Life at Sea 1974, as amended (IMO) |
| **SQEP** | Suitably Qualified and Experienced Personnel |
| **STCW** | Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended (IMO) |
| **STW** | Speed Through the Water |
| **UA** | Uncrewed Aircraft |
| **UAS** | Uncrewed Air System |
| **UMS** | Uncrewed System |
| **UNCLOS** | United Nations Convention on the Law of the Sea, 1982 |
| **UNECE** | United Nations Economic Commission for Europe |
| **USV** | Crewless Surface Vessel |
| **WIN** | Watercraft Identification Number |



*Blue Essence OW*

# Notes


Published by Maritime UK


Sponsored by BAE Systems