Maritime UK
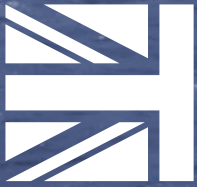
BEING A RESPONSIBLE INDUSTRY

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

A Voluntary Code
Version 7
November 2023

**Maritime
UK**

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

Supporting over 1.1 million jobs and contributing £116 billion to the UK economy every year, maritime is responsible for facilitating 95% of UK global trade, worth over £500bn per year. The UK maritime workforce is 45% more productive than the average UK worker, and maritime careers pay on average 30% more than the UK benchmark.

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, Connected Places Catapult, Institute of Chartered Shipbrokers, Isle of Man Maritime, Maritime London, Maritime UK South West, Mersey Maritime, Nautilus International, Port Skills and Safety, Shipping Innovation, Society of Maritime Industries, Solent LEP, The Baltic Exchange, The Seafarers' Charity, The Workboat Association, Trinity House, UK Chamber of Shipping and the UK Major Ports Group.

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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) was adopted by the Maritime Safety Committee (MSC) of the International Maritime Organisation (IMO) for their Regulatory scoping exercise (RSE) which completed at MSC 103 on the 14th May 2021. The outcome of the RSE is at MSC.1/Circ.1638 dated 3 June 2021. The scoping exercise undertaken by the Legal Committee (LEG) was completed in July 2021 and the Facilitation Committee of International Maritime Traffic (FAL) is expected to complete their work in 2021 with the further engagement from the Marine Environmental Protection Committee (MEPC). Information concerning their output is available through IMODOCS. The IMO Maritime Safety Committee (MSC) is drafting a MASS Code to address the functions needed to obtain safe and reliable operation of MASS where they are not addressed in other IMO instruments. The IMO plans to make this code non-mandatory in 2025, and mandatory in 2028.

1.3   The UK MCA revised and published MGN 664 (M+F) Amendment 1: Certification process for vessels using innovative technology in September 2023, and the Workboat Code Edition 3 with an annex on Remotely Operated Unmanned Vessels is due for publication in 2023.

1.4   Version 7 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, and Part 2 is the Code of Practice.

1.5   This Code seeks to provide practical guidance for the design, construction and safe operation of autonomous and semi-autonomous MASS, primarily less than 24m, while the more detailed regulatory framework for MASS is developed under the Merchant Shipping Act 1995.

1.6   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 Unmanned 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 IMO is published, and as the MCA develops policies to meet the needs of forthcoming technological, commercial and regulatory developments. These will include the Merchant Shipping (Small Workboats and Pilot Boats) Regulations 2023 and accompanying Code ("Workboat Code Edition 3") and MGN 664 (M+F) - Certification process for vessels using innovative technology.

1.7   The primary aim in developing the Code has been to establish standards and best practice for those who design, build, manufacture (including testing and commissioning), own, operate and control MASS, primarily of less than 24 metres in length. It will also establish some principles and guidance which will be applicable for those operating larger MASS.

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

1.9 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).

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

1.11 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).

1.12 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.

1.13 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

1.14 Compliance with the guidelines in 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.

1.15 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 also 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.

1.16 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 Owner/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.

1.17 When new standards are developed and finalised by the British Standards Institution (BSI), European Committee for Standardisation (CEN), International Maritime Organisation (IMO), International Organisation 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.

1.18 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.*

1.19   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
- Blue Yonder
- BMT Group
- Birch Reynardson & Co
- British Marine
- British Ports Association
- 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)
- Intrepid Hydrographic Ltd
- Irish Lights
- Knowledge Transfer Network
- L3HARRIS
- Lloyds Register
- 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 Maritime
- Seebyte
- Seiche
- Setfords
- Sonardyne International Ltd
- Stehr Consulting
- 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 School – Solent University
- Zulu Associates bv
- 3SpheresUK

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.

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.

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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.

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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 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.**

PART 2
UK CODE OF PRACTICE

Terms and Terminology

In this Code the following terms and terminologies have been established for the sake of clarity, taking into account ISO 23860:2022 – ships and marine technology – vocabulary related to autonomous ship systems. 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 Organisation for their Regulatory Scoping Exercise.

Table 1-2: Degrees of Autonomy (IMO)	
1	**Ship with automated processes and decision support.** 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.** 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.** The ship is controlled and operated from another location. There are no seafarers on board.
4	**Fully autonomous ship.** 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. In the UK, the associated regulations remain in force under the Recreational Craft Regulations 2017 for Great Britain and separately for Northern Ireland. 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).

"Maritime Autonomous Systems (MAS)" general term is used to refer to systems of a remotely operated, semi-autonomous, or autonomous nature.

"MoD Maritime Levels of Automation" – the following Levels of Automation are proposed by the Royal Navy to categorise maritime air, surface and underwater automated systems, whilst allowing the manning state to be decoupled from the complexity of automation in use. The Automation State and Oversight Condition are specified in tandem to describe the current system state (e.g. Automation Level 4D).

Table 1-5: MoD Maritime Levels of Automation			
Automation State	**Description**	**Oversight Condition**	**Description**
1 – None	There is no automation in use. All activity is under the direct control of an operator. MAS will generally not fall into this category, but the operator may decide to revert to this state when in Oversight Condition B or C, such as for safety or tactical reasons.	**A – On-board control**	The MAS is controlled by onboard operators.
2 – Follow tasks (directed)	The MAS employs rudimentary automation which is not "self-directed", but instead requires operator command and control. This includes basic activity such as maintaining a course or following a track, with little or no regard to the operating environment.	**B – Off-board, Close Control**	**Close Control:** A form of Mission Control in which the MAS is continuously controlled, for example in speed and heading, in order for the mission to be accomplished. Supervision by the operator is continuous in this Oversight Condition.
3 – Seek goals (delegated)	The MAS conducts largely pre-programmed missions, employing automation to seek defined goals, for example: surveying an area, intercepting a target, or safely navigating to a location.	**C – Off-board, Loose Control**	**Loose Control:** A form of Mission Control in which the MAS determines its own actions, e.g. speed, heading and the appropriate tactics required to accomplish the assigned task. Supervision may be intermittent in this Oversight Condition, and one operator may supervise multiple systems.
4 – Plan, execute and exploit (autonomous)	The MAS can sense the environment, identify possible activity, decide and act in order to achieve the operator's specified intent. Depending on the capabilities of the system, the MAS can also determine follow-on actions without recourse to the operator in order to exploit the situation, such as shadowing and reporting a located vessel of interest or conducting clearance of detected mine-like objects.	**D – None**	The MAS is operating without operator supervision.

"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.

"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.

"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 organisations recognised by it. In the UK, for vessels under 24m load line length, these organisations include MCA approved Classification Societies and Certifying Authorities. 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.

"Unmanned" – An unmanned ship is a ship with no humans onboard.

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	Hull Length <7m	*Derived from MCA High-Speed Craft Code (https://assets.publishing. service.gov.uk/government/ uploads/system/uploads/ attachment_data/file/292155/hsc _2000_rev06-09_full- comp-all.pdf)
Light	Hull Length ≥ 7m to <13m	
Small	Hull Length ≥ 13m to Load Line Length <24m	
Large	Load Line Length ≥24m	where ∇ = moulded displacement, in m^3, of the craft corresponding to the design waterline.
High-Speed	Operating speed V is not less than V = 7.19 $\nabla^{1/6}$ knots	

2.1.4 For the purposes of this Code, these classes 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 exclusively 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 uncrewed 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, LOA and Load Line Length;*
- *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

Map produced by the UK Hydrographic Office

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 Maritime Future Technology Team, 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 When a MASS operator is planning to complete operations within designated areas where offshore structures are present, or are being constructed, it is expected the appropriate approval from the Offshore operator is sought from the Offshore Wind Farm Developer or Oil/Gas Installation Operator. As part of this operator approval of the mission, Risk assessment, emergency response plan and a communication plan will be required.

3.7.11 In general, all offshore structures have operational coordination. This will be through a Marine Co-ordination Centre (MCC) for Offshore wind, or Offshore Installation Manager (OIM) for Oil/Gas installations. The MASS operator must liaise with the appropriate coordinator to seek permission to access the work area and follow the Simultaneous Operations (SIMOPS) and entry protocols.

3.7.12 The documentation submitted by the owner/operator will be as appropriate for the intended operation and could include full formal safety assessments. As a minimum it should be to the standard expected by the relevant Health and Safety Executive.

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 Master Operating & Emergency contacts 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]
Include use of guard ship/support vessels employed or on immediate stand-by
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;
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].
[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 MASS Shoreside Interface Guidance

4.1 OBJECTIVE

> **The objective of this Chapter is to provide guidance on the requirements for those visiting or operating around Ports and other shore facilities, where services may be needed during MASS activities.**

4.2 SCOPE

4.2.1 The purpose of this Chapter is to summarise some of the key requirements when MASS are being operated in and around ports. It is not an exhaustive list and does not cover all aspects but sets the initial points for consideration.

4.3 LIFTING AND LAUNCHING

4.3.1 Consideration should be given to the following when mobilising the MASS from shore to sea:

- *Are you going to offload the risks of moving/launching the MASS to a 3rd party or are you going to do it yourself? Generally it is appropriate to offload to a 3rd party as you will not be able self-launch in a Port or Marina unless you have in advance agreed the procedures, risk assessments and liability.*

- *Are all lifting arrangements (slings/strops etc) in date for test and certificates available? Your vessels lifting arrangements need to be in date. So review the shackles, lifting eyes and anything else a 3rd party will be connecting to. You may have to present certificates to the 3rd party. If you are attending the lift and launch ensure that you have discussed with the 3rd party what PPE you need and the demarcation of responsibilities has been agreed.*

- *Has the date of launching been considered well in advance and discussed with all involved. From experience post Covid and during holiday periods, a number of Port's and Boatyards in the South have long waiting times to launch/lift vessels. Ensure you plan ahead.*

- *Have Pre and Post launch checklists to ensure that all critical equipment and systems are checked off. All underwater fittings are listed and seacocks are shut.*

- *Contact your local boatyard and set up a meeting to go through the process before the launch/lift date. This clarifies points of detail and ensures that all are prepared.*

- *Prior to the launch hold a short brief to detail your team on the post launch checks, discuss how long you need with the boatyard team to hold the vessel in the slings at water level and how your onboard team will be divided up and report back watertight status.*

- *Make sure you have a tool kit with the appropriate tools to tighten up and leak stop.*

- *Post launch, use your checklists to check for leaks prior to and post opening seacocks.*

4.4 BERTHING

4.4.1 There are a number of considerations when utilising berthing for your MASS.

- *Do you have permission to operate the MASS autonomously or remotely to/from the berth by the Port/Port operator, or in accessing the Port or Port berth, has the navigational authority allowed you to operate the vessel to make passage to the berth?*

- *If not, then a towing service from the point of cessation of autonomous/remote operating will need to be arranged.*

4.5 SERVICES

4.5.1 Consider the services you need at or near the berth:

- *Locks or Sills: Check with the Port operator on the restricted movement times. Some Ports have a Lock In/Lock Out arrangement where a "Full Flood" gives unrestricted lock access or there are operation times in place. Some Ports have a tidal Sill (Cill) that will restrict your entry or exit at certain tide times.*

- *Shore Power: Voltage and Current. Do you know what you need? Do you have a suitable Port shore cable connection? Bring your own shore cable as the Port won't provide.*

- *Payment for shore power. Check with the Port on the connecting and disconnecting procedure and when/what you will be charged. This can be provisioned by a pre-payment card or when you depart on your final day.*

- *Fresh Water: To top up cooling systems, ballast systems or to give that fresh water washdown. In the majority of Port's on the South Coast and increasingly elsewhere, freshwater is provided at a tap, but a hose isn't. Bring your own hose with you.*

- *Fuel: Generally taken on first entering or prior to departing the Port. Check that the fuelling point has a spill kit. However, it is good practice for the MASS team to carry their own spill kit in any case. Diesel is available at the majority of Ports, but petrol is less likely. If you have a petrol driven MASS, choose your location with that in mind.*

4.6 LOCAL UK PERMISSIONS

4.6.1 There are a number of permissions required by Navigational Authorities to allow MASS to operate. Whereas traditionally, manned vessels can refer to an Almanac, or other publications to scrutinise what is required for a Port or Port visit, or to operate in a sea area, at the moment there is not very much information for MASS visiting Ports. It is advisable to check in the latest version of the Almanac or Port Guides for general maritime information anyway, but MASS guidance is scarce. Currently Harbourmasters issue local and time expired guidance through Local Notice to Mariners (LNTM's) or similar.

4.6.2   There are in the South Coast areas LNTM's issued by KHM Portsmouth, VTS Southampton and KHM Plymouth about the notice and documentation required to allow operation. These are as follows:

■   *KHM Portsmouth has issued LNTM17/22 which defines a notice period and documentation requirements to undertake autonomous vessel operations in the dockyard port of Portsmouth. There are no designated MASS operating areas in the Solent. Operators are to file a plan 14 days prior to the operation for approval by KHM. Trials Plans, Risk Assessments, Method Statements and operating procedures are examples of what is to be forwarded*

■   *VTS Southampton has issued NTM 17/22 detailing the requirements for operating UUV's and ASV's in VTS's jurisdiction of Southampton Water. This gives the same notice period of 14 days to provide similar information to VTS as KHM Portsmouth. It also requires the qualifications of personnel operating the AUV/MASS and who is considered the "Master" of the AUV/MASS*

■   *KHM Plymouth. There are 2 designated MASS operating areas in Plymouth, namely Cawsand Bay and South of the Breakwater. KHM Plymouth has issued LNTM 020/22 which illustrates these areas. No advance no-tice, nor documentation is required. If Autonomous Surface Vehicle activity is planned outside of the designated areas, operators are to liaise with KHM Plymouth*

4.7   COMMUNICATIONS

4.7.1   Line of Sight Control System Radios and other transmission devices: Licensing is required from OfCom to operate control system radios and other transmission devices. The current response time for the granting of licences is around 6-8 weeks, which can give scheduling challenges if these timescales are not planned in for your operation/trial. Ensure you apply in plenty of time.

4.7.2   VHF Communications: As with all coded manned power or sail vessels VHF communications are utilised on those MASS's that have a manned/unmanned capability and those that are unmanned should have a VHF capability on the support vessel. When planning operations you will need to advise the approving authority which vessel has the VHF station and which channels you will be monitoring. In some sea areas a number of channels will need monitoring and utilised for Tx/Rx (16, 11, 80 etc).

4.7.3   AIS: The MASS should be fitted with AIS to identify the vessel to other maritime users and port authorities. Generally, Class B is acceptable for the majority of MASS unless a particular use case determines Class A should be used.

4.7.4   Satellite Communications and over the horizon operation: See further details in Chapter 10.

4.8   DOCUMENTATION

4.8.1   Increasingly a number of Authorities are requesting documentation when approached by a MASS operator to authorise a trial. There are many variants depending on who requests the information. Examples of some that are in existence and requested (not exhaustive) are as follows:

■   *Vessel Design Specifications*
■   *Stability Book/Stability Curves*
■   *Class, Society or coding documentation*
■   *Qualifications and Commercial Endorsement of Operators*
■   *Contingent Liability Insurance*

- *Mini Trials Plans*
- *Complex Trials Plans*
- *Loadline Exemptions*
- *Shipping Register Status (SSR)*
- *Risk Assessments for the Operation that the vessel is about to undertake*
- *Standard Operating Procedures (SOP)*
- *Vessel Log Books*
- *User Manuals*
- *OfCom License*
- *Load Test Certification of lifting arrangements*

4.8.2 On initial engagement with a trial or operation authorisation agency, agree up front on the documentation required for the trial/demonstration or operation and build this into the delivery schedule to produce.

Remote Control Centre used for training

5 Cyber Security Considerations for MASS (Autonomous and Remotely Controlled)

5.1 OBJECTIVE

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

5.2 SCOPE

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

5.3 GENERAL

5.3.1 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.

5.3.2 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.

5.3.3 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.

5.3.4 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).

5.3.5 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 used to allow a computer to control a system or asset, such as a MASS vessel.

5.3.6 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.

5.3.7 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.

5.4 CYBERCRIME

5.4.1 Cybercrime is the unauthorised 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)*

5.4.2 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 unauthorised access to the system or location.

5.4.3 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.

5.5 CYBERCRIME IN THE UK

5.5.1 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.

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

5.6.1 Cybercrime is a very lucrative market and is estimated to be worth 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*

5.6.2 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.

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

5.6.4 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.

5.6.5 Cyber-crime is an unfortunate fact that we must live with. It is a very lucrative market estimated to be worth trillions 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.

5.6.6 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.*

5.7 CYBERCRIMINALS

5.7.1 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.*
- *Take control of a system or asset*
- *Access other people's accounts*
- *Conduct Industrial espionage*
- *Initiate Government instability prior to an overthrow*

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

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

5.7.3 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 to credentials*
- *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*

5.8 THREAT/ATTACK VECTORS

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

Figure 5-1 Typical threat/attack vectors *(Courtesy of Threat Vector Security)*

5.9 CYBER SECURITY

5.9.1 Cyber security is a process used to control and protect an organisation's computer systems, networks, and data from, and reduce the risk of, Cyberattack.

5.9.2 Cyber security's core function is to protect the 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.

5.9.3 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.
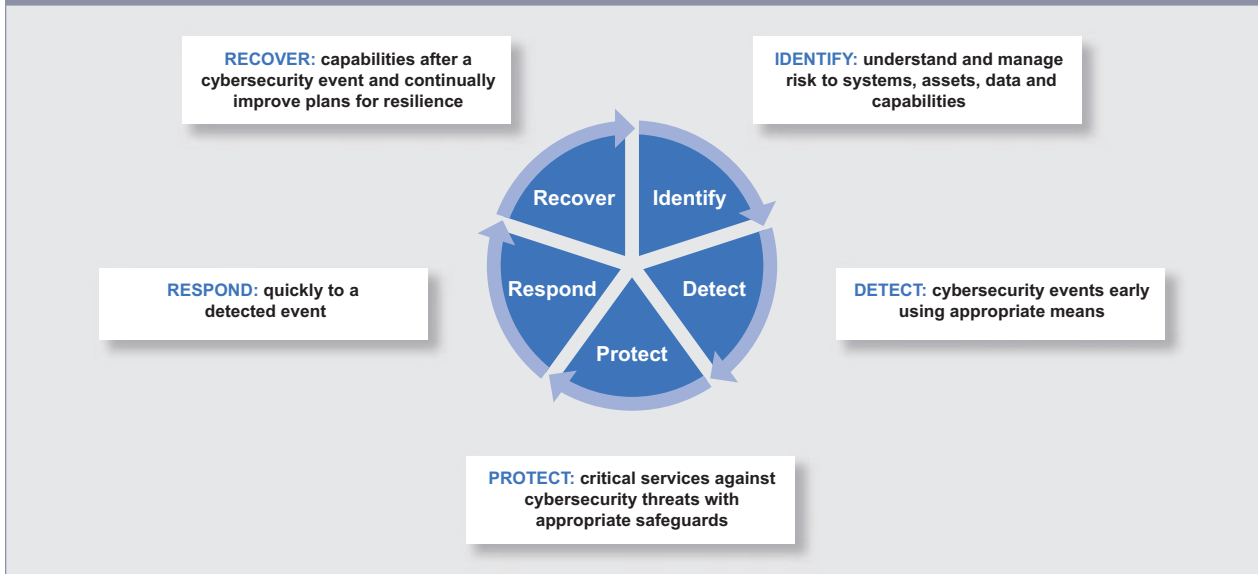
5.10 IT/OT CONVERGENCE

5.10.1 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.

5.11 THE DIFFERENCE BETWEEN IT AND OT

5.11.1 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).

5.11.2 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."

5.11.3 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."*

5.11.4 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.*

5.11.5 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 5-2 - Proactive model to ensure future protection *(Courtesy of the Athens Group)*

RECOVER: capabilities after a cybersecurity event and continually improve plans for resilience

IDENTIFY: understand and manage risk to systems, assets, data and capabilities

RESPOND: quickly to a detected event

DETECT: cybersecurity events early using appropriate means

PROTECT: critical services against cybersecurity threats with appropriate safeguards

Recover — Identify — Detect — Protect — Respond

5.11.6 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.

5.12 WHAT IS A ROBUST CYBER SECURITY SYSTEM?

5.12.1 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.*

5.12.2 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 5-1 following.

Table 5-1 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 5-1 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 5-1 Vessel

CREWED

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

5.13 CYBER SECURITY STANDARDS

5.13.1 Many organisations 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 organisations 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 organisational security.

5.13.2 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 Organisation 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.

5.13.3 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 organisation 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 categorised into 14 different categories. Some of the categories include information security policies containing two controls; information security organisation 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 organisation should use to manage the security of information systems. The ISO 27002 is designed for use alongside ISO 27001, and most organisations 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 organisations 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 organisations 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 Assurance

The IASME Cyber Assurance standard was developed over several years during a government funded project to create a cyber security standard which would be an affordable and achievable alternative to other international standards. It allows small and medium enterprises in a supply chain to demonstrate their level of cyber security for a realistic cost and indicates that they are taking good steps to properly protect their customers' information.

A wide range of UK and International industry sectors now accept the Level 2 audited IASME Cyber Assurance certification as an alternative to other international standards. Examples are the UK Ministry of Justice and the Government of Jersey. This is a significant step towards reducing barriers to entry for smaller organisations in a supply chain as IASME Cyber Assurance gives SMEs a legitimate way to prove their compliance.

The IASME Cyber Assurance certification includes GDPR requirements and is available in two levels: Level One Verified Assessment and Level Two Audited. There is a prerequisite to applying for IASME Cyber Assurance; you must hold a valid Cyber Essentials certificate throughout your IASME Cyber Assurance certification.

4. IASME Maritime Baseline Scheme

The Maritime Cyber Baseline scheme provides an affordable and practical way for vessel owners, operators, managers, and builders to improve the cyber security systems onboard their vessels and helps reduce the possibility of a cyber-attack occurring.

Maritime Cyber Baseline covers all vessel classifications and supports a path towards compliance within the IMO Maritime Cyber Risk Management guidelines.

The Maritime Cyber Baseline scheme is supported by the Royal Institution of Naval Architects..

https://iasme.co.uk/iasme-cyber-assurance/about-iasme-cyber-assurance-level-2/

5. SOC 2

The American Institute of Certified Public Accountants (AICPA) developed the SOC 2 framework. The framework purpose to enable organisations 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

6. 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 organisations. Most companies perceive the security requirements as best practices since the CIS has a credible reputation for developing baseline security programs. The framework categorises 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 organisations 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 organisations to create budget-friendly cyber security programs. It also allows them to prioritise cyber security efforts.

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

7. NIST 800-53

NIST created NIST 800-53 publication for enabling federal agencies to realise 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 organisations 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 organisations to implement. The requirements recommended in the framework include controls for enhancing physical security, penetration testing, guidelines for implementing security assessments and authorisation policies or procedures, among others. NIST 800-53 is a useful framework for organisations maintaining federal information systems, companies with systems that interact with federal information systems, or institutions seeking FISMA compliance.

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

8. 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

9. COSO

COSO (Committee of Sponsoring Organisations) is a framework that allows organisations 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 categorised 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 organisational 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 organisation. The framework further allows for continuous monitoring of security events to permit prompt responses.

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

10. 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 organisations. It focuses on ensuring that organisations 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

11. 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 organisations 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/

12. 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/

13. 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 recognises 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 organisational cyber security. As such, the framework uses broad descriptions but with lesser technicalities to explain the various cyber risks, defences, 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.

14. FedRAMP

FedRAMP (Federal Risk and Authorisation Management Program) is a framework designed for government agencies. The framework provides standardised 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 authorisations 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/

15. HIPAA

HIPAA (Health Insurance Portability and Accountability Act) contains various guidelines for enabling organisations to implement sufficient controls for securing employee or customer health information. HIPAA standards also require healthcare organisations to comply since they collect and store health information for all patients. The standards comprise of different security requirements that need organisations 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

16. 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 organisations 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 unauthorised access to stored data. These are access control measures such as least privilege and role-based access controls, and multi-factor authentication schemes. Organisations 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/

17. 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:

- *Categorising 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*
- *Authorise the use of secure information systems*
- *Continuous monitoring of implemented controls.*

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

18. 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 organisations and the third parties they interact with for different businesses. Among others, NY DFS requires organisations 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, organisations covered by the NY DFS must implement systems for detecting cyber security events.

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

19. 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 organisation 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

20. SCAP

SCAP (Security Content Automation Protocol), is a regulation standard containing security specifications for standardising the communication of security products and tools. The specifications aim is to standardise the processes through which security software programs communicate security issues, configuration information, and vulnerabilities. Through the standardised specifications, SCAP intends to enable a company to measure, express, and organise security data using universal criteria and formats. As such, the security software can allow a business to maintain enterprise security by utilising 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/

21. 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 organisations 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/

22. NIST SP 800-12

This framework provides an overview of control and computer security within an organisation. Also, NIST SP 800-12 focuses on the different security controls an organisation can implement to achieve a strengthened cyber security defence. Although most of the control and security requirements were designed for federal and governmental agencies, they are highly applicable to private organisations 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

23. NIST SP 800-14

NIST SP 800-14 is a unique publication that provides detailed descriptions of commonly used security principles. The publication enables organisations 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

24. 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 realise 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 organisations 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

5.14 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.

6 Safety Management

6.1 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.**

6.2 SCOPE

6.2.1 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.

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

6.3 GENERAL

6.3.1 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.*

6.3.2 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 Organisation, administrations (e.g. The MCA), Classification Societies (e.g. Lloyds Register) and maritime industry organisations are taken into account..*

6.3.3 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..*

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

6.4 SAFETY AND ENVIRONMENTAL PROTECTION POLICY

6.4.1 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.

6.4.2 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.

6.4.3 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."*

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

6.5 OPERATOR RESPONSIBILITIES AND AUTHORITY DOCUMENTATION

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

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

6.5.3 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.

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

6.5.5 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.

6.5.6 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.*

6.5.7 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.

6.5.8 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.

6.6 GENERAL HEALTH & SAFETY PROTECTION POLICY

6.6.1 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.

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

6.6.3 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.

6.7 SAFETY CULTURE

6.7.1 Safety culture refers to how safety is addressed and communicated in the workplace. It encompasses the attitudes, beliefs, perceptions, and values of all employees in an organisation in relation to safety.

6.7.2 In this regard, operators are encouraged to create a positive safety culture – where all employees actively participate in health and safety. New employees are likely to adopt safe ways of working, and existing employees will require less supervision longer term.

6.7.3 Some ways of adopting a positive safety culture include:

■ *Involve workers in health and safety discussions, risk assessments, reviews etc.;*

■ *Train, motivate and encourage;*

■ *Praise rather than criticise;*

■ *Celebrate success rather than focus on failures;*

■ *Build trust and create a sense of community amongst colleagues;*

■ *Listen and encourage open communication;*

■ *The use of neutral assessment for safety investigations – Just Culture;*

■ *Proactive safety reporting to inform organisational and individual behaviours.*

6.8 ISM CODE CERTIFICATION

6.8.1 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.*

6.8.2 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.

6.9 RISK ASSESSMENT

6.9.1 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.

6.9.2 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.*

6.9.3 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.

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

6.9.5 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.

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

6.9.7 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).

6.10 PROCEDURES TO ENSURE SAFE OPERATION OF MASS

6.10.1 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.*

6.10.2 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.

6.10.3 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.

6.10.4 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.*

6.10.5 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.*

6.11 CREWING REQUIREMENTS FOR LARGER SHIPS WHEN PILOTAGE IS REQUIRED

6.11.1 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.

6.11.2 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.

Figure 6-1 - Pilot Card

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

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

6.12 LINES OF COMMUNICATION BETWEEN PERSONNEL, ASHORE AND AFLOAT

6.12.1 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.

6.12.2 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.

6.13 PROCEDURES FOR REPORTING ACCIDENTS

6.13.1 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. More detail about these requirements is at chapter 16.

6.13.2 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.

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

6.13.4 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.

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

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

6.14 PROCEDURES FOR RESPONDING TO EMERGENCY SITUATIONS

6.14.1 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 from or 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.

6.14.2 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).*

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

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

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

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

6.14.7 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.

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

6.15 PERSONNEL AND TRAINING

6.15.1 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).

6.15.2 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.*

6.15.3 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.

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

6.15.5 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.

6.15.6 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.*

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

6.16 MAINTENANCE OF THE MASS AND EQUIPMENT

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

6.16.2 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.

6.16.3 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.*

6.16.4 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.

6.16.5 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.

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

6.16.7 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.

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

6.17 REVIEW

6.17.1 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.

6.17.2 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.*

6.18 MASS VESSEL DATA RECORDING (VDR)

6.18.1 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.

6.18.2 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.

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

6.18.4 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.

6.18.5 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.*

ANNEX A TO CHAPTER 6 – 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*

7 | Automation on Inland Waterways

> **The objective of this Chapter is to summarise the current position 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.**

7.1 SUMMARY

7.1.1 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 Standardisation 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.

7.1.2 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:

- *Organise 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 harmonisation of the legal framework for international IWT*

7.1.3 Automation on inland waterways and smart shipping have been introduced in the agenda of SC.3 and SC.3/WP.3 since February 2018, following the request of its member States that work actively in this sphere. In 2023, both Working Parties continued discussion on the definitions for automation and smart shipping based on the definition of automation levels in inland navigation edition 2022 adopted by the Central Commission for the Navigation of the Rhine (CCNR) and the terms proposed for smart shipping and the relevant terminology from the "Maritime Autonomous Surface Ships UK Industry Conduct Principles and Code of Practice". SC.3 at its sixty-seventh session in October 2023 considered it desirable to prepare a resolution on this issue to ensure consistency of the terminology at the pan-European level.

7.1.4 At its eighty-third session in February 2021, ITC adopted the updated Intelligent Transport Systems (ITS) Road Map for the period 2021–2025. The updated Road Map included automation in inland navigation, in particular, preparations for the deployment of automated inland navigation in the national capacity building support provided by the ECE secretariat to assist member States and the dissemination of information and awareness raising on automation in inland navigation and related issue.

7.1.5 In 2023, both Working Parties continued discussion on harmonizing the ECE legal framework and policy areas for fostering innovations in inland navigation, in particular, policy areas and proposals for evaluation of international conventions and ECE resolutions to identify gaps, challenges and bottlenecks that hamper the development of automated navigation. This includes, first of all, the European Code for Inland Waterways. The core rules are applicable to the traffic on all inland waterways in the UNECE region.

7.2 INTERNATIONAL DEFINITION OF AUTOMATION LEVELS IN INLAND NAVIGATION

7.2.1 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.

7.2.2 After two years, the CCNR found that the international definition of levels of automation in inland navigation is widely used by pilot projects in inland navigation, national authorities and international institutions, such as UNECE or the Permanent International Association of Navigation Congresses (PIANC). In this context, during its plenary session in autumn 2021, the CCNR decided to extend the period of validity of the definition of automation levels in inland navigation until 31 December 2022 (Resolution 2020-II-20). From the experience gained with various research and development projects and pilot projects already carried out, it was also recognised that there is a need to review the current definition of levels of automation in inland navigation, as some pilot projects have difficulties in giving a single level of automation for a project. Often, it is rather a combination of levels that is more appropriate.

7.2.3 At its plenary session in December 2022, CCNR adopted the international definition of levels of automation in inland navigation edition 2022 by its resolution 2022-II-17, that was transmitted to the UNECE secretariat (ECE/TRANS/SC.3/WP.3/2023/15). The 2022 edition also includes an explanatory note* to provide additional information. Compared to the international definition of levels of automation in inland navigation published in 2018, the changes made are rather minor adjustments. The number of levels of automation remains unchanged. Some terms used are clarified. In addition, the role of the boatmaster is better taken into account; it is now also listed in the context of monitoring and responding to the navigational environment in automation level 3. Finally, the subject of remote control has been removed from the definition of levels of automation. Remote control is not in itself automation, but there is an important link to the levels of automation. For example, it may not be possible to use remote control safely on every type of craft if there are insufficient fallback performance systems, should the connection between the craft and the landside fail. Further clarification on remote control and its relation to automation is provided in the explanatory note. Also, the examples originally added to the definition are now included in the explanatory note. *https://www.ccr-zkr.org/files/documents/AutomatisationNav/Note_explicative_en.pdf

7.2.4 In February 2023, CCNR established the authorisation procedure for a pilot project for automated navigation on the Rhine.

7.2.5 The definition of automation levels in inland navigation edition 2022 is given below. For this purpose, the following terms and preliminary definitions are applied:

- *"Level of automation" is understood as the level in which an automated craft may be operated during its voyage. Depending on the context, an automated craft may achieve different levels of automation*
- *"Navigation" is understood as all tasks (like planning, steering, controlling, manoeuvring etc.) taken to direct a craft in a waterway from one place to another.*
- *"Dynamic navigation tasks" are understood as the set of navigational craft operations, such as operation of rudder apparatus, propulsion, anchor winches or elevating wheelhouse. The complexity of these tasks is dependent upon the context considered (for example, the mooring of the craft can be excluded from a context).*
- *"Context-specific" is understood as confined navigational conditions such as navigation on specific river waterway sections or lock crossing, as well as craft arrangements with convoys or platooning. The context includes infrastructure relevant for automated navigation, for example type and capacity of radio transmission networks. The context also includes the influence of natural conditions like current or weather or limitations due to the infrastructure like water level or bridge clearance.*
- *"Navigational environment" is understood as fixed and dynamic conditions such as the waterways' shape, water level, weather, visibility, craft crossing, etc. The navigation automation system can use only part of the information available on the navigational environment (for example, under level 1, rate-of-turn indicators do*

not use information on craft crossing). The response to the navigational environment includes the radiocommunication with boatmasters of other craft.

- **Collision avoidance"** is the critical task in responding to the environmental conditions (other crafts, bridges, etc.).
- For the purposes of this definition of levels of automation, the word **"boatmaster"** has to be understood as a human boatmaster.

	Level of automation [1]	Designation	Vessel command (manoeuvring, propulsion, wheelhouse, ...)	Monitoring and reacting to the navigational environment	Fallback performance of dynamic navigation tasks
The boatmaster performs some or all of the dynamic navigation tasks	0	**No automation** The full-time performance by the boatmaster of all aspects of the dynamic navigation tasks, even when supported by warning or intervention systems	👤	👤	👤
	1	**Steering assistance** The context-specific performance by a steering automation system using certain information about the navigational environment and with the expectation that the boatmaster performs all remaining aspects of the dynamic navigation tasks	🚢👤	👤	👤
	2	**Partial automation** 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 boatmaster performs all remaining aspects of the dynamic navigation tasks	🚢👤	🚢👤	👤
The system performs all dynamic navigation tasks	3	**Conditional automation** The sustained context-specific performance by a navigation automation system of all dynamic navigation tasks, including collision avoidance, with the expectation that the boatmaster will be receptive to requests to intervene and to system failures and will respond appropriately	🚢	🚢👤	🚢👤
	4	**High automation** The sustained context-specific performance and fallback performance by a navigation automation system of all dynamic navigation tasks, without expecting a boatmaster responding to a request to intervene [2]	🚢	🚢	🚢
	5	**Autonomous = Full automation** The sustained and unconditional performance and fallback performance by a navigation automation system of all dynamic navigation tasks, without expecting a boatmaster responding to a request to intervene	🚢	🚢	🚢

1 Different levels of automation may make use of remote control but different conditions to be defined by competent authorities might apply in order to ensure an equivalent level of safety.

2 This level introduces two different functionalities: the ability of "normal" operation without expecting human intervention and the exhaustive fallback performance. Two sub-levels could be envisaged.

8 Ship Design and Manufacturing Standards for MASS

8.1 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.**

8.2 SCOPE

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

8.2.2 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.

8.2.3 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.*

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

8.3 SELECTION OF DESIGN BUILD AND SURVEY REQUIREMENTS

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

8.3.2 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 Unmanned 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.*

8.3.3 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).

8.3.4 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).*

8.3.5 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. In the UK, the justification for departure from the manned standard has to be made to the Maritime Administration (MCA); the selected RO or CA can assist with this.

8.4   STRUCTURE

8.4.1 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.

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

8.5   STABILITY

8.5.1 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.

8.6   PROPULSION AND MANOEUVRING

8.6.1 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.

8.6.2 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.

8.7 ELECTRICAL SYSTEMS

8.7.1 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.

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

8.7.3 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.

8.8 FIRE SAFETY

8.8.1 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.

8.9 AUXILIARY SYSTEMS

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

8.9.2 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.

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

8.9.4 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).

8.10 SOFTWARE INTEGRITY

8.10.1 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.*

8.10.2 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.

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

8.10.4 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.*

8.10.5 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.

8.10.6 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.

8.10.7 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.

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

8.10.9 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.

8.11 IN-SERVICE REQUIREMENTS

8.11.1 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.

8.11.2 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.*

8.11.3 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.
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8.12 SAFETY STANDARDS

8.12.1 There are a number of functional safety standards that should be considered for adoption when providing remote or autonomous systems using electrical, electronic or software based solutions. These include ISO 26262 from the automotive sector and IEC 61508, which detail how to establish the safety integrity level (SIL) for functions critical to safety in the system and the specification, design, implementation and testing processes that should be followed to ensure the required integrity is met.

8.12.2 IEC 61508 is an international standard published by the International Electrotechnical Commission consisting of methods on how to apply, design, deploy and maintain automatic protection systems called safety-related systems. It is titled Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems (E/E/PE, or E/E/PES).

8.12.3 IEC 61508 is a basic functional safety standard applicable to all industries. It defines functional safety as: "part of the overall safety relating to the EUC (Equipment Under Control) and the EUC control system which depends on the correct functioning of the E/E/PE safety-related systems, other technology safety-related systems and external risk reduction facilities." The fundamental concept is that any safety-related system must work correctly or fail in a predictable (safe) way.

8.12.4 The standard has two fundamental principles:

- *An engineering process called the safety life cycle is defined based on best practices in order to discover and eliminate design errors and omissions*
- *A probabilistic failure approach to account for the safety impact of device failures*

8.12.5 Zero risk can never be reached, only probabilities can be reduced.

8.12.6 Non-tolerable risks must be reduced (ALARP).

8.12.7 Optimal, cost effective safety is achieved when addressed in the entire safety lifecycle.

8.12.8 Specific techniques ensure that mistakes and errors are avoided across the entire life-cycle. Errors introduced anywhere from the initial concept, risk analysis, specification, design, installation, maintenance and through to disposal could undermine even the most reliable protection. IEC 61508 specifies techniques that should be used for each phase of the life-cycle. The seven parts of the first edition of IEC 61508 were published in 1998 and 2000. The second edition was published in 2010.

8.13 MASS DISPOSAL

8.13.1 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.

8.13.2 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..*

8.13.3 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.*

8.13.4 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). For a UK Registered MASS, the sale must be accompanied by an MCA Bill of Sale document, or similar for overseas nations.

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

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

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

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

8.13.9 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

9 Navigation Lights, Shapes and Sound Signals

9.1 OBJECTIVE

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

9.2 SCOPE

9.2.1 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.

9.3 LIGHTS, SIGNALS & SHAPES

9.3.1 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.

9.3.2 Table 9-1 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 9.3.1 for all operations not covered.

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

Table 9-1: 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 *OR* a masthead light, 2 miles; a sidelight, 1 mile; a stern light, 2 miles; a towing light, 2 miles a white, red, green or yellow all-round light, 2 miles. *OR* (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; a sidelight, 2 miles; a stern light, 2 miles; a towing light, 2 miles; 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)
≥50m	a masthead light, 6 miles; a sidelight, 3 miles; a stern light, 3 miles; a towing light, 3 miles; 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.

9.4   SOUND SIGNALS

9.4.1   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.

9.4.2   Table 9-2 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 9.1 for all operations not covered.

Table 9-2: 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

10 | Situational Awareness and Control

10.1 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.**

10.2 SCOPE

10.2.1 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.

10.3 FUNCTIONAL OBJECTIVES

10.3.1 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.

10.3.2 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.

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

10.3.4 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.

10.3.5 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.*

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

10.3.7 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.

10.4 RISK ASSESSMENT

10.4.1 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.*

10.4.2 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.*

10.4.3 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.

10.4.4 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.*

10.4.5 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).

10.4.6 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).

10.4.7 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.

10.5 SITUATIONAL AWARENESS SENSORS

10.5.1 Most of the sensors considered in Paragraphs 10.6 and 10.7 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.

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

10.6 INTERNAL SENSORS (PLATFORM MONITORING)

10.6.1 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.

10.6.2 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.*

10.6.3 The level at which these may be considered essential depends on the type of MASS and operational conditions, as indicated in Table 10.1 below. The need should be driven by the necessity to reach equivalent safety levels for all MASS with their manned counterparts.

Table 10-1: 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

10.6.4 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.

10.7 EXTERNAL SENSORS AND SOURCES OF DATA

10.7.1 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.*

10.7.2 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.

10.7.3 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.

10.7.4 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.

10.7.5 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.

10.8 NAVIGATION PRODUCTS & DATA

10.8.1 During the planning phase of MASS operations, including testing and trials of MASS, official and up to date navigation products, services or data (i.e. issued by or on the authority of a Government or authorised Hydrographic Office) should be used for the intended voyage or area of operation. This will demonstrate responsible use of the shared water space, best practice situational awareness and is in line with the International Convention for the Safety of Life at Sea (SOLAS) Chapter V – Safety of navigation. These official navigation products should include, but are not limited to, paper and/or electronic nautical charts and data, paper and/or nautical publications including radio signals, lists of lights and sailing directions, paper or digital applications for

tide tables and atlases, and the latest Notices to Mariners. These can be obtained from an ADMIRALTY Distributor.

10.8.2 During the execution and monitoring of MASS voyages, including testing and trials of MASS, it is again advised that official navigation products, services and data should be used, including Notices to Mariners and other bulletins. As outlined in Para 10.7.1, ADMIRALTY Distributors can supply these products. However, it is recognised that these products are intended for humans to use whilst on board navigating a vessel and as such may not offer the optimum solution for autonomous navigation systems. To that end the UK Hydrographic Office is making richer data sets available that can be used within the MASS navigation system during execution and monitoring of MASS operations. These data sets include:

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

10.8.3 Furthermore, the UK Hydrographic Office is working on the International Hydrographic Organisation's (IHO) next generation of navigation products and standards, collectively known as the S-100 standards. These new standards will begin to replace the ENC data standard (S-57) and will introduce new standards for navigation data sets such as gridded bathymetry and tidal data. These standards are still under development. However, in the future they will become the IMO mandated standards in manned shipping and are therefore likely to be endorsed for unmanned shipping. Sample data sets for trial purposes can be downloaded from the UKHO's ADMIRALTY website **https://discover.admiralty.co.uk/access-data/s-100**.

10.9   RESILIENCE OF POSITION FINDING

10.9.1 A navigation system must be able to provide continuity of service; that is the determination of a vessel's position, to an acceptable level of accuracy in all circumstances which may be encountered during the vessel's intended operations.

10.9.2 Resilience should be delivered through the selection of sources of positional information which offer independent Primary, Tertiary and Backup sources of position. It should be accepted that a drop off in accuracy may be inevitable with the loss of higher tier sources of position, however the three tiers of position finding should enable the vessel to be safely navigated throughout the voyage in the event of disruption to two of the minimum three sources of positional information. It is prudent to consider the Primary and Tertiary sources in the context of maximising accuracy, while a Backup source should be that which provides the greatest resilience when used with the appropriate navigation techniques and processes.

10.9.3 By examining the sources and applicable navigation techniques and processes available during each of the stages of the vessels intended operations it should be possible to identify the most appropriate Primary, Tertiary and Backup sources of position, recognising that these may change based on the area and nature of the operation.

10.9.4 In more complex systems, the use of Inertial Navigation Systems (INS) to bridge the gap between disruptions and outages may be of benefit.

10.9.5 Although reference is made here to Primary, Tertiary and Backup sources of position finding it should be noted that this constitutes a minimum safe provision. A navigation system should make use of all available sources of position finding and periodically, at an interval appropriate to the proximity of navigational hazards, verify the veracity of the vessel's position by reference to all available sources of information.

10.9.6 Resilience of position finding should be addressed by conducting a Position, Navigation and Timing Risk Assessment. The factors considered should include, but are not limited to:

- *Required navigation accuracy during each stage of the vessels intended operations;*
- *The quality of navigation products, services or data supporting the generation of position finding, and the avoidance of grounding (for example the quality of survey data);*
- *The sources of position and time which are likely to be available during each stage of the vessels intended operations and their projected accuracies;*
- *The identification of the most appropriate Primary, Tertiary and Backup sources of position finding during each stage of the vessel's intended operations, noting that these may change;*
- *The impact on the accuracy of navigation resulting from the loss of either Primary, Tertiary or Backup sources of position during each stage of the vessel's intended operations;*
- *The method by which the degradation, denial or loss of an intended Primary, Tertiary or Backup source of position finding will be detected during each stage of the vessel's intended operations;*
- *The action to be taken, during each stage of the vessel's intended operations, following the detection of a degradation, denial or loss of a Primary, Tertiary or Backup source of position finding, noting that this may result in the consideration for an additional available source.*

10.10 DATA INTERPRETATION

10.10.1 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.*

10.10.2 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.*

10.10.3 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.*

10.10.4 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).

10.10.5 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.

10.11 CONTROL

10.11.1 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.*

10.11.2 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.

10.11.3 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.

10.12 EMERGENCY STOP

10.12.1 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.*

10.12.2 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.

10.12.3 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.

10.12.4 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.

10.12.5 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).

10.13   PROPULSION CONTROL

10.13.1 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.

10.14   STEERING CONTROL

10.14.1 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.

10.14.2 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.

10.15   COLREG – COMPLIANT BEHAVIOURS AND FAIL-SAFES

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

10.15.2 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).

10.15.3 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.*

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

1. *Accept externally defined fixed exclusion zones (e.g. based on geographical data);*
2. *Accept externally directed control (third party) (e.g. VTS);*
3. *Accept dynamic data on both fixed and moving obstacles via automatic electronic sensors (such as AIS, Radar with automatic target tracking (ATT);*
4. *Take control of the MASS heading;*
5. *Take control of the MASS propulsion;*
6. *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);*
7. *Calculate and apply manoeuvring commands where practicable in such a manner as to comply with an appropriate interpretation of COLREGs where applicable;*
8. *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.*

10.15.5 A classification matrix may be used to summarise 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 10-2.

Table 10-2: Illustrative Classification Matrix								
	Criterion in accordance with Para 9.15.4							
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

11 | Communications Systems

11.1 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.**

11.2 SCOPE

11.2.1 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.

11.2.2 RF communications requirements for MASS will include the following:

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

11.3 GMDSS REQUIREMENTS

11.3.1 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.

11.3.2 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.

11.3.3 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).

11.3.4 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 11-1.

11.3.5 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.*

11.3.6 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 11-1: 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				

11.4 COMMUNICATIONS FOR CONTROL SYSTEM MONITORING AND INPUT

11.4.1 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).

11.4.2 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).

11.4.3 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.

11.4.4 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.

11.4.5 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.

11.5 RF COMMUNICATIONS INSTALLATION

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

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

11.5.3 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.

11.5.4 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.).

11.5.5 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.*

11.5.6 Notwithstanding the provisions of Paragraph 11.4, 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.

11.5.7 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.

11.5.8 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

12 Remote Control Centre – Operation

12.1 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.**

12.2 SCOPE

12.2.1 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.

12.2.2 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.

12.2.3 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.

12.3 SUB-SYSTEM ARCHITECTURE

12.3.1 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.*

12.4 TASKING CYCLE OF THE MASS

12.4.1 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 12-1.

Table 12-1: Tasking Cycle of a MASS PHASE 1 MISSION APPRAISAL	
Task	**Description**
Operation Planning	Can be conducted ahead of actual operation and includes: ◼ Determine operational area; ◼ Notification and permissions from port/sea authorities, joint force, other organisations; ◼ Notice to Mariners; ◼ Environmental assessment; ◼ RF licences; ◼ Route planning; ◼ Infrastructure; ◼ 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? 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? ETA? How – Air/sea/road? Parties involved? 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. Seek permission for operations. Determine required level of qualification required for operators. If vessel will operate between nations, ensure both authorities are aware. Seek acceptance for control centre location. 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? 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? 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? Are they in a fit state, (any illnesses)? Drug and alcohol policy?
Operation planning	Vessel route planned, transit areas identified, watch routine established Timings of key phases for the pre-launch Give a summary of the pre-launch to the team Necessary liaison complete? 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: ■ Propulsion and steering; ■ Communications links; ■ MASS Health / BITE status; ■ 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
	Special Conditions: Constrained by Draft; Restricted in Ability to Manoeuvre; Not under Command; Grounding; Towing; Anchoring; Operating in restricted visibility
	Sounds and Shapes required by COLREGs; Collision; Navigational Incident/Near miss; Fire; Grounding; Flood; Unauthorised Boarding/Interference; Piracy; Cyberattack; Salvage
	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)? 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.	

12.5.1 In most cases, there will be several personnel involved in the operation of the MASS with different types and levels of responsibility. While the titles given to these personnel may differ depending on the type of commercial or military activity, it is necessary to have clearly defined roles and responsibilities for all personnel involved.

12.5.2 An example of a responsibility diagram is provided in Figure 12-1 below. This example highlights the key roles required when operating or conducting a mission from a port. Even with a qualified and experienced Master per vessel, the nature of operations still requires several other personnel to fulfil the demands required to conduct both safe navigation and complete the mission purpose.

Figure 12-1: Illustrative Responsibility Diagram

The roles and responsibilities of the MASS Team are detailed below.

Command

■ *Certified MASS Master*

– *The Certified MASS Master has ultimate responsibility for the execution of all maritime laws, rules and regulations as issued by the authorities of the flag of the vessel, by Classification Society, by I.M.O. Port Authorities and by the vessels owners management.*

– *The Certified MASS Master is responsible for the overall command of the MASS and her crew. Working from the CONTROL station of a Remote Operation Centre, the Certified MASS Master is responsible for shift to shift operation of a MASS, and liaises with all other designated QHSE Department heads for any matters regarding safety and the marine environment. The Certified MASS Master shall also liaise with a Superintendent (or equivalent role) and RCC/ROC Operations Director (or equivalent role).*

– *In matters of safety, pollution prevention, security, and all other general ship matters including any cargo distribution, ballast and ship stability, the Certified MASS Master has the overriding authority and responsibility to take whatever actions considered to be in the best interest of the vessel and / or marine environment. Consequently, the Certified MASS Master should have full and unlimited permission to request the company's assistance in supporting them to carry out their duties, as and when required. While speed and economy are important, the Certified MASS Master must understand that both are considered secondary to safety issues.*

– *The Certified MASS Master shall liaise with a Certified MASS Remote Operator in matters of navigational planning and navigational conduct. On all matters relating to the technical operation of a MASS, the Certified MASS Master should ensure that when conducting operations, procedures are in compliance with the Safety Management System.*

– The Certified MASS Master should in delegating tasks to their crew, do so in a professional manner. This manner in which this is carried out must ensure that designated tasks are within the scope and jurisdiction of the MASS rank, as ultimate responsibility remains with the Certified MASS Master for conducting operations on each watch or shift.

– The Certified MASS Master is responsible for coordinating emergency response, including the remote fire-fighting response.

– When a MASS is at sea, the Certified MASS Master must ensure that only the Certified MASS Master, Certified MASS Remote Operator or Certified MASS Watchkeeper takes charge of a watch. The duties required in taking charge of a watch should be limited by any operational constraints in regard to following: the area of operations, vessel size, or limitations in the duties that can be performed when using personnel who are working in the capacity a Certified MASS Watchkeeper.

– The Certified MASS Master is qualified to lead a watch and is responsible for the safe navigation of the MASS, during their hours of watch.

– The Certified MASS Master manages the interaction between the Certified MASS operator, payload operators and Crane Operators.

– Where an RCC/ROC is fitted with GMDSS radio communication equipment, the MASS Master shall be suitably qualified.

– The Certified MASS Master must report any major incidents or accidents immediately to Operations Director

Navigation and Watchkeeping

■ *Certified MASS Remote Operator*

The Certified MASS Remote Operator is responsible for:

– The Certified MASS Remote Operator is qualified to lead a watch and is responsible for developing the Passage Plan for approval by the Certified MASS Master, and the safe navigation of the MASS, during their hours of watch and for the duration of their shift. They are directly Involved in mission planning, execution and post mission evaluation.

– The Certified MASS Remote Operator is a qualified watch leader and is responsible for the safe navigation of the MASS, during their hours of watch and duration of their shift.

– The Certified MASS Remote Operator is responsible for designating duties to or on behalf of the Certified MASS Master to the Certified MASS Watchkeeper.

– The Certified MASS Remote Operator is responsible for maintenance of all marine safety equipment. This includes the upkeep of navigational charts/ENCs, ECDIS, light lists and radio signals.

– The Certified MASS Remote Operator will assist in emergency response, including the remote fire-fighting response.

■ *Certified MASS Remote Watchkeeper*

The Certified MASS Remote Watchkeeper is able to:

– Monitor the operational status of the MASS, which may include a basic knowledge of machinery, propulsion systems and technical equipment permanently installed on board the MASS.

– Report any defects relating to plant or machinery installed on board to the Certified MASS Master or Certified MASS Remote Operator.

– Lead a team to secure a MASS safely alongside a harbour wall or pontoon including MASS launch and recovery.

The Certified MASS Remote Watchkeeper is able to assist the Certified MASS Master or Certified MASS Remote Operator as follows:

– Take charge of a watch for limited periods to release the Certified MASS Master or Certified MASS Remote Operator to perform other duties as required for the safe operation of the MASS.

– Take charge of a watch for limited periods to release the Certified MASS Master or Certified MASS Remote Operator to take rest breaks or meal breaks.

– When in charge of a watch, be able to conduct collison avoidance under the following conditions, conducted during daylight hours with good visibility, and when operating in open sea where traffic density is limited. Clear guidance must be used in the form of company agreed standing orders.

– Assist in USV pilotage and berthing manoeuvres under the direct supervision of a Certified MASS Master or Certified MASS Remote Operator, or when operating as part of the crew of a mother vessel, under the supervision of the vessel Master.

Additional Roles

■ *Crane Operator*
  – Can receive commands from the Certified MASS Master or Certified MASS Remote Operator or designated banksman responsible to the Certified MASS Master or Certified MASS Remote Operator;
  – Responsible for lifting and lowering MASS to/from water;
  – Will require to have communication with the MASS RCC/ROC and Certified MASS Remote Watchkeeper if working on deck or ashore as appropriate.

■ *MASS Payload Operator*
  – Receives commands from the Certified MASS Master;
  – Could receive commands directly from the Certified MASS Remote Operator;
  – Responsible for operation of payload; (ROVs, AUVs, towed systems and UAS);
  – Could be fully or partially responsible for launch and recovery of vehicle payload when qualified to the level of Certified MASS Watchkeeper;
  – This role could be conducted by the Certified MASS Watchkeeper.

12.6 DYNAMIC POSITIONING STATION KEEPING SYSTEMS FOR MASS AND REMOTE OPERATIONS

12.6.1 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.

12.6.2 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. These are expected to be issued in January 2022 by The Nautical Institute.

12.7 TRANSFER OF MASS CONTROL

12.7.1 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.

12.7.2 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.*

12.7.3 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.*

12.8 | CONTROLLING MASS FROM AN RCC

12.8.1 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).*

12.8.2 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.*

12.9 RELATIONSHIP BETWEEN AUTONOMY LEVELS OF CONTROL AND RCC

12.9.1 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.

12.10 SUGGESTED RCC OPERATIONAL REQUIREMENTS

12.10.1 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 (See also Para 5.18 MASS Vessel Data Recording (VDR):*
  – *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.*

12.11 WORKING WITHIN PILOTAGE WATERS

12.11.1 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.

12.11.2 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.

12.11.3 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*

12.12 MANAGING RCC WORKFORCE WELLBEING

12.12.1 The human element has been seen to be a consistently occurring factor in the majority of maritime incidents. The nature of remote vessel operation can intensify the importance of some of these people-related factors.

12.12.2 Managing workforce wellbeing should be a priority in the management of any Remote Control Centre operation. Placing adequate importance on human performance, as well as system performance, is necessary to ensure the safety of operations as well as an obligation towards the health of the workforce.

12.12.3 Human factors, including management of the so called 'deadly dozen' people-factors, should be considered in both planning and operation of any RCC:

- *Being aware of Situational Awareness to allow for the three elements, perception, comprehension and projection for dealing with operational risks;*
- *Building a Just Culture to promote alerting and raising issues, counteracting risks of distractions, complacency and memory lapses;*
- *Enabling strong and resilient communication structures and working language protocol;*
- *Recognising the risks of complacency adjusting work patterns and structures to eliminate complacency risk where possible;*
- *Development of a strong culture based on strong safety behaviours and compliance to practices that underpin safe operations;*
- *Ensuring continuity of practices between RCC and local operations where relevant, such as the use of the same software and operational practices:*
- *Fostering efficient teamwork between personnel in the RCC, multiple control centres, support personnel locally and shore management;*
- *Ensuring a capable and competent workforce who have been trained in both technical and soft-skills to be able to perform in routine and emergency situations;*
- *Planning operations, workforce quotient and resources to limit the build-up of real or perceived pressure that can degrade performance;*
- *Minimising distractions and putting barriers in place to ensure operations in the RCC are not compromised by unnecessary distractions or interference;*
- *Putting fatigue mitigation measures in place to minimise the risk of fatigue, and developing a fatigue-conscious workforce;*
- *Prioritising workforce fitness for duty and providing sufficient support in case fitness for duty is compromised.*

12.12.4 The nature of RCC operations can result in a significant use of display screen equipment. The risks and potential impact on workforce health should be assessed and mitigated.

12.12.5 The design and layout of the control stations, taking into account human factors, should be considered in the design of RCCs.

12.12.6 Fatigue Risk Management policies and procedures should be developed and enacted by operators to minimise the long-term impact of fatigue, over and above the procedures to manage short-term tiredness that may impact RCC operations.

12.12.7 Where RCC operations require a shift pattern, particular attention shall be given to the mitigation of fatigue, and particularly the high-risk times for fatigue:

- *Long continuous work durations;*
- *Work between 00:00 and 06:00 during the 'circadian low' period;*
- *Handover periods at the beginning and end of shifts;*
- *Initial night duty in a shift rotation:*
- *Where shift patterns have not allowed for enough recovery time between shifts.*

12.12.8 Mental workload and the risks on safe operation of MASS shall be mitigated considering operational practices, design factors and efficient planning.

13 | System Integrity Certification and Test Procedures

13.1 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.

13.2 SCOPE

13.2.1 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.

13.2.2 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.

13.3 SYSTEM TEST BASED ON RISK ASSESSMENT

13.3.1 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.

13.3.2 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.

13.3.3 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.

13.3.4 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.

13.3.5 Virtual test Environments (VTE) may be used to verify levels of performance of decision making systems, where it is possible to generate sufficient confidence in the relationship between the virtual environment and the real world.

13.4 SENSOR TESTS

13.4.1 Any sensor whose performance is critical to MASS safety should be tested and certified to give reliable results and to demonstrate that it meets the performance required of the MASS concept of operations. 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.

13.4.2 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.

13.4.3 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.

13.5 EMERGENCY STOP TEST

13.5.1 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.

13.6 CYBER SECURITY

13.6.1 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..

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

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

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

13.6.4 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).

13.6.5 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.*

13.6.6 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..

13.6.7 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.

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14 Operator Standards of Training, Qualifications, Competence and Watchkeeping

14.1 OBJECTIVE

> **The objective of this chapter is to provide guidance and recommendations for key roles within MASS operating organisations on workforce competencies, which in many cases complement existing training and certification.**

14.2 SCOPE

14.2.1 Industry agreement on the competency requirements to conduct safe and efficient MASS operations in advance of the establishment of governing regulations is crucial. However, operators should also demonstrate a clear understanding of the relevant extant IMO instruments (COLREGs, SOLAS, MARPOL and STCW) and those of other relevant bodies and organisations to track progress on international and national level workforce competency agreements.

14.2.2 Guidance is aimed at those operating in the field as well as those operating from Remote Control Centres, for various classes of MASS and operating using various levels of autonomy control.

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

14.2.4 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.

14.2.5 It is recommended that the owner or operating organisation should produce a Safe Manning Document following the guidance laid out in MSN1868 (M) Amendment 1: UK Requirements for Safe Manning and Watchkeeping.

14.3 GENERAL PRINCIPLES

14.3.1 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 trand 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.*

14.4 APPLICABILITY

14.4.1 In determining the required knowledge, skills and attributed for MASS operators, owner/operators 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 Workboat Code 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 18)*
- *The equipment fitted onboard and the need for suitable training to ensure its correct operation and understanding of information presented.*

14.5 OWNER/OPERATOR RESPONSIBILITIES

14.5.1 In line with the requirements of MGN 664 (M+F) Amendment 1: Certification process for vessels using innovative technology, the organisation should 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.

14.5.2 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 and are able to demonstrate the competencies detailed in paragraph 14.8.

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

- *Provide for safe practices in MASS operations and a safe working environment;*
- *CContinuously 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.*

14.5.4 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, unexpected events and emergency situations.

14.5.5 Where operators are dual-purpose or dual-qualified (e.g. RCC Operator and Payload Operator, or dual Deck/Engine licensed), the MASS Operating Company should ensure that tasking of operators does not impose undue workload

on an operator. In addition, where cross-trained operators are conducting critical operations, the operator should not be conducting a secondary operation e.g. monitoring a payload operation in parallel to conducting a Bridge watch.

14.6 ENTRY REQUIREMENTS

14.6.1 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 in the following references:

- *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.*

14.6.2 Operators of vessels greater than 24M LOA and/or 500gt may need to make reference to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 and Manila 2010 Amendments. In future, operators will have access to further guidance from new IMO MASS codes.

14.6.3 All MASS owners/operators should consider whether the personnel that they are employing have completed vocational or generic MASS operator's training. This training should include, but not be limited to the requirements outlined in paragraph 14.8. Additional training should be undertaken for type and mission specific skills, for example, the type of training delivered by Original Equipment Manufacturers (OEM) for their respective systems. It is recommended that the level of skill required for each mission should be assessed, agreed and audited by an independent party.

14.6.4 All training undertaken should be endorsed by the training provider and all subsequent operational experience should be documented by the remote operator. Operational experience should also be verified by an appropriate company representative. Evidence can include dates and times, operational hours, operational area, as well as where and when any further training or testing took place. Further guidance on the logbook requirements of remote operators is provided later in this chapter.

14.7 CERTIFYING REMOTE OPERATORS TRAINING AND EXPERIENCE

14.7.1 It is recognised that MASS is an emerging technology. On this basis, the approach recommended for workforce development is to succession plan the existing maritime workforce through upskilling and reskilling. A combination of training in the operation of MASS with relevant seafarer/mariner related knowledge and skills is required at this early stage of operational complexity. However, specific training needs will continue to emerge, and development of new solutions should always be considered. This includes the training of personnel as required from other relevant disciplines or professions to ensure that the operational environment can maintain parity to changing competencies, as the complexity of operations increases. Attention is drawn to industry Principle 9 and the sharing of best practice and experience.

14.8 | REMOTE OPERATOR COMPETENCIES

14.8.1 The competencies for MASS operators have been categorised using three distinct functional levels in accordance with STCW: namely Support Level, Operational Level and Management Level. Each level encompasses specific responsibilities tailored to ensure the safe, efficient, and compliant operation of MASS.

14.8.2 Competencies are based on an operator holding a seafarer qualification as detailed in paragraph 14.6.1 and are aimed at supplementing this standard level of maritime training.

14.8.3 MASS Operator training should follow a logical progression of increased complexity that mirrors the increasing level of responsibility they will undertake as they move from a support level role to an operator role and ultimately a management level position.

14.8.4 The Support level is primarily focused on hands-on operation and preparation of the MASS systems. Stationed at the location from which the MASS is deployed, they handle all preparatory tasks and may assume control of the MASS up to port limits. Their responsibilities encompass:

- *Safe operation of the MASS systems in line with established protocols.*
- *Execution of pre-deployment checks and routine maintenance.*
- *Collaboration with team members for optimal MASS performance.*
- *Adherence to safety policies, national and international legislations, and industry standards.*
- *Troubleshooting technical issues with the MASS systems.*
- *Participation in mission planning, execution, and documentation.*
- *Continuous professional development related to MASS systems and operations.*
- *Engagement in emergency response drills and training.*
- *Reporting of incidents and contribution to investigations.*

14.8.5 The Operational level emphasizes the safe execution of MASS operations in collaboration with the Management level. Responsibilities include:

- *Supporting the Management level in MASS operations.*
- *Compliance with safety policies, legislations, industry standards, and company policies.*
- *Identifying issues in the MASS operational systems.*
- *Maintenance of records, reports, and certificates.*
- *Leading in mission planning, execution, and documentation.*
- *Leading in emergency response drills and training.*
- *Leading in navigation, payload management, and navigational equipment maintenance.*
- *Effective communication with the Management level and team members.*
- *Adherence to safety protocols and policies.*

14.8.6 The Management level assumes overarching responsibility for the MASS and its operations. Responsibilities encompass:

- *Overall responsibility for the MASS and its operations.*
- *Implementation and enforcement of safety policies.*
- *Compliance with legislations, industry standards, and company policies.*
- *Leadership and motivation of the MASS operational team.*
- *Issuance of clear orders and instructions.*
- *Management of the MASS for efficient and cost-effective operations.*

- *Management of records, reports, and certificates.*
- *Investigation and reporting of incidents and malfunctions.*
- *Coordination and delegation of activities for timely completion.*
- *Approval of mission planning, execution, and documentation.*
- *Training and preparation of personnel for emergencies.*
- *Liaison with other teams for knowledge sharing and operational continuity.*
- *Oversight of navigation, payload management, and equipment maintenance.*
- *Familiarisation for new team members.*

14.8.7 Annex A details the full range of competencies that should be held by MASS Operators.

14.9 BEHAVIOURS

14.9.1 In addition to the competencies identified for MASS operators outlined in paragraph 14.8 for support, operational and management functions, owners and operators will also need to consider how MASS operators' non-technical skills such as, leadership and communication skills are developed through their training. Further behavioural markers will need to be developed in order to assess operators' behaviours during training and operations to ensure that they have the necessary non-technical skills to work effectively within an RCC.

14.10 TRAINING RECORDS

14.10.1 Comprehensive records of operator training should be maintained to evidence the training undertaken by an operator. Where a training record book is provided as part of a recognised training scheme, it will offer guidance to an organisation and operator on the tasks that need to be completed as part of that scheme, and may also form the basis of a continuous training plan.

14.11 OPERATOR'S RECORD BOOK

14.11.1 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.

14.11.2 Outline requirements for a MASS Operator's Record Book are at Annex B to Chapter 14.

## 14.12 MASS OPERATORS TRAINING REQUIREMENTS ASSESSMENT

14.12.1 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.

14.12.2 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.

14.12.3 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.

14.12.4 Figure 14-1 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 14-1: Flow diagram to determine level of Operators Training

14.13 OPERATIONAL DEVELOPMENT
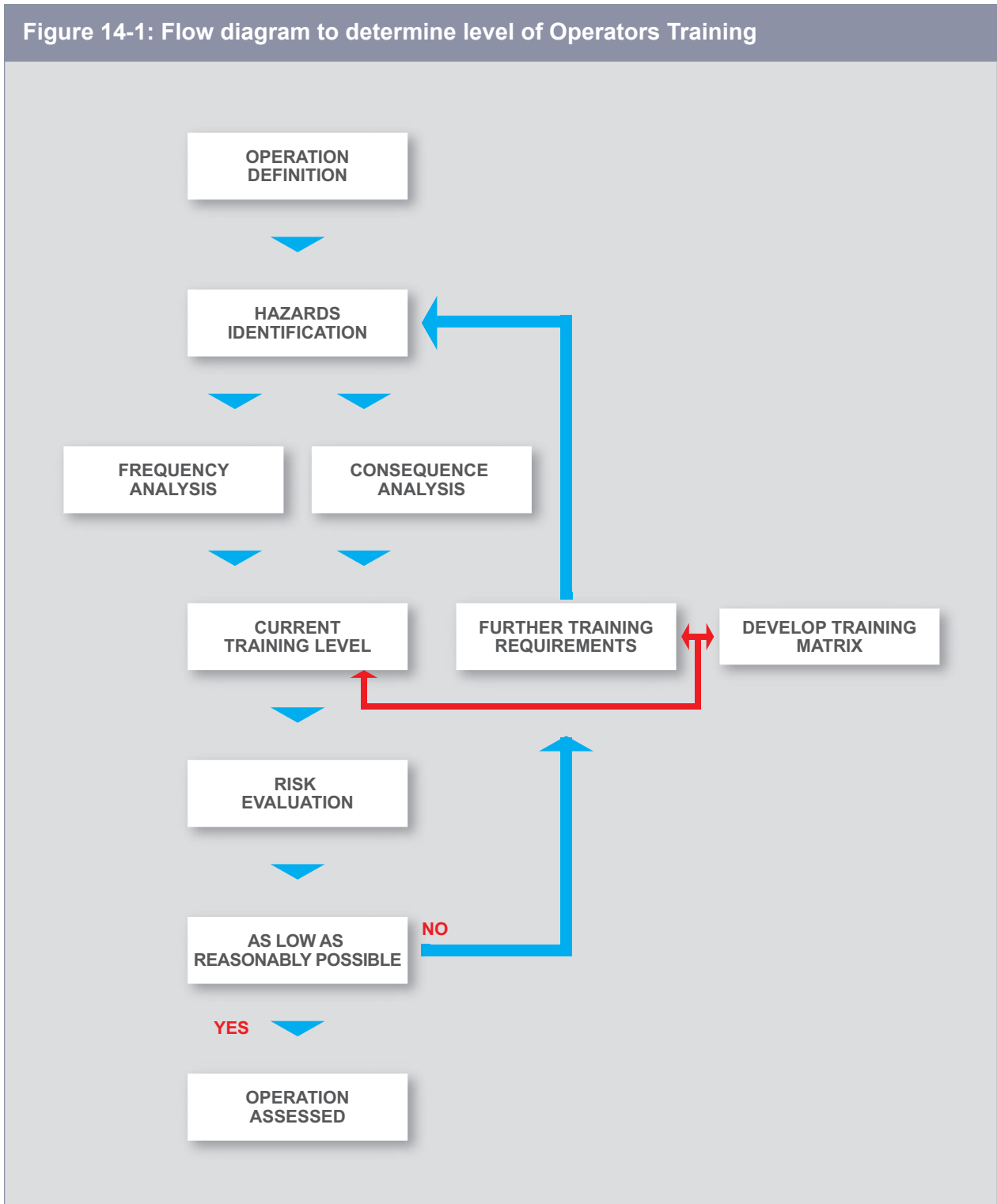
14.13.1 A clearly defined outline for the expected operations of the MASS should be agreed to establish the nodes, examples include:

- *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?*

14.13.2 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.

14.13.3 Hazards Identification. The hazards, issues and difficulties of each of the operational elements outlined in paragraph 14.12 should then be considered. Once again, this must be approached from a multi-disciplinary viewpoint.

14.13.4 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.

14.13.5 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 14.12. This can be re-assessed as a part of the continuous development as outlined in paragraph 14.12.4.

14.13.6 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.

14.13.7 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.

14.13.8 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?

14.13.9 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. See further details at Chapter 16.

14.13.10 Operators of MASS should also encourage the use of external reporting systems such CHIRP Maritime. See further details at Chapter 16.

14.13.11 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.

14.14   AS LOW AS REASONABLY PRACTICABLE (ALARP)

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

14.14.2   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.

14.14.3   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.

14.14.4   The ALARP principle is shown below in Figure 14-2.

Figure 14-2: The ALARP Principle

RISK

Intolerable Risk

Additional mitigation required

Tolerable Risk or ALARP

Risk is reduced and no further reasonable, practicable measures remain

The risk is reduced to ALARP
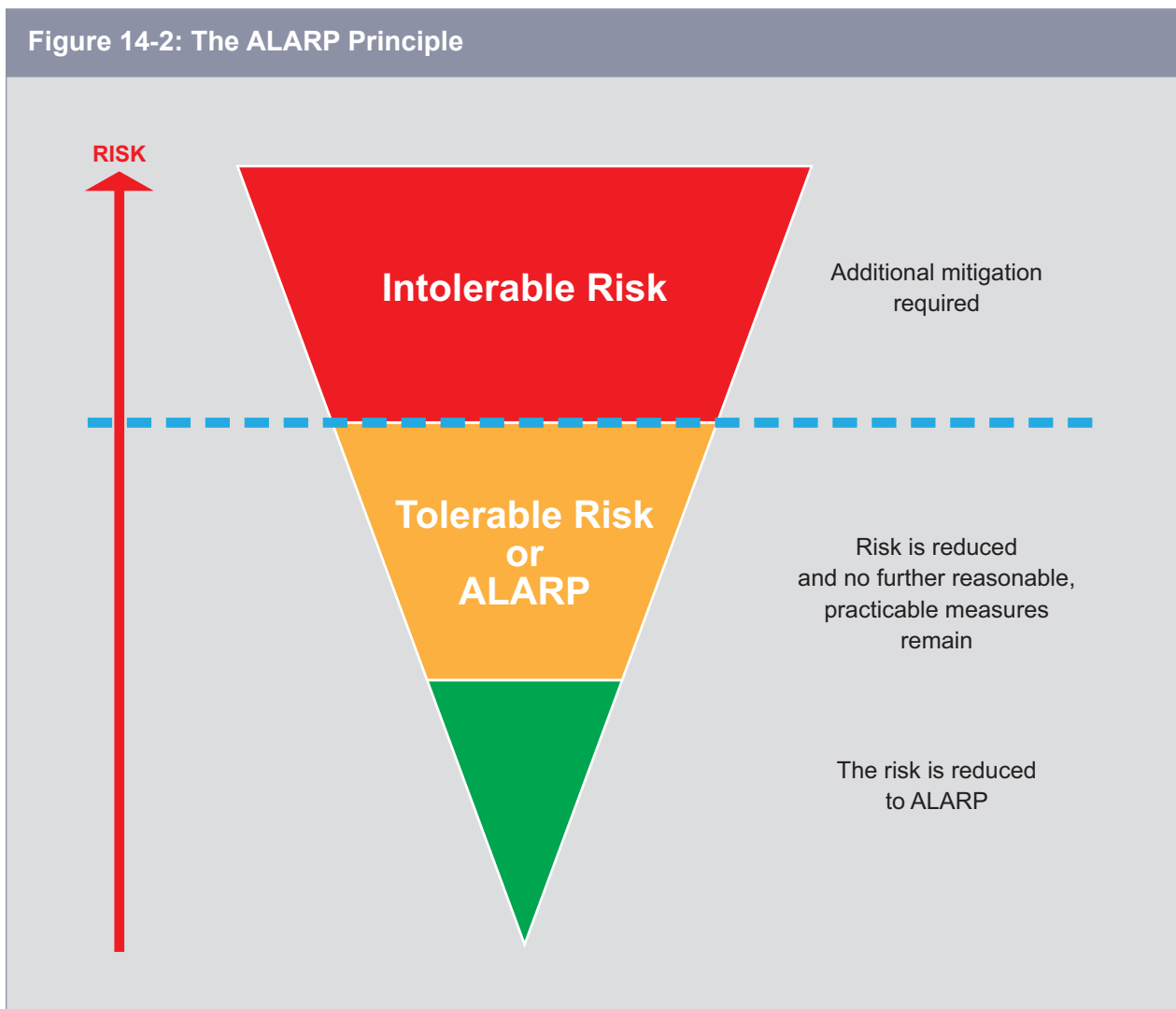
14.15   OPERATIONAL ASSESSMENT AND CONTINUOUS IMPROVEMENT

14.15.1   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.

14.15.2 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.

14.15.3 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.

14.15.4 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 14-3.

Figure 14-3: Closed Loop Safety Assessment
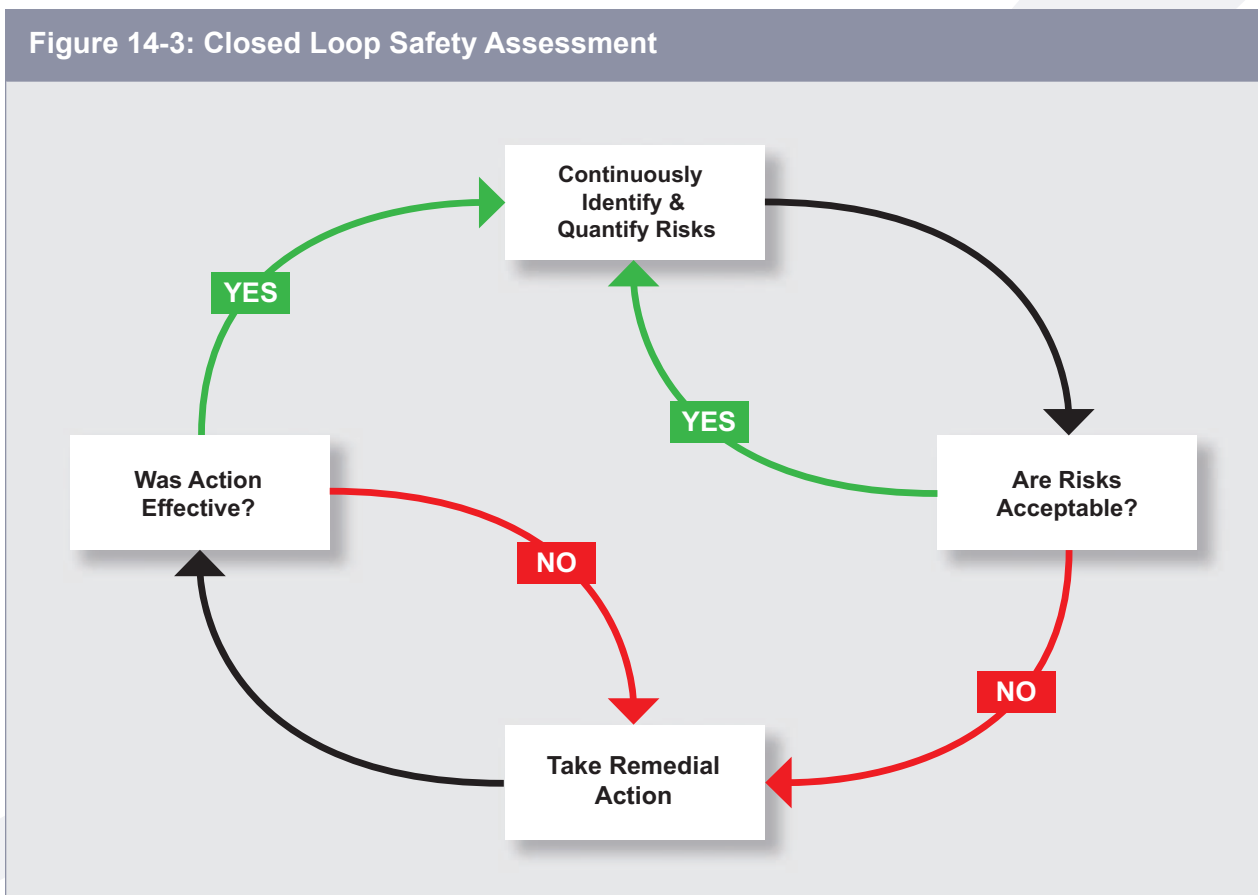
14.16   MARITIME AUTONOMOUS INFRASTRUCTURE

14.16.1 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.

14.16.2 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). It is recommended that, where appropriate, cloud based or digital systems should be adopted.

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

ANNEX A TO CHAPTER 14 – MASS Operator Competence Tables

SECTION 1 – SUPPORT LEVEL

Standard of Competence

1. Every candidate involved in the operation of a MASS at a support level shall be required to demonstrate the competence to perform the functions as specified in table A-1.

2. The minimum knowledge, understanding and proficiency required of an operator at the support level is listed in column 2 of table A-1.

3. Every candidate for endorsement will be required to complete a period of operational training that follows an approved programme which:

   – *ensures that, during the required period of operational experience, the candidate receives systematic practical training and experience in the tasks, duties, and responsibilities of a MASS Operator,*

   – *is closely supervised and monitored by qualified MASS operators tasked with operating the MASS and/or working with the RCC associated with the MASS on which operational experience is gained; and*

   – *is adequately documented in a training record book or similar document.*

Table A-1: Specification of minimum standard of competence when conducting MASS operations at a support level	
Function: Equipment Operation at the Support Level	
Competence	*Knowledge & Skills*
Contribute to the operation of key vessel systems	■ Identify key components of MASS vessel systems, including; – *propulsions system (Conventional twin/single-screw, azimuth propulsion)* – *tunnel thrusters, azimuth bow thrusters,* – *fuel system* – *hydraulic systems* ■ Operation of MASS specific vessel systems – *operating systems and OEM software* – *communication systems* – *OEM specific data-link equipment*
Operate Camera Systems	■ Classify different camera types ■ Recognise the impact of lighting and how it affects video images ■ Identify the impact of environmental conditions (e.g. rain, wind, snow, fog, temperature changes) ■ Operate camera systems
Operate MASS Local Control Systems	■ Set up a local control system ■ Perform MASS manoeuvres using local control systems
Operate Launch and Recovery Systems	■ Identify the risks associated with launch and recovery operations ■ Explain the procedures for the raising and lowering of an Underwater Retractable Mast or equivalent system ■ Explain the processes for the safe deployment of a MASS using – *A-Frame* – *Crane* – *Davit* – *Ramp/Slipway* – *Intermediate Capture Device* ■ Explain the procedures for the operation of upper deck systems such as a retractable mast ■ Demonstrate the safe deployment of a MASS ■ Demonstrate the safe mobilisation and demobilisation of the MASS for transportation

Competence	Knowledge & Skills
Contribute to Pre-Mission Preparations	■ Explain payload equipment pre-mission checks ■ Describe the key components of a LOC ■ Describe vessel - LOC/ROC Communications ■ Identify key alerts and alarms as they occur during pre-mission checks ■ Set up launch and recovery systems ■ Carry out vessel prestart checks ■ Carry out fuelling and defueling of vessel
Support Payload Operations	■ Explain the procedures for the pre-mission inspection of a payload

Function: MASS Manoeuvring at the Support Level

Competence	Knowledge & Skills
Contribute to the safe navigation of the MASS	■ Define safe passage planning procedures ■ Outline correct system settings ■ Recognise the limitations of MASS navigational systems ■ Describe the methods of compliance with chart carriage requirements ■ Describe the information provided by the navigation systems, and how this supports the determination of risk of collision ■ Carry out MASS navigation to maintain the safety of the vessel under supervision ■ Explain vessel handover and acceptance procedures
Conduct basic MASS Manoeuvring	■ Describe the berthing and unberthing procedures for a MASS ■ Describe emergency towing arrangements ■ Understand the manoeuvring characteristics of a MASS ■ Carry out MASS berthing and unberthing in benign conditions ■ Carry out MASS manoeuvres in clear conditions with no traffic
Understand MASS Operational Parameters	■ State MASS safe operational parameters

Function: Maintenance and Repair at the Support Level

Competence	Knowledge & Skills
Manage Vessel Software	■ Outline basic software principles
Operate Battery and Hybrid Propulsion	■ Describe battery maintenance and charging systems including power distribution systems ■ Describe the operation of hybrid drive systems

Function: Communication maintenance at the Support Level

Competence	Knowledge & Skills
Maintain Communication Systems between the ROC and MASS	■ Describe the command-and-control structure used in MASS operations ■ Outline the roles and responsibilities of different personnel involved ■ Describe the limitations of each control methodology ■ Describe the principles of various forms of communication, RF, 4G, Satcom

Function: Safety and Security at the Support Level

Competence	Knowledge & Skills
Support implementation of Cyber-protection measures	■ Summarise the basics principles of cyber security. ■ Understand the principles of Networking ■ Understand of IT/OT system architecture
Support implementation of anti-piracy measures	■ Identify areas of likely piracy activity ■ Describe anti-piracy procedures ■ Implement physical anti-piracy measure prior to deployment

Function: Emergency and Abnormal Operation Response at the Support Level

Competence	Knowledge & Skills
Recognition and response to abnormal situations	■ Recognise how human factors influence response to emergencies ■ Identify the various vessel monitoring systems and potential alarms ■ Identify key vessel systems ■ Understands root causes of fire ■ Perform the initial responses at a local level to emergency scenarios on-board the MASS including; – Loss of navigational equipment – Loss of propulsion – Loss of steering – Dragging anchor – Failure of towed payload system – Grounding – Collision – Fire – Flooding – Piracy Attack
Support Vessel Recovery	■ Describe the procedures for dead-ship recovery ■ Describe the procedures for towing the MASS ■ Perform the recovery of a dead ship

Function: Vessel and ROC Operations at the Support Level

Competence	Knowledge & Skills
Support Operations	■ Explain the role of the ROC in the overall operation of an uncrewed vessel ■ Understand legislation and guidance relating to the operation of the MASS and ROC, including; the development of bespoke legislation the adaption of existing conventions, and the application of non-maritime law to shore-based centres

Function: Use of AI and Advanced Technologies at the Support Level

Competence	Knowledge & Skills
Utilisation of AI / ML / HMT /HMI	■ Explain Human-Machine teaming and how it relates to the operation of a MASS ■ Describe basic definitions used within the fields of Automation, Autonomy and Artificial Intelligence

SECTION 2 – OPERATIONAL LEVEL

Standard of Competence

1. Every candidate involved in the operation of a MASS at an operational level shall be required to demonstrate the competence to perform the functions as specified in table A-2.

2. The minimum knowledge, understanding and proficiency required of an operator at the operational level is listed in column 2 of table A-2.

3. Every candidate for endorsement will be required to complete a period of operational training that follows an approved programme which:

   – *ensures that, during the required period of operational experience, the candidate receives systematic practical training and experience in the tasks, duties, and responsibilities of a MASS Operator,*

   – *is closely supervised and monitored by qualified MASS operators tasked with operating the MASS and/or working with the RCC associated with the MASS on which operational experience is gained; and*

   – *is adequately documented in a training record book or similar document.*

Table A-2: Specification of minimum standard of competence when conducting MASS operations at an operational level	
Function: Equipment Operation at the Operational Level	
Competence	*Knowledge & Skills*
Operate Vessel Functions	■ State the level of automation and autonomy of various MASS systems in use. ■ State what intervention is possible for the different autonomous or remotely operated systems and how this is instigated ■ Identify the levels of system redundancy for the monitoring and control of the MASS ■ Explain the power generation and propulsion systems and their management ■ Operate vessel equipment to effectively achieve the mission aim
Operate Camera Systems	■ Understand video distribution systems between a MASS and ROC ■ Utilise MASS Camera systems to gain and maintain situational awareness ■ Application of different camera types in MASS Operations
Operate Remote Control Systems	■ Understand data transmission principles ■ Knowledge of the impact of environmental conditions (e.g. rain, wind, snow, fog, temperature changes) on control systems ■ Apply the principles of data transmission during remote MASS operations ■ Operate vessel data link equipment
Conduct MASS Launch and Recovery	■ Plan MASS transportation to operational location ■ Plan and execute the launch and recovery of the MASS ■ Plan and execute the launch and recovery of deployable payloads from the MASS
Conduct pre-mission checks	■ Identify safety critical elements and processes ■ Understand pre-mission survey system integrity requirements ■ Describe alerts and visual interactions which may affect the remote set-up integrity ■ Perform payload equipment pre-mission checks ■ Prepare a LOC for operations ■ Establish vessel - LOC/ROC communications ■ Carry out pre-mission checks of the ROC

Competence	Knowledge & Skills
Operate MASS Payload Systems	■ Liaise with the payload operator to establish the parameters of the mission and develop a suitable plan ■ Plan and execute the launch and recovery of deployable payloads from the MASS

Function: MASS Manoeuvring at the Operational Level

Competence	Knowledge & Skills
Plan and execute MASS Navigation	■ Identify the limitations of the navigational systems in use onboard MASS ■ Apply proper passage planning methodology to MASS mission planning ■ Evaluate different approaches to electronic navigation and the voyage planning interface. ■ Evaluate the information provided by navigational sensors to determine if a risk of collision exists and the action that should be taken ■ Identify and respond to loss of critical navigational sensors. ■ Carry out chart updating procedures ■ Set-up the navigation systems for safe passage ■ Use electronic navigational equipment and other navigation aids when engaged in pilotage. ■ Perform vessel handover as per SMS procedures
Conduct MASS Manoeuvring and Berthing	■ Explain the impact of external forces on MASS manoeuvres ■ Describe the pivot point and its impact on MASS handling ■ Demonstrate hand-camera-eye co-ordination ■ Demonstrate MASS manoeuvring utilising different propulsion methods
Operate MASS Safely in prevailing conditions	■ Interpret observed meteorological conditions ■ Interpret sea-state conditions from camera projections
Identify and respond to hazards	■ Utilise all available systems to gain and maintain situational awareness ■ Utilise all available systems to make a full appraisal of the situation and take appropriate action to avoid a Collison ■ Identify potential threats to the MASS and take appropriate action mitigate these in a timely manner ■ Interact and co-ordinate with other traffic to maintain vessel safety

Function: Maintenance and Repair at the Operational Level

Competence	Knowledge & Skills
Manage Vessel Software	■ Describe software uploading procedures ■ Explain the importance of software maintenance and upkeep ■ Maintain software configuration logging ■ Demonstrate the software testing process and evaluate the results ■ Perform software rollbacks
Operate Battery and Hybrid Propulsion	■ Perform routine maintenance on battery & charging systems including power distribution systems ■ Perform routine maintenance on hybrid drive systems

Function: Communication maintenance at the Operational Level

Competence	Knowledge & Skills
Operate mission Communication Systems	■ Describe the impact of environmental conditions on communications systems ■ Perform diagnostic procedures on Command-and-Control Systems ■ Maintain command and communication systems

Function: Safety and Security at the Operational Level

Competence	Knowledge & Skills
Operate Cyber-protection Measures	■ Identify a potential cyber-attack and take appropriate initial actions ■ Implement and monitor cyber-security protection measures
Respond to Piracy Attacks	■ Describe procedures for deletion of sensitive data. ■ Describe the emergency procedures to be undertaken if vessel is subject to piracy attack ■ Respond to physical piracy attack, taking appropriate defensive measures

Function: Emergency and Abnormal Operation Response at the Operational Level

Competence	Knowledge & Skills
Respond to Abnormal and Emergency Scenarios	■ Identify critical systems onboard the MASS ■ Describe vessel failure modes and vessel capabilities ■ Initialise back-up or secondary systems to maintain vessel safety ■ Maintain control of the vessel during an emergency scenario ■ Respond to emergencies within the RCC, including; – Loss of communications – Receipt of a distress call – Cyber Attack – Emergency within the RCC – Incapacity of Operator ■ Respond to vessel alarms, taking appropriate initial responses ■ Respond to emergencies within the RCC
Safely Recover the Vessel	■ Respond to a dead-ship occurrence, taking appropriate initial responses

Function: Vessel and RCC Operations at the Operational Level

Competence	Knowledge & Skills
Conduct MASS Operations	■ Explain the organisational structure within the RCC and the key roles and responsibilities therein ■ Describe the challenges involved in conducting multi-vessel operations ■ Maintain the security of the RCC ■ Prepare a watchkeeping schedule for missions based on the qualifications of personnel and the nature of the work being undertaken. ■ Monitor remote processes onboard vessel, evaluate data, and implement appropriate response.

Function: Use of AI and Advanced Technologies at the Operational Level

Competence	Knowledge & Skills
Utilisation of AI / ML / HMT / HMI	■ Understand Human-Machine Teaming and its incorporation into effective working patterns ■ Understand different AI models (Symbolic / Neural Networks etc) and their practical use cases ■ Understand the integration of AI processes within a RCC ■ Explain the manner in which automated system gather data about the operating environment ■ Demonstrate an understanding of the limitations of AI processes when used in decision making for the avoidance of collisions

SECTION 3 – MANAGEMENT LEVEL

Standard of Competence

1. Every candidate involved in the operation of a MASS at a management level shall be required to demonstrate the competence to perform the functions as specified in table A-3.

2. The minimum knowledge, understanding and proficiency required of an operator at the management level is listed in column 2 of table A-3.

3. Every candidate for endorsement will be required to complete a period of operational training that follows an approved programme which:

    – *ensures that, during the required period of operational experience, the candidate receives systematic practical training and experience in the tasks, duties, and responsibilities of a MASS Operator,*

    – *is closely supervised and monitored by qualified MASS operators tasked with operating the MASS and/or working with the RCC associated with the MASS on which operational experience is gained; and*

    – *is adequately documented in a training record book or similar document.*

Table A-3: Specification of minimum standard of competence when conducting MASS operations at a management level	
Function: Equipment Operation at the Management Level	
Competence	*Knowledge & Skills*
Operate Vessel Functions	■ Monitor the status of vessel systems ■ Verify the maintenance status of the autonomous, remotely operated or remotely supported vessel's machinery systems
Operate Camera Systems	■ Integrate the use of Camera Systems with other sensors to ensure the maintenance of Situational Awareness ■ Assess the impact of environmental conditions on MASS operational effectiveness ■ Monitor the integrity of video distribution systems ■ Prioritise video feeds in relation to bandwidth limitations
Manage MASS Control Systems	■ Oversee the operation of data link equipment ■ Prioritise the recovery of systems when operating in an abnormal manner
Manage the Launch and Recovery of MASS and Payloads	■ Manage the safety of Launch and Recovery Systems ■ Monitor the launch and recovery of the MASS and associated ROV/AUV
Manage Pre-Mission Preparations	■ Assess system integrity prior to mission ■ Survey Equipment pre-mission checks ■ Prioritise safety of personnel ■ Manage process and team to ensure the provision of an operational vessel able to complete a task ■ Evaluate the consequences of alerts and failures. ■ Manage RCC and Vessel mission preparation ■ Analyse settings / readings received from systems prior to deployment
Manage Payload Operations	■ Oversee the MASS team during Payload deployment and operations ■ Monitor the launch and recovery of a payload system

Function: MASS Manoeuvring at the Management Level

Competence	Knowledge & Skills
Manage the safe navigation of the MASS	■ Approve passage plans ■ Monitor the integrity of navigational systems during MASS missions ■ Manage the response to navigational emergencies ■ Assess the potential impact of environmental conditions on MASS operations ■ Monitor the action taken in response to a risk of collision ■ Monitor the interactions of an Uncrewed vessel with other crewed or uncrewed vessels ■ Manage the vessel handover procedure ■ Manage the response to issues arising from a loss of control during a handover
Manage MASS Manoeuvring	■ Monitor prevailing conditions and assess their impact on operational capability
Assess the safety of MASS Operations	■ Monitor prevailing conditions and assess their impact on operational capability
Manage the detection and response to hazards	■ Monitor the effectiveness of situational awareness amongst MASS teams

Function: Maintenance and Repair at the Management Level

Competence	Knowledge & Skills
Manage Vessel Software	■ Inspect the status of vessel software
Manage the use of Battery and Hybrid Propulsion	■ Manage the maintenance and operation of Propulsion Systems

Function: Communication maintenance at the Management Level

Competence	Knowledge & Skills
Manage mission Communication Systems	■ Manage the maintenance and operation of Command-and-Control systems

Function: Safety and Security at the Management Level

Competence	Knowledge & Skills
Manage Cyber - protection measures	■ Implement measures to protect systems from attack ■ Manage the response to a cyber attack ■ Monitor the integrity of cyber protection measures
Manage the implementation and action of anti-piracy measures	■ Manage the response to physical piracy attack

Function: Emergency and Abnormal Operation Response at the Management Level

Competence	Knowledge & Skills
Manage the response to abnormal and emergency situations	■ Manage the response to abnormal or emergency procedures on board ■ Prioritise the restoration of critical systems during abnormal or emergency occurrences onboard ■ Manage the human factors during a response to an abnormal or emergency occurrence ■ Manage the response to an abnormal or emergency scenario within the RCC ■ Assess the impact of the loss of critical systems to the safety of the vessel and others
Oversee the Recovery of a Vessel	■ Manage the recovery of a dead ship, ensuring the completion of risk assessments and identification of most appropriate methods

Function: Vessel and RCC Operations at the Management Level

Competence	Knowledge & Skills
Manage Operations	■ Apply the principles and Best Practice relating to the operation of a RCC and an autonomous vessel ■ Manage the personnel within the RCC, ensuring appropriate certification is held in accordance with company SMS ■ Develop an effective training programme to ensure the readiness of MASS team to respond to a range of scenarios and emergencies ■ Manage watchkeeping schedules to ensure the fitness of personnel and safety of operations ■ Write standing and night orders to ensure the continuity of behaviour within MASS /RCC team ■ Ensure the adherence to all applicable legislation relating to a shore-based establishment ■ Ensure adherence to all applicable legislation relating to the operation of a MASS ■ Manage multi-vessel operations, ensuring that all personnel are cognisant of their roles and responsibilities ■ Establish effective security procedures for the RCC ■ Maintain and review the SMS and all SOPs/RAs relating to the safe running of the RCC

Function: Use of AI and Advanced Technologies at the Management Level

Competence	Knowledge & Skills
Utilisation of AI / ML / HMT / HMI	■ Integrate processes for the validation of information received from AI or autonomous sources ■ Oversee the interaction of AI or automated systems with VTS or other management/control systems/instruction

ANNEX B TO CHAPTER 14

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		

15.1 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.**

15.2 IDENTIFICATION

15.2.1 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.

15.2.2 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.

15.2.3 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.

15.2.4 It is recommended that identification be as shown at Table 15-1. Large MASS are included for reference only.

15.2.5 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.

15.2.6 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.

Zulu MASS Short Sea Vessel

Table 15-1: Identification Requirements for Classes of MASS		
MASS Type	**Description**	**Requirement**
Large MASS	Merchant ships > 300GT (except passenger ships Generally, length >24m	IMO number "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 As a minimum a MASS of these classes should obtain a WIN.	"IMO" followed by a unique 7-digit number Managed by IHS Markit Watercraft Identification Number 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.	

15.3   REGISTRATION

15.3.1 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 process for obtaining registration in the UK is 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 15.2.

15.3.2 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.

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

15.3.4 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*

15.3.5 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.

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

15.3.7 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.

15.4   SURVEY & CERTIFICATION

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

15.4.2 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 only be undertaken by the MCA. On receipt of the survey report, UK Ship Register will arrange the issue of the appropriate Instrument of Appointment.

15.4.3 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 will then follow in due course.

15.4.4 Where mandatory requirements do not apply, the factors in Table 15-2 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.

15.4.5 The MCA has issued MGN 664 which refers to maritime vessels utilising Innovative Technology, including autonomy and remote control. In any sea area that is in the jurisdiction of the MCA (up to the 12Nm limit and not covered by another navigational authority), owners/operators are to engage early with the MCA to discuss the upcoming operations/trials. There is a direction from the MCA that MASS's will be certified taking into account their use of the Innovative Technology and this will be done by the submission of documentation to satisfy a safety case for the MASS and the operation/trial. This on the face of it looks like it could be a lengthy process for which funding/time has not been allowed for in legacy vessels or those who are going into concept design who are unaware of this MGN. The certification to operate within MCA waters will be given by conferring a loadline exemption on the MASS.

Table 15-2: Certification Considerations for Classes of MASS					
R = Recommended M = Mandatory	**MASS Category**				
	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. Workboat Code	**R** Approved Design Code e.g. Workboat Code	**R** Approved Design Code e.g. IMO HSC Code	**M** Approved Design Code or Class Rules
Vessel certificate issued by	Flag State	Flag State	Flag State	Flag State	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	Flag State	Flag State	Flag State	Flag State	Flag State
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. Note 2. Details will be added in a later version, but appropriate Software Certifications should be considered by Owners/Operators.					

15.5 SURVEY & CERTIFICATION PROCEDURE

15.5.1 The owner or operator will apply as appropriate to the Flag State for any mandatory survey & certification of remote or autonomous systems. Copies of the certificates should be held in the company and/or owner offices and should be available in hardcopy or electronically on demand.

15.6 SURVEY PROCEDURES

15.6.1 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.

15.6.2 Surveys of vessels which fully comply with the current regulations and intend to operate manned will be conducted by ROs or Certifying Authorities as approved by the Flag State administration.

15.7 MAINTENANCE PROCEDURES AND RECORDS

15.7.1 All MASS should be provided with a recommended maintenance schedule from the designer/manufacturer.

15.7.2 Configuration control of maintenance procedures and maintenance records should be assured as part of the Safety Management System and procedures for the operator.

15.8 RESPONSIBILITIES FOR RECORD KEEPING

15.8.1 Survey & maintenance records should be kept up to date by the operator and be readily accessible for inspection.

16 Reporting of Marine Casualties (Accidents), Incidents and Near Misses

16.1 OBJECTIVE

> **The objective of this Chapter is to identify applicable obligations on MASS and/or their operating personnel in a Remote Control Centre (RCC) under international and national law to report accidents, incidents and near misses and to prescribe the means by which any such duty might be effectively discharged.**

16.1.1 This Chapter also introduces the confidential navigational and human elements incident reporting systems that are provided by The Nautical Institute's MARS programme and CHIRP Maritime, on an international basis. MASS operators are encouraged to engage with The Nautical Institute and CHIRP for confidential reporting of such incidents and also near misses, assessment of lessons learned from which best practice can be improved. 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.

16.2 REQUIREMENTS OF INTERNATIONAL AND NATIONAL LAW

16.2.1 Article 94 of the United Nations Convention on the Law of the Sea, 1982 (UNCLOS) requires flag States to enact laws to institute an "inquiry" (investigation) into accidents on the high seas. Accidents occurring elsewhere such as in territorial waters or inland waters are not covered by UNCLOS nor is any reference made on the investigation aims. In addition to UNCLOS, however, the conventions on Safety of Life At Sea (SOLAS) and Marine Pollution (MARPOL) touch on certain regulations connected with accident investigations. Article 2 of UNCLOS establishes the right of Coastal States to investigate the cause of any marine casualty occurring within their territorial seas (12miles) which might pose a risk to life or to the environment, involve the coastal State's search and rescue authorities, or otherwise affect the coastal State. The statutory obligation to investigate marine casualties is also included in all main IMO/ILO Conventions. IMO Code A.849(20) as amended by A.884(21) for the investigation of marine casualties and incidents is widely applied internationally, by Flag and Port States.

16.2.2 For all ships and vessels operating in United Kingdom territorial waters, and for all UK Flag ships and vessels wherever they are operating in the world, there is a legal requirement upon ship operators and ship's Masters to report marine accidents and incident, set out at:

■ *The Merchant Shipping (Accident Reporting and Investigation) Regulations 2012, UK Statutory Instrument 2012 No. 1743.*

MCA Guidance on definitions of casualties and reporting procedures are given at:

■ *Marine Guidance Note MGN 564(M + F) Amendment 1, dated March 2019.*

The MGN provides guidance on the legal obligation to notify marine casualties and marine incidents, formerly known as marine accidents, as contained in The Merchant Shipping (Accident Reporting and Investigation) Regulations 2012 (as amended).

16.2.3 Marine casualties (accidents) and incidents in UK territorial waters or onboard UK Flag ships and vessels are reported to the Marine Accident Investigation Branch (MAIB) of the UK Department for Transport. The MAIB investigates marine casualties involving UK vessels worldwide and vessels of any flag in UK territorial waters. The MAIB's purpose is to help prevent further avoidable accidents from recurring, it does not seek to apportion blame or establish liability. The MAIB is responsible for:

- *Carrying out investigations to determine the causes of accidents at sea;*
- *Publishing reports that include safety recommendations on improving safety at sea;*
- *Increasing awareness of how marine accidents happen;*
- *Improving national and international cooperation in marine accident investigations.*

The MAIB's reports draw attention to lessons learned from marine casualties, to inform the shipping industry, the leisure craft community and the public of those lessons.

16.2.4 The Role of the MCA in Investigation and Enforcement: Whereas the role of the MAIB is to investigate and report marine casualties (accidents) and incidents without attributing blame, MASS operators and controllers should be aware that the UK MCA has a duty to investigate casualties and incidents and, where there has been a suspected significant breach of duty of care, design or regulatory requirement, may take enforcement and legal action against the Masters, operators, builders and designers of MASS that are involved in a marine casualty or incident.

16.2.5 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.

16.2.6 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.

16.3 APPLICABILITY TO MASS OPERATIONS

16.3.1 Under the Regulations and as advised in the guidance, the master/skipper of a UK ship must notify the MAIB of any marine casualty or marine incident in accordance with the procedures provided in the Regulations and guidance. The international and Flag State requirement for reporting is normally 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.

16.3.2 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 a casualty or incident.*

Under most circumstances, the MASS will fall into the legal definition of a "ship", as identified in UK Law. It is therefore incumbent that the required accident and incident reporting procedures should be complied with, by operators of the MASS.

16.3.3 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. Whatever their location, the operator of a UK MASS therefore becomes responsible to ensure that accident and incident reporting is undertaken in accordance with the Regulations.

16.4 MASS REMOTE CONTROLLER CASUALTY (ACCIDENT) OR INCIDENT REPORTING REQUIREMENTS

16.4.1 The duty to report marine casualties (accidents) and incidents of a UK Flag MASS will 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.

16.4.2 The duty is qualified by what is reasonably to be expected given the limitations and characteristics of the relevant MASS.

16.4.3 There may be circumstances in which the remote controller of a MASS will not breach the duty for failing to report the Marine Casualty. However, all persons involved in the control of MASS should be aware that a Marine Casualty (Accident) or incident may be reported by other parties and that subsequent investigations by the MAIB may draw attention to the operation of the MASS.

16.4.4 The MASS's technical capabilities and sensor systems may well define the nature, capability, and the requirements of the duty for awareness of a marine casualty. However, in designing, outfitting, and operating the MASS, it should be recognised that situational cognisance and communications capability will be expected and required by the regulations.

16.4.5 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 a marine casualty or incident, the MASS remote controller should make best endeavours to report the casualty or incident in accordance with the Regulations, through whichever means appropriate i.e. radio, camera live feed, radar, etc.;*
- *In most circumstances (and presuming that the MASS has survived the encounter / situation), the MASS remote controller should ensure that the MASS is brought or remains in reasonable proximity with other ships involved in the situation, to act as a visual reference point and communications point for any search and rescue activity that may follow the casualty or incident.*

16.4.6 See Chapter 20 of this Code of Practice for other follow up actions that may be necessary, in the event of a marine casualty, with regard to immediate actions for preservation of life.

16.5 VOLUNTARY CONFIDENTIAL REPORTING OF NAVIGATIONAL ACCIDENTS AND NEAR MISS INCIDENTS IN MASS OPERATIONS

16.5.1 The Nautical Institute MARS Accident and Incident Reporting System: The Mariners' Alerting and Reporting Scheme (MARS) is primarily a confidential reporting system run by The Nautical Institute, to allow full reporting of accidents (and near misses) without fear of identification or litigation. As a free service to the industry, MARS reports also regularly comprise alerts condensed from official industry sources, so that issues resulting from recent incidents can be efficiently relayed to the mariner on board. With access to the internet from vessels becoming more affordable, the MARS database is a valuable risk assessment, work planning, loss prevention tool and training aid for crew and management.

16.5.2 The concept of the confidential alerting and reporting scheme is to assist in accident prevention. By sharing experiences with other maritime professionals anonymously reproduced in SEAWAYS, MASS operators can help them to avoid similar situations. Typical MARS reports include information about any unsafe practices, dangerous occurrences, personal accidents, near miss situations or equipment failures which MASS operators at any level have experienced, and any methods that operators have adopted to prevent repetitions. Within the context of maritime operations, the scheme is unlimited, international in outlook, and open to commercial, naval, fishing, MASS, and pleasure users.

16.5.3 The Nautical Institute assures persons submitting reports that all reports are treated in the strictest confidence and stored temporarily on the Institute's server for back-up purposes. Providing that reports meet the above criteria, The Nautical Institute will publish, anonymously, as many as possible in SEAWAYS, and through The Nautical Institute website: **https://www.nautinst.org/resource-library/mars.html**

16.5.4 To reinforce the confidentiality of the system, any original written or online report submitted will be destroyed prior to publication or, if not published, sent back to the author.

16.5.5 Submitting a MARS Confidential Report: MARS reports can be submitted either:

- *By writing an email with all appropriate details to the MARS Editor, at **mars@nautinst.org**; or*
- *By downloading and completing the MARS Report Form from The Nautical Institute website and posting the completed form to the following address:*
  MARS Editor (Private and Confidential), The Nautical Institute, 202 Lambeth Road,
  LONDON SE1 7LQ, United Kingdom

The MARS Report Form and further details are available through The Nautical Institute's website MARS reporting page: **https://www.nautinst.org/resource-library/mars/submit-a-report.html**

16.6 VOLUNTARY CONFIDENTIAL REPORTING OF HUMAN ELEMENT INCIDENTS IN MASS OPERATIONS

16.6.1 CHIRP: The Confidential Human Factors Incident Reporting Programme: Is a voluntary programme for reporting of incidents that may arise, yet fall short of a marine casualty as defined in the Regulations, is provided by the Charity The CHIRP Charitable Trust. The programme started with providing a confidential reporting system for the aviation sector, but was broadened out to cover the maritime sector in 2003. The aim of CHIRP Maritime is to contribute to the enhancement of maritime safety worldwide, by providing a totally independent confidential (but – note – not anonymous) reporting system for all individuals employed in or associated with the maritime world.

16.6.2 CHIRP Maritime: The CHIRP Maritime programme compliments the requirements for marine casualty reporting as set out by UNCLOS Convention and UK Regulations, and also compliment other formal reporting systems operated by many UK organisations, by providing a means by which individuals are able to raise issues of concern without being identified to their peer group, management, or the Regulatory Authority. It should be noted that anonymous reports are not normally acted upon as they cannot be validated.

CHIRP Maritime receives confidential incident reports from professional and amateur participants in the maritime sector, both from within the UK and overseas and across all disciplines. On being received, reports are validated as far as is possible and reviewed with the objective of making the information as widely available as possible whilst maintaining the confidentiality of the source. When appropriate, report information is discussed with relevant agencies with the aim of finding a resolution.

Only disidentified data is used in discussions with third party organisations and the confidentiality of the reporter is assured in any contact with an external organisation. No personal details are retained from reports received. After ensuring that the report contains all relevant information, all personal details are deleted when the report is closed with an acknowledgement letter sent to the reporter. Each report is allocated unique reference identification. After the deletion of personal details, CHIRP is unable subsequently to contact the reporter. The reporter may, if he/she wishes, contact the CHIRP office for additional information by using the report reference identification.

16.6.3 CHIRP FEEDBACK: The newsletter Maritime FEEDBACK is published quarterly by CHIRP Maritime, covering current topics from disidentified reports, and including new report forms, and is distributed widely, currently with a hard copy circulation of around 38,000. Some reports are disidentified further (e.g. time and place, company, reporter's gender) before being published in FEEDBACK. FEEDBACK maintains an awareness of Human Factors issues within the broad maritime sector, worldwide, and provides a forum for discussion. CHIRP uses Facebook to comment on current maritime safety issues, particularly those in which confidential reporting of hazardous incidents could contribute to improvement.

16.6.4 Confidential Reporting through CHIRP Maritime: Operators and other persons involved with the design, construction and operations of MASS are encouraged to engage with and learn from the CHIRP Maritime programme. Online copy of the CHIRP Maritime FEEDBACK and more information about the programme is available at the CHIRP Maritime programme website: **https://www.chirpmaritime.org/**

Confidential reports should be submitted to CHIRP Maritime by use of the on-line reporting process, at the following link: **https://report.chirpmaritime.org/submit.aspx**

The process of reporting and all guidance necessary is provided as the submission is made. But all persons making a report should be aware that all information provided is treated by CHIRP Maritime and its contributing professionals with the utmost confidentiality.

SEA-KIT USV 'Maxlimer'

17 | Security

17.1 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.

17.2 SCOPE

17.2.1 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.*

17.2.2 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).

17.2.3 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.

17.2.4 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.

17.2.5 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.

17.2.6 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.

17.3 MASS TECHNICAL REQUIREMENTS

17.3.1 MASS shall be designed so as to ensure appropriate compliance with the objectives of this Chapter.

17.3.2 The MASS should be provided with a MASS Security Alert System.

17.3.3 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.

17.3.4 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.

17.3.5 There should be protection from third-party interference with MASS communications.

17.3.6 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.

17.3.7 There should also be a mechanism for safely shutting MASS communications down when the security of the control station centre has been compromised.

17.3.8 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.*

17.3.9 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.

17.4 MASS OWNER/OPERATOR OBLIGATIONS

17.4.1 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.*

17.4.2 The MASS security assessment should be documented, reviewed, accepted and retained by the MASS Owner/Operating Company.

17.5 MASS SECURITY PLAN

17.5.1 The MASS Owner/Operator should ensure that each vessel has a MASS Security Plan approved by the Administration.

17.5.2 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.

17.5.3 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.*

17.6 RECORDS

17.6.1 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.*

17.6.2 Records should be protected from unauthorised access or disclosure.

17.6.3 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.

17.6.4 The MASS Operator should employ both a Company Security officer and a MASS Security Officer.

17.7 COMPANY SECURITY OFFICER

17.7.1 The MASS Owner/Operator should ensure that each of its MASS is assigned to the responsibility of a Company Security Officer (CSO).

17.7.2 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.*

17.8 MASS SECURITY OFFICER

17.8.1 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.

17.8.2 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.*

17.9 VERIFICATION AND CERTIFICATION

17.9.1 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

17.9.2 The verifications will be undertaken by officers of the Administration.

17.9.3 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.

17.9.4 Renewal verifications should be undertaken at intervals specified by the Administration.

17.9.5 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.

17.9.6 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

18 Prevention of Pollution

18.1 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.**

18.2 GENERAL

18.2.1 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.

18.2.2 Responsibility for the MASS to be properly equipped and maintained to meet the prevailing requirements rests with the Owner/Operator.

18.2.3 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.

18.2.4 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 (SI 2009 No.1776), as amended. Further guidance on the applicability of these Regulations can be found in MGN 563 - Port Waste Reception Facilities Regulations 2003 and the "Port Waste Management Planning – A Guide to Good Practice" booklet available as an annex to MGN 563. MASS operators should ensure they manage their waste in a sustainable manner and fulfil the applicable requirements (if any) of these Regulations.

18.2.5 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.

18.3 OIL POLLUTION

18.3.1 MASS should retain on board oil or oily mixtures for discharge to shore facilities.

18.4 GARBAGE

18.4.1 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.

18.5 AIR POLLUTION

18.5.1 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).

18.5.2 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). There are additional requirements for compliance with IMO MARPOL Annex VI Regulation 13 (NOx emissions) that require a vessel operating in an Emissions Control Area (ECA) to be fitted with engines compliant to IMO Tier III, certified by an Engine International Air Pollution Prevention (EIAPP) certificate.

18.6 BALLAST WATER

18.6.1 MASS should comply with the International Convention for the Control and Management of Ships' Ballast Water and Sediments (2004) as applicable.

18.7 USE OF ANTI-FOULING COATINGS AND PAINTS

18.7.1 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.

18.7.2 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

19 Carriage and Transfer of Cargo (including Dangerous Goods)

19.1 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.**

19.2 SCOPE

19.2.1 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.

19.2.2 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).*

19.2.3 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.

19.2.4 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.

19.2.5 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.

19.2.6 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.

19.3 CARGO DEMARCATION

19.3.1 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.

19.3.2 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.*

19.3.3 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.

19.4 SHIPS' STORES

19.4.1 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.*

19.4.2 For the purpose of this Code, when a total quantity of 25kg/25litres of the following dangerous goods are carried and used on board light, small and large categories 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.

19.5 CONSTRUCTION/CERTIFICATION REQUIREMENTS TO MAINTAIN MASS EQUIVALENCE

19.5.1 Scuppers and Drains:

- *The scupper and drainage arrangements are to be directed overboard with no connections to internal spaces.*

19.5.2 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.*

19.5.3 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.*

19.5.4 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).

19.5.5 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.

19.5.6 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.

19.6 OPERATIONAL CONSIDERATIONS

19.6.1 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.*

19.6.2 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.*

19.6.3 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.*

19.6.4 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.*

19.6.5 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.*

19.6.6 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.*

19.7 TRANSFER ARRANGEMENTS OF MGO, UN1202, FROM DESIGNATED TANKS

19.7.1 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.

19.7.2 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).

19.7.3 The installation should be surveyed by the RO and the vessel's Certification should be endorsed to permit this operation.

19.7.4 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.

19.7.5 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*

19.7.6 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.

19.7.7 Emergency response and contingency plans to be developed for spills, fire etc.

19.7.8 MASS remote sensing and monitoring should form part of the design risk based assessment of fuelling design and operations.

19.8 TRANSFER ARRANGEMENTS FOR RECEPTACLES CONTAINING LESS THAN 200 KG OR 200 LITRES OF DANGEROUS GOODS

19.8.1 Receptacles should be secured within save-all (bunded) structures and any lifting to be carried out should use appropriate purpose-built cages/equipment.

DANGEROUS GOODS CLASSES

19.9.1 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 Oxidising 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

20 Rendering of Assistance to Persons in Distress at Sea

20.1 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.

20.2 REQUIREMENTS OF INTERNATIONAL LAW

20.2.1 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.

20.2.2 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.

20.2.3 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.

20.3 APPLICABILITY TO MASS OPERATIONS

20.3.1 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.

20.3.2 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.*

20.3.3 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.

20.4 MASS REMOTE CONTROLLER TASK REQUIREMENTS

20.4.1 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.

20.4.2 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.

20.4.3 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.

20.4.4 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.

20.4.5 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.*

20.4.6 Efforts should not be made to embark persons if this cannot be done safely, relative to the peril faced by persons in distress.

21 | Salvage and Towage

21.1 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.

21.2 GENERAL

21.2.1 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.

21.3 MASS SALVAGE

21.3.1 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).

21.3.2 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.

21.3.3 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.

21.3.4 MASS owners should accept redelivery of the MASS after the salvage operation when reasonably requested to do so by the salvors.
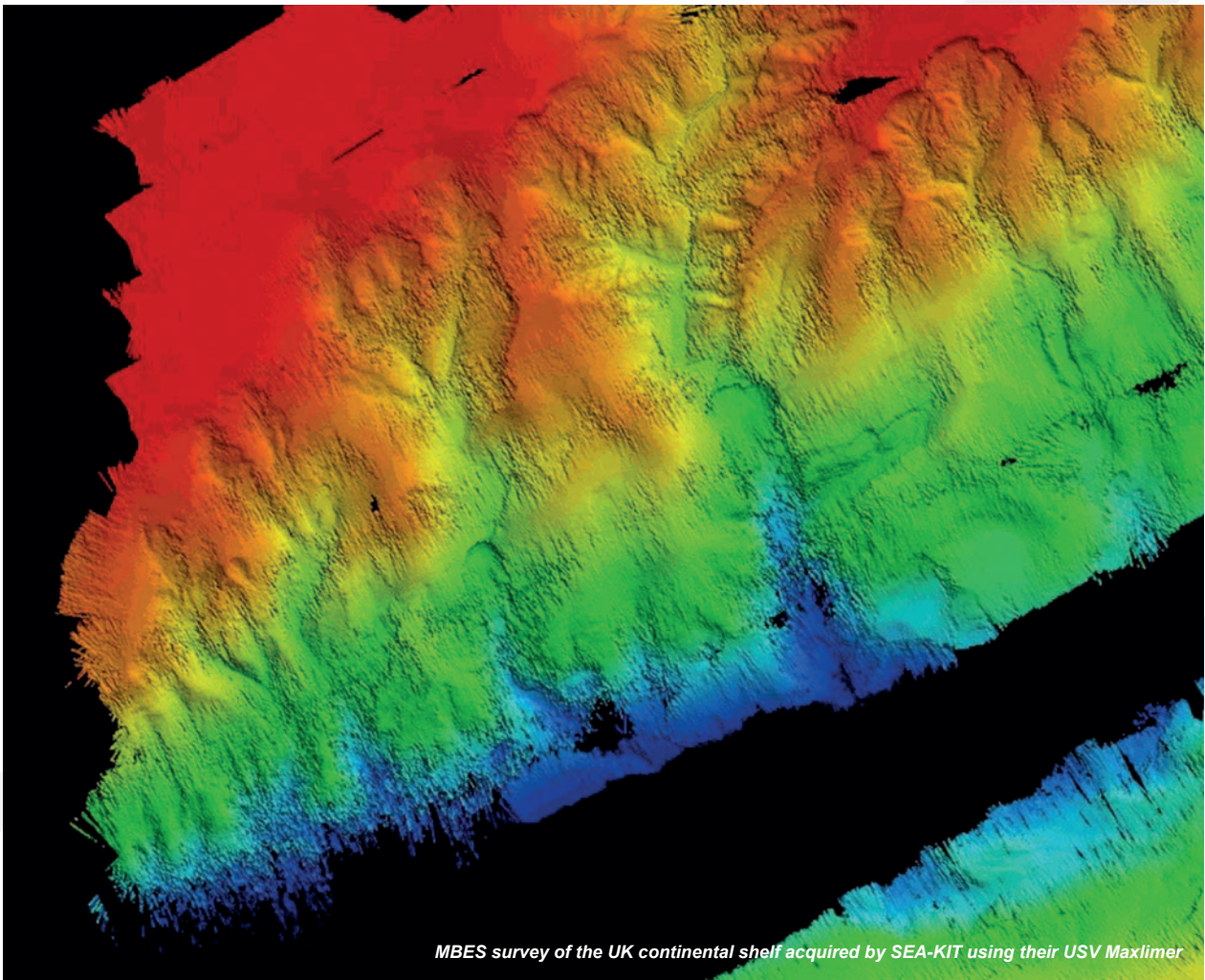
21.4 MASS TOWAGE

21.4.1 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.

21.4.2 MASS owners should disclose and provide to the towage service provider information reasonably necessary for the safety of the towage operation.

21.4.3 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.

21.4.4 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 therefore.

21.4.5 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

22 | Glossary

AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
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	Course 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 Organisation
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 Ship System
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 Maritime System
UNCLOS	United Nations Convention on the Law of the Sea, 1982
UNECE	United Nations Economic Commission for Europe
USV	Unmanned Surface Vessel
WIN	Watercraft Identification Number

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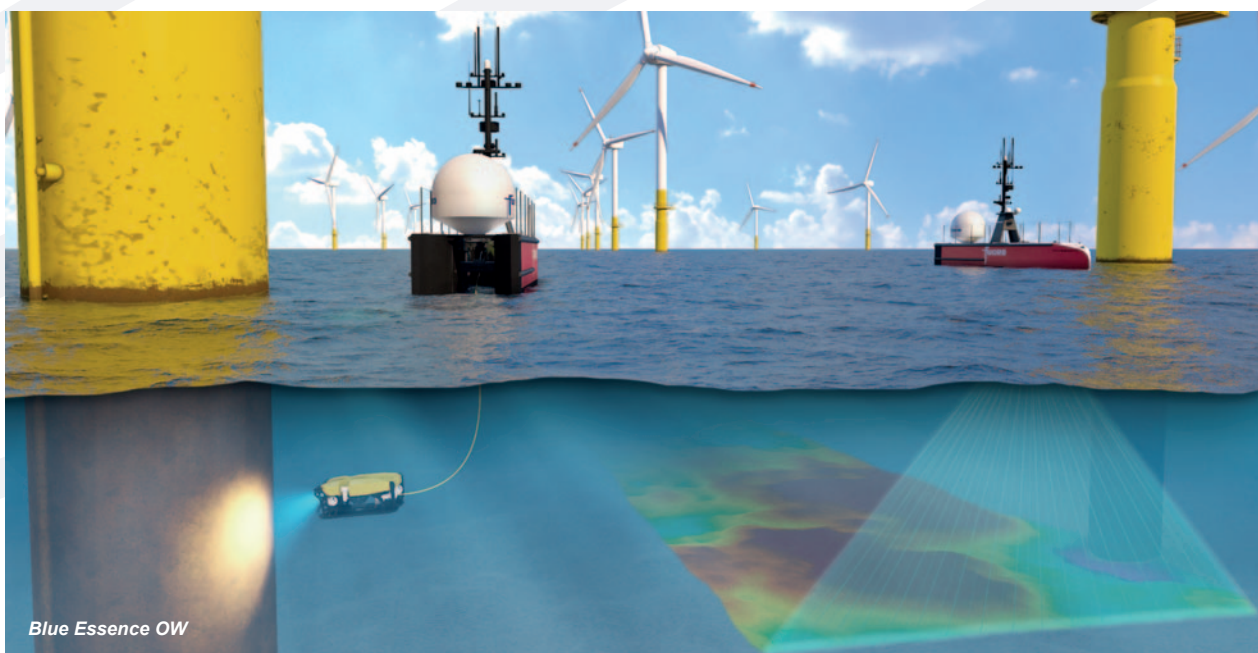
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