GUIDELINE

G1185

CONSIDERATIONS FOR ENHANCING THE SAFETY AND EFFICIENCY OF NAVIGATION AROUND OFFSHORE RENEWABLE ENERGY INSTALLATIONS (OREI)

Edition 2.0

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DOCUMENT REVISION

Revisions to this document are to be noted in the table prior to the issue of a revised document. The latest edition of the Guideline is the only version in force unless the Guideline is explicitly revoked by the Council.

Date	Details	Approval
December 2024	Edition 1.0	Transition Council 3
June 2026	Edition 2.0 Revision of the whole document by ARM and VTS. The guideline is now associated with R1010.	Council 04

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1. INTRODUCTION

1.1. BACKGROUND

The contribution of reliable, high-capacity energy from Offshore Renewable Energy Installations (OREI) to national power grids and net zero emissions is widely recognised, leading to their increasing establishment in coastal waters globally.

It is also increasingly being recognised this has implications for traditional waterway users, such as shipping, ferries, commercial and recreational fishing, recreational craft. Specifically, these are associated with the competing use for the same waterway space.

Careful consideration is required by relevant authorities and stakeholders to ensure the safety of life at sea, safety of navigation, safety of OREI, and protection of the marine environment is not compromised with this development.

1.2. PURPOSE

The purpose of this document is to offer guidance, based on current best practice and knowledge, when considering navigational safety issues including Marine Aids to Navigation (AtoN) in and around OREI.

This document is intended to assist authorities and other relevant stakeholders e.g. OREI developers, in connection with the planning, establishment and operation of an OREI.

Guideline G1185 is associated with Recommendation R1010 The Involvement of Maritime Authorities in Marine Spatial Planning (MSP) [1], a normative provision of Standard S1010 Aton Planning and Service Requirements [2].

1.3. SCOPE

This guidance includes potential risk mitigation measures to enhance the safety and efficiency of navigation. These include ships' routeing measures, incident response planning, and other information.

This guidance should be read in conjunction with Guideline G1121 Navigational Safety Within Marine Spatial Planning [3] as well as G1070 VTS Role in Managing Restricted or Limited Access Areas [4]

The definition of Offshore Renewable Energy Installations (OREI) is a fixed or tethered infrastructure, either singularly or grouped and the associated cables, for the purpose of exploiting a renewable energy resource. OREI include, but are not limited to, wind turbine power generators, offshore substations or equivalent, tide and wave power generating devices, floating solar power generation devices, tidal lagoon power generating devices.

2. RISK MANAGEMENT

Risk management is the identification, evaluation and prioritization of risks defined in the International Standard on Risk Management ISO 31000[1] as the effect of uncertainty on objectives, followed by the coordinated and economical application of resources to minimize, monitor, and control the probability or impact of adverse events.

ISO 31000 provides a generic description of the risk management process. It is based on best practices, extensive consultation and expert input, and links risk assessment with organizational processes. It is used in many industries, including various maritime sectors.

Risk management in the context of OREI should be jointly considered between authorities and other relevant stakeholders dependent on national regulations.

1 ISO 31000 is a family of international standards relating to risk management codified by the International Organization for Standardization. The standard is intended to provide a consistent vocabulary and methodology for assessing and managing risk, resolving the historic ambiguities and differences in the ways risks are described.

2.1. RISK ASSESSMENT

The Formal Safety Assessment (FSA) methodology adopted by the International Maritime Organization (IMO) is a structured and systematic process, recommended for assessment and control of maritime risks.

IMO has recommended the use of FSA for the maritime sector since 2002. The current version of the procedure is described in MSC-MEPC.2/Circ.12/Rev2 Revised guidelines for Formal Safety Assessment (FSA) for use in the IMO rule-making process [4].

The International Organization for Marine Aids to Navigation (IALA) has developed a Risk Management Toolbox that contains qualitative and quantitative models. These proven models are suitable for use with OREI. The IALA risk management toolbox should be consulted for more information and guidance on risk management and consist of:

- Guideline G1018 Risk Management [5]
- Guideline G1123 The Use of IALA Waterway Risk Assessment Programme (IWRAP)
- Guideline G1124 The Use of Ports and Waterways Safety Assessment (PAWSA MKII) Tool
- Guideline G1138 The Use of the Simplified IALA Risk Assessment Method (SIRA)
- Guideline G1058 Use of Simulation as a Tool for Waterway Design and Aids to Navigation Planning

2.2. MITIGATION MEASURES

IMO Resolution A.671(16) Safety zones and safety of navigation around offshore installations and structures [6] states that: “Every coastal State which authorizes and regulates the operation and use of offshore installations and structures under its jurisdiction should (…) take adequate measures to prevent infringement of safety zones around such offshore installations or structures. Such measures may include effective lights and sound signals, racons, permanent visual look-out and radar watch, listening for and warning vessels on VHF channel 16 or other appropriate radio frequencies and the establishment of vessel traffic services.”

Risk mitigation measures for scenarios in, and around, OREI could include, but are not limited to:

- Aids to Navigation
- Vessel Traffic Services (VTS)
- Ship Reporting Systems (SRS)
- Ship routeing measures
- A formal marine spatial plan
- Local surveillance of the OREI
- Emergency response and contingency plans

These, and some other measures are addressed in this document.

3. NAVIGATIONAL SAFETY

3.1. SHIPS’ ROUTEING

As per SOLAS regulation V/10 [7], Ships' Routeing systems are recommended for use by, and may be made mandatory for all ships, certain categories of ships or ships carrying certain cargoes, when adopted and implemented in accordance with the guidelines and criteria developed by IMO.

SOLAS regulation V/10 also states Contracting Governments shall refer proposals for the adoption of ships' routeing systems to IMO, which will disseminate relevant information on any adopted ships' routeing systems.

IMO Resolution A.572(14) General provisions on ships' routeing [8] contains instructions on how to establish IMO-adopted ships' routeing systems and is also included in the IMO publication Ships' Routeing. The publication is primarily intended for administrations responsible for planning and implementing routeing systems for use by international shipping. The Resolution states that "the purpose of ships' routeing is to improve the safety of navigation in converging areas and in areas where the density of traffic is great or where freedom of movement of shipping is inhibited by restricted sea-room, the existence of obstructions to navigation, limited depths or unfavourable meteorological conditions".

Ships' routeing measures may include traffic separation schemes (TSS) including inshore traffic zones, two-way routes, recommended tracks, areas to be avoided and precautionary areas. The objectives of any ships' routeing system will depend on the particular risk which it is meant to mitigate.

It may be necessary to implement ships' routeing systems adopted by IMO through national legislation.

Navigation in or around windfarms may be prohibited for some or all types of vessels.

IMO MSC/Circ.1060 and MSC.1/Circ.1060 Add.1 are two IMO circulars that can help Member States developing submissions on ships' routeing. Such submissions need to be made to IMO's Sub-Committee on Navigation, Communications and Search and Rescue (NCSR) for assessment and approval as per MSC.1/Circ.1608.

3.2. SHIP REPORTING SYSTEMS

Ship Reporting Systems (SRS) are designed to provide coastal States with information on the presence of either all or specified categories of ships, within specific waters. SRS aim to enhance navigational safety and environmental protection and better respond in any developing situation.

As per SOLAS regulation V/11, IMO is recognized as the only international body for developing guidelines, criteria and regulations on an international level for ship reporting systems. A SRS, approved by IMO, could be mandatory in international waters.

3.3. VESSEL TRAFFIC SERVICES

As per SOLAS regulation V/12 Contracting Governments planning and implementing VTS shall, wherever possible, follow IMO Resolution A.1158(32) Guidelines for Vessel Traffic Services [9] and should also, when considering the use of VTS in and around OREI, take into account IALA standards and associated recommendations, guidelines and model courses.

VTS should have the capability to interact with vessel traffic and respond to developing situations within a VTS area to improve the safety of navigation. Therefore, VTS could be considered a risk mitigation measure for OREI. It should be noted that a VTS may only be made mandatory in sea areas within the territorial seas of a coastal State. When implemented in international waters, the VTS can only be voluntary.

3.4. LIMITED ACCESS AREAS AROUND OREI

The risk assessment plays an important role in identifying the most appropriate limited access areas around OREI to improve safety of navigation.

As regard VTS management, examples on the restricted of limited access areas can be found in Guideline G1070.

Specific examples that may be relevant when establishing an OREI are detailed below.

3.4.1. SAFETY ZONES

Under the United Nations Convention on the Law of the Sea 1982 (UNCLOS) [10] Article 60 4-6 states:

"4. The coastal State may, where necessary, establish reasonable safety zones around such artificial islands, installations and structures in which it may take appropriate measures to ensure the safety both of navigation and of the artificial islands, installations and structures.

5. The breadth of the safety zones shall be determined by the coastal State, taking into account applicable international standards. Such zones shall be designed to ensure that they are reasonably related to the nature and function of the artificial islands, installations or structures, and shall not exceed a distance of 500 metres around them, measured from each point of their outer edge, except as authorized by generally accepted international standards or as recommended by the competent international organization. Due notice shall be given of the extent of safety zones.

6. All ships must respect these safety zones and shall comply with generally accepted international standards regarding navigation in the vicinity of artificial islands, installations, structures and safety zones."

This means that coastal States have exclusive rights over artificial islands and structures, such as OREI, in their exclusive economic zones (EEZ). It's important to note that these structures do not create territorial seas, EEZs, or affect their boundaries. These constructions can provide economic benefits, however, they must not hinder safe navigation or harm the environment.

The safety zones aim to ensure safety of navigation and prevent marine pollution. Within these safety zones navigation can be prohibited for all or certain types of vessels. Mariners should be advised to exercise caution and allow a safe distance when navigating in close proximity to and within OREI.

In addition to the above, PIANC MarCom WG report no: 161 Interaction Between Offshore Wind Farms and Maritime Navigation [11] recommends safe distances to be maintained between traffic lanes, channel entrances, and OREI depending on the identified type of traffic and level of risk acceptable to the relevant maritime authority. A formal risk assessment may assist in determining these distances. Factors to be considered include the location of the OREI, weather conditions including potential ice coverage, current and projected growth and patterns of maritime traffic.

An example of these areas extending around a windfarm and the associated cable corridor in Portugal is shown below.

Figure 1 Example of Charted Safety Zone from Portugal

3.4.2. AREAS TO BE AVOIDED

An Area To Be Avoided is a routeing measure which is defined in IMO Resolution A.572(14) as "an area within defined limits in which either navigation is particularly hazardous, or it is exceptionally important to avoid casualties, and which should be avoided by all ships, or certain classes of ship".

Coastal States may consider establishing Areas to Be Avoided in or around OREI based on the results of the risk assessment conducted as a potential risk mitigator. Restrictions can be applied to navigating within such areas.

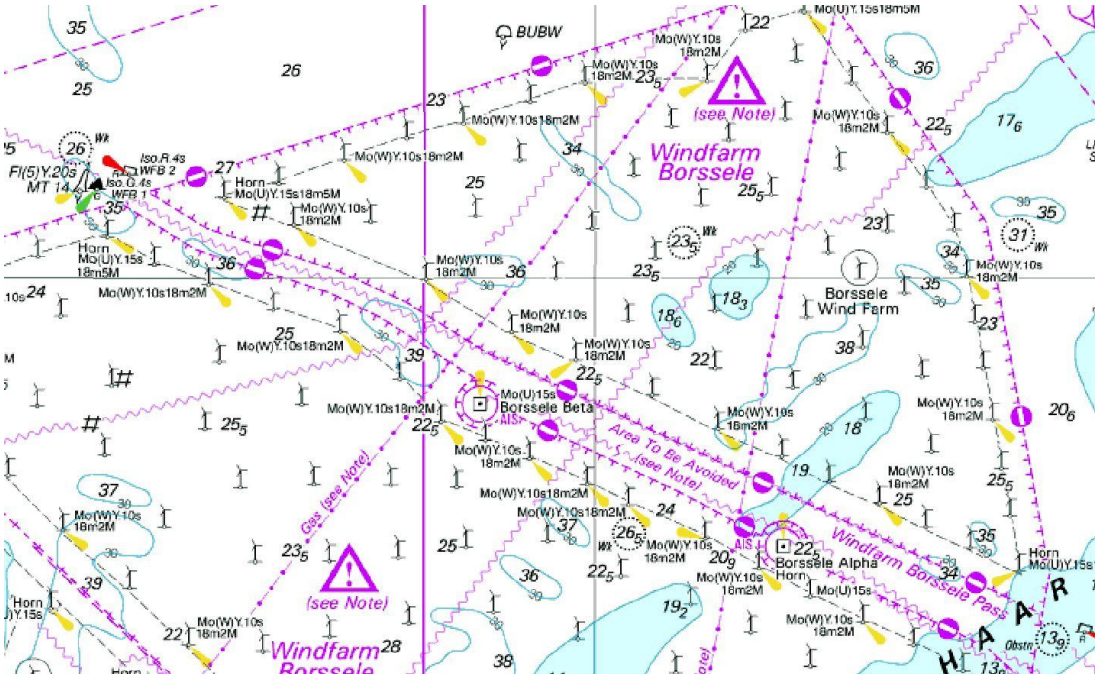

Figure 2 Example of Area to Be Avoided at Netherlands OREI shown on UKHO Chart

3.4.3. PRECAUTIONARY AREAS

IMO Resolution A.572(14) defines a precautionary area as an area within defined limits where ships must navigate with particular caution and within which the direction of flow of traffic may be recommended.

Rules can be made for navigating within and in the proximity of such areas.

3.5. LIGHTING AND MARKING

There is guidance available for the lighting and marking of OREI for safe navigation. The lighting and marking of OREI should be in accordance with the latest edition of Guideline G1162 The Marking Of Offshore Man-Made Structures [12].

OREI developers should consider this guideline and consult with the relevant authorities.

AtoN lighting can be obscured by, and to, vessels operating in the area. The AtoN must not be confused with other lighting including working lights and other background lighting.

OREI may also have an impact on the visibility of racon to vessels operating around a windfarm.

3.5.1. ADJACENT DEVELOPMENTS AND EXTENSIONS

OREI which are extended, or adjacent developments being constructed close to each other, could be perceived by an external observer as one OREI leading to confusion and impacting the safety of navigation. Relevant authorities and OREI developers should ensure mitigation measures are implemented to reduce the perceived impact.

Relevant authorities in neighbouring countries should cooperate with each other when OREI are constructed at, or near, international borders.

3.6. NAUTICAL CHARTS AND PUBLICATIONS

All OREI should be charted by the national hydrographic authority appropriately for the different phases of the development during construction, operation and decommissioning. Whether all individual structures and submarine cables associated with the OREI appear on a chart depends on the scale of the chart.

Significant depth reductions may be encountered where cables cross or have additional protection laid on them where burial depths have not been achieved. This should be apparent to the mariner from accurate charting and taken into consideration when passage planning over cables.

OREI developers and mariners should be aware that individual devices, sub stations, cables to and from devices, and other infrastructure may not be visible on ENC/ECDIS if the operator has not displayed the corresponding layer.

Relevant authorities could consider identifying and establishing navigable channels, or recommended routes, around or through OREI areas.

3.7. OBSCURATION OF OTHER VESSELS

Vessels involved in turbine maintenance and safety duties may be encountered within or around a wind farm. Mariners should be alert to the likely presence of such vessels and be aware that the structures may occasionally obscure them. This is particularly relevant at night when other vessels navigating through, or past installations may become obscured or confused with background lighting from turbines of other devices.

3.8. IMPACT ON COMMUNICATIONS

VHF maritime communication may to be impacted by physical deployment of OREI and could be impacted by the associated VHF communication infrastructure deployed at these installations to support other systems. These radiocommunication capabilities could include command and control systems, emergency warning and information systems, security communications or general radiocommunications (land mobile).

Operators of OREI should ensure radiocommunication site planning is undertaken to minimize interference being caused to or from maritime radio communication systems.

When using shore-based radio direction finder (RDF), whether for VTS or search and rescue purposes, the direction finding (DF) function may be degraded due to the electromagnetic radiation of an offshore wind farm. This impact may be mitigated by adding an additional fixed shore-based RDF station or equipping mobile units such as vessels with RDF base stations.

OREI may obstruct the propagation of AIS signals. This is particularly relevant in offshore wind farms where wind turbines may block the line-of-sight transmission of AIS signals between vessels as well as between vessels and base stations when vessels are near or passing through the wind farm. As a result, signal strength may be weakened, communication quality may be reduced, and vessel information such as position, heading, and speed may not be received and identified by AIS base stations in a timely or accurate manner—thereby increasing the risk of collision.

Wind turbines also generate electromagnetic fields during operation, which may interfere with the frequency band used by AIS signals. If the electromagnetic compatibility design of the wind farm is inadequate, the resulting electromagnetic noise may drown out or distort AIS signals, leading to transmission errors or signal loss, ultimately reducing the reliability and accuracy of the AIS system.

The negative effects of OREIs on AIS signal transmission between vessels as well as between vessels and shore AIS stations may be partially addressed by installing additional AIS base stations within a windfarm area on an appropriate platform or structure.

3.9. IMPACT ON RADAR

3.9.1. IMPACT ON SHIPBORNE RADAR

Shipborne radar displays can be significantly impacted by an OREI. At close range turbines may degrade radar performance that may mask real targets. The structures may also produce blind spots and shadow areas on the radar display.

Radar usage and settings for navigation during winter periods in ice differ from periods of clear waters. Potential radar interference by wind farms will be different for ice and open water navigation. In winter navigation, the use

of radar requires receiving a reflection from the ice to find a navigable route, while during the open water season, radar is used to detect objects around the vessel.

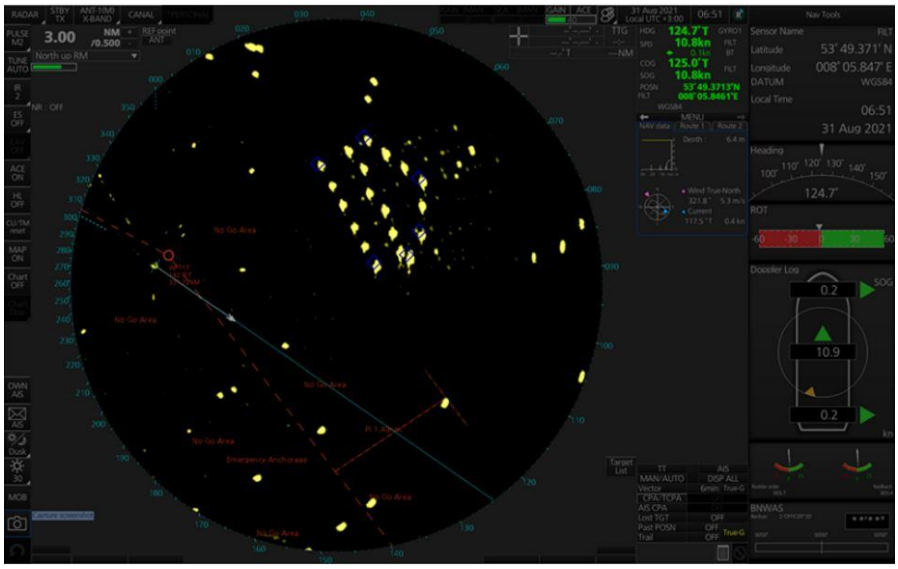

Figure 3 Finnish Infrastructure in Clear Seas

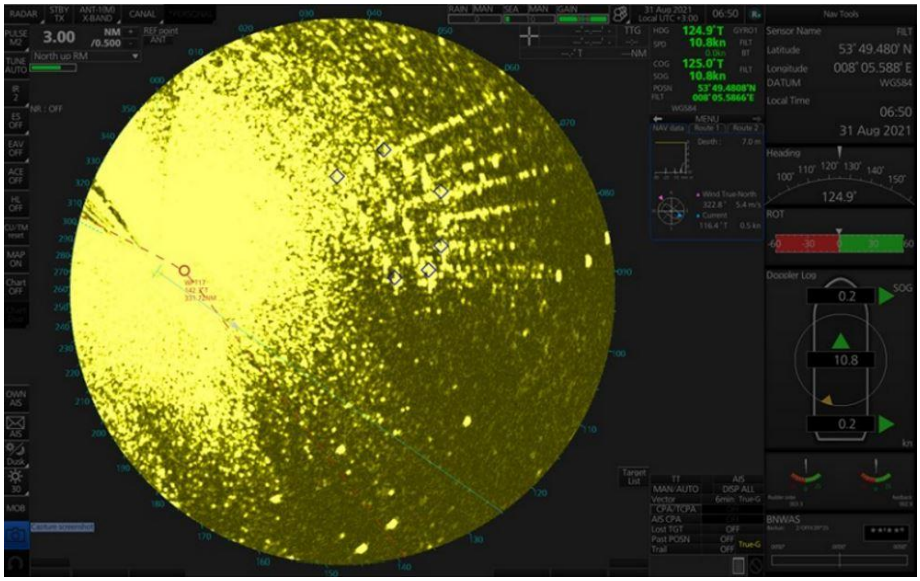

Figure 4 Same Finnish Infrastructure During Ice

3.9.2. IMPACT ON VTS RADAR

A wind turbine or farm may create a blind spot or false reflected signals for the VTS radar that interfere with radar surveillance and make it more difficult to detect and locate vessels, especially if there are several blind spots and they are located close to each other.

During the design and construction phases of OREI, full consideration should be given to their impact on VTS radar. Applying radar-absorbing materials to the towers of turbines that cause significant interference can reduce electromagnetic wave scattering, thereby mitigating the reflection of radar signals from a wind farm. Alternatively, additional radar base stations may be installed within a windfarm area on an appropriate structure.

3.10. WEATHER

Existing and predicted weather patterns and their effect on maritime traffic should be considered within the risk assessment process. This could include wind patterns, wave formation, and reductions in visibility due to fog.

3.11. ICE AND SUB POLAR REGIONS

Navigation during ice-free period differs significantly from navigation in ice. During harsh ice conditions space for maritime traffic cannot be limited to the straightforward routes used during ice-free periods.

Winter navigation routes are dependent on the ice situation at the given moment. Using the optimal route in ice conditions is a key factor in maintaining the smooth, low-emission operation of navigation to the ports of the area during the winter season. OREI placed in the vicinity of shipping channels and areas of maritime activity increase the need for assistance during winter navigation. To ensure the safety of navigation it is not possible to leave vessels waiting for assistance in moving ice near OREI. For instance, as the masses of ice move, the ice may push the vessel towards a windfarm which may cause the vessel to collide with a wind turbine.

Cameras and radar equipment suitable for monitoring the movement of ice in or around OREI could improve the monitoring of the overall ice situation in order to assign icebreaking assistance.

3.12. INTERACTION WITH AVIATION

Offshore renewable energy sites also display navigational warning lights prescribed by the national aviation authority. These lights are normally red and have various characteristics depending on the national requirement, they are also higher powered and visible from longer ranges than Marine Aids to Navigation so the mariner will see these first and should take care not to confuse these with smaller vessels' navigation lights.

4. INCIDENT RESPONSE

4.1. SEARCH AND RESCUE (SAR)

It is vital OREI are sited, constructed, equipped, and operated so as to minimise their impact on any SAR or emergency response and salvage operation. OREI developers should be required to provide evidence of suitable risk mitigation measures in this regard.

When establishing an OREI, careful consideration should be given to:

- Linear layout of individual turbines, with preferably 2 lines of orientation
- Clear and unique identification marking visible to surface vessels and SAR aircraft
- Control and rapid shutdown of individual and groups of OREI devices (wind turbines in particular)

The layouts of OREI with fixed, floating and/or surface piercing devices and structures need to be designed to allow safe transit of surface vessels, including rescue craft and SAR helicopters through OREIS.

Multiple lines of orientation are preferred as they provide alternative options for planning SAR operations for vessels and aircraft to counter the effects of the environment (e.g. sea state, tide, and visibility) on manoeuvring.

Where OREI are proposed to be very large, the relevant maritime authority may consider refuge areas being included in the OREI area.

4.2. SHIP LOSS OF PROPULSION

Sufficient margin between OREI and shipping lanes should be maintained to mitigate the risk of vessels losing power/propulsion and drifting into the OREI area. The relevant maritime authority should advise the OREI developers on the required safe distance, or using potential other mitigation measures like emergency response vessels. This should be considered on a case by case basis .

4.3. COLLISIONS, ALLISIONS AND GROUNDINGS

The establishment of OREI will increase the risk of collision, allision and possibly grounding in the area.

Relevant maritime authorities and OREI developers should have, and regularly review, plans for reacting to accidents including collisions, allisions and groundings.

5. MARINE SPATIAL PLANNING

As per the Intergovernmental Oceanographic Commission (IOC) of UNESCO (2009), Maritime Spatial Planning is defined as a public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives specified through a political process.

The main purpose of Marine Spatial Planning is to achieve a balance between navigational safety, environmental protection, economic effects and communication (information management) (R-1010 The Involvement of Maritime Authorities in Marine Spatial Planning (MSP)).

Specific navigational concerns should be considered when assessing the impact on existing marine traffic routeing and navigational safety caused by offshore developments in accordance with Guideline G1121 Navigational Safety within Marine Spatial Planning.

A formal, national and multi-lateral Marine Spatial Planning process is important, as it can bring together multiple stakeholders, such as governments, shipping, OREI, aquaculture, fishing, conservation and recreational users, to make informed, coordinated decisions on how to use marine resources sustainably and reduce conflict between users.

5.1. FREEDOM OF NAVIGATION AND INNOCENT PASSAGE

Part V of UNCLOS is about the EEZ and amongst others addressing issues about rights, jurisdiction and duties of the coastal states. This actively interacts with Marine Spatial Planning and therefore OREI. This is more specifically addressed in art 60.

UNCLOS contains sections addressing the principles, rights and requirements of freedom of navigation and innocent passage.

IALA members recognise the need to identify what is a “recognised sea lane” and interpretation differs globally.

“Recognised sea lanes” could include, but not be limited to, shipping routes linking recognised IMO routeing measures, historical routes along nations coastal waters and between nations primarily used by commercial shipping.

6. OTHER CONSIDERATIONS: MARITIME AUTONOMOUS SURFACE SHIPS (MASS)

Relevant maritime authorities and OREI developers need to be aware of the increasing use of differing types of MASS. Mitigation measures for the safe operation of MASS in or around OREI should be implemented as agreed between all stakeholders.

7. ACRONYMS AND ABREVIATIONS

DF	Direction finding
EEZ	Exclusive Economic Zone
ECDIS	Electronic Chart Display and Information System
ENC	Electronic Navigational Chart
FSA	Formal Safety Assessment
IOC	Intergovernmental Oceanographic Commission

ISO	International Organization for Standardization
MASS	Maritime Autonomous Surface Ships
MSP	Marine Spatial Planning
OREI	Offshore Renewable Energy Installations
PIANC	World Association for Waterborne Transport Infrastructure
RDF	Radio direction finder
SAR	Search and Rescue
SOLAS	International Convention for the Safety of Life at Sea 1974
SRS	Ship Reporting Systems
TSS	Traffic Separation Scheme
UNCLOS	United Nations Convention on the Law of the Sea
VHF	Very High Frequency

8. REFERENCES

[1] IALA. Recommendation R1010 The Involvement of Maritime Authorities in Marine Spatial Planning (MSP)

[2] IALA. Standard S1010 Aton Planning and Service Requirements

[3] IALA. Guideline G1121 Navigational Safety Within Marine Spatial Planning

[4] IMO. (2018) MSC-MEPC.2/Circ.12/Rev.2 Revised guidelines for Formal Safety Assessment (FSA) for use in the IMO rule-making process

[5] IALA. Guideline G1018 Risk Management

[6] IMO. Resolution A.671(16) Safety Zones and Safety of Navigation around Offshore Installations and Structures

[7] IMO. (1974) The International Convention for the Safety of Life at Sea Convention, 1974 as amended, (SOLAS)

[8] IMO. (1985) Resolution A.572(14) General provisions on ships' routeing

[9] IMO. (2021) Resolution A.1158(32) Guidelines for Vessel Traffic Services

[10] United Nations. (1994) United Nations Convention on the Law of the Sea (UNCLOS)

[11] PIANC. (2018) MarCom WG report no: 161 Interaction between Offshore Windfarms and Maritime Navigation

[12] IALA. Guideline G1162 The Marking of Offshore Man-made Structures

9. FURTHER READING

[1] IALA. NAVGUIDE

[2] IALA. Recommendation R0139 The Marking of Offshore Man-made Structures

[3] IALA. Recommendation R1010 Involvement of Maritime Authorities in Marine Spatial Planning

[4] AMSA. (2024) Offshore renewable energy infrastructure policy.

[5] Finnish Transport Infrastructure Agency (2023) Coordinating offshore wind power, maritime transport and maritime transport infrastructure.

[6] IMO. (1977) Resolution A.379(X) Establishment of Safety Zones and Fairways or Routeing Systems in Off-Shore Exploration Areas

[7] IMO. (1987) Resolution A.621(15) Measures to prevent infringement of Safety Zones around Offshore Installations or Structures.

[8] IMO. (1989) Resolution A.672(16) Guidelines and standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone

[9] IMO. (2003) MSC/Circ.1060 Guidance note on the preparation of proposals on ships' routeing systems and ship reporting systems for submission to the sub-committee on safety of navigation

[10] IMO. (2006) MSC.1/Circ.1060 Add.1 Amendments to the Guidance note on the preparation of proposals on ships' routeing systems and ship reporting systems for submission to the sub-committee on safety of navigation

[11] IMO. (2019) MSC.1/Circ.1608 Procedure for the submission of documents containing proposals for the establishment of, or amendments to, ships' routeing systems or ship reporting systems