IALA GUIDELINE

G1162
THE MARKING OF OFFSHORE MAN-MADE STRUCTURES

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1. INTRODUCTION

The world has experienced a proliferation of renewable energy installations and other man-made structures offshore. The number of such installations is continuing to increase, as technology and efficiencies improve and costs reduce.

These structures can be isolated or in groups, small or large, and close to or away from shipping routes. Additionally, areas with multiple structures can be either closed or open to navigation. Man-made structures offshore have the potential to impact the safety of navigation and the maritime environment.

IALA will review and update its guidance on the marking of manmade structures, as required. This will ensure competent authorities have clear and unambiguous information on their marking, so as to ensure safety at sea. Competent authorities that require specific guidance in this area are invited to contact IALA (contact@iala-aism.org) to obtain advice on current best practice.

The following sections of this document detail IALA guidance for the marking of different types of structures.

The marking of structures as defined in this guideline could be considered a minimum requirement to ensure the safety of navigation in the vicinity of the structures. After assessing the risks associated with the structure(s) competent authorities may require more stringent marking.

Offshore structure - within this guideline the term "offshore structure" refers to any man-made infrastructure placed in the marine environment separated from the coastline of a state. These will include, but not be limited to:

- Structures used in the exploration and production of Oil or Gas
- Structures developed or reused for the purpose of Carbon Capture or Hydrogen Storage
- Renewable energy infrastructure
- Facilities used in the Aquaculture industry
- Floating devices developed for the capture of maritime garbage

IALA recognizes that technology changes meaning more infrastructure will need to be placed in the marine environment and these new technologies should be considered offshore structures and marked accordingly by the competent authority.

1.1. SCOPE

This guidance is for stakeholders such as competent authorities, lighthouse, port, and, aviation authorities and other maritime authorities, aids to navigation providers, and the contractors, developers and operators involved in each type of the structures mentioned in the following sections.

1.2. FIELD OF APPLICATION

The guidance contained in this document applies to all structures fixed in position temporarily or permanently which extend above or below the surface of the sea and which are obstructions to navigation, e.g., structures used for drilling or exploring for oil and/or minerals, oil production platforms, oil well protective jackets, offshore renewable energy installations, ocean data platforms, or offshore aquaculture farms.

1.3. INFORMATION AND PROMULGATION

Competent authorities must ensure that all stakeholders are informed of installed Marine Aids to Navigation (AtoN) and markings in accordance with these guidelines. These must be published on nautical charts, in relevant publications and by promulgation of Maritime Safety Information (MSI).

1.4. EMERGENCY PROVISION AND CONTINGENCY PLANS

1 In case of main power failure, an adequate backup system is recommended to maintain the function and availability of AtoN, including racon and AIS AtoN, for time specified by the competent authority (AtoN); typically 96 hours.

2 AtoN and AtoN systems should have availability in accordance with IALA Recommendation *R0130 Categorization and Availability Objectives for Short Range AtoN* and Guideline *G1035 Availability and Reliability of AtoN.*

3 Remote monitoring of the AtoN system is recommended.

4 Relevant national bodies are responsible for providing MSI when an operator reports any AtoN malfunction.

5 Operators of man-made structures are recommended to develop contingency and emergency response plans which address the possibility of individual devices breaking loose and becoming floating hazards.

6 Operators are recommended to have a reliable maintenance and AtoN defect response regime in place to ensure the required availability targets are met. This will include having the necessary AtoN spares on hand, with provision made at the design stage, where necessary, to ensure safe access.

2. MAN-MADE OFFSHORE STRUCTURES

Man-made structures present very different characteristics. Therefore, these structures have been grouped as follows:

- Section 2.1: Offshore Structures in General
- Section 2.2: Cables and Pipelines
- Section 2.3: Oil and Gas Platforms
- Section 2.4: Offshore Wind Farms
- Section 2.5: Wave and Tidal Energy Devices
- Section 2.6: Aquaculture Farms
- Section 2.7: Other Floating Infrastructure

2.1. MARKING OF MAN-MADE STRUCTURES

2.1.1. IN GENERAL

The marking requirements defined in this section must be complemented with those in sections 2.2 to 2.7 for the specific types of man-made structures.

Consultation between the stakeholders should take place at an early stage. In general, development of all structures mentioned in this section must not prejudice the safe use of Traffic Separation Schemes, Inshore Traffic Zones, recognized sea-lanes and safe access to anchorages, harbours and places of refuge.

On a case-by-case basis, national authorities may consider establishing exclusion or safety zones and areas to be avoided in order to prohibit or restrict vessels from entering areas of man-made structures. Such information must be identified on the nautical charts and publications and promulgated through MSI.

The competent authority shall bear in mind that the marking guidelines herein may be adjusted based on risk assessments that consider background lighting, traffic density, proximity to ports, proximity to dangers, tidal considerations and other factors.

In order to avoid confusion from a high-density of AtoN (and other general lighting), it is recommended that full consideration be given to the use of synchronized lights, different light characters and varied light ranges.

There has been some evidence that sea-bed erosion, at the bases of offshore renewable energy installations in areas of strong tides or currents has resulted in significant deposits of material in other locations. Monitoring of the bathymetry by the operator may be required.

2.1.2. MARKING

The general rules for the marking of Offshore Structures are as follows:

1 If implemented, it is recommended that hazard warning signals (HWS) meet the minimum requirements identified by the competent authority. The recommended requirements are that they:

- are ideally located not less than six metres and not more than 30 metres above highest astronomical tide (HAT);
- have a minimum range of two nautical miles;
- have the character Mo (U) 30s with a minimum duration for the short blast of 0.75 seconds; and
- are operated when the meteorological visibility is two nautical miles or less – a visibility detector will typically be used.

2 Where there is a requirement to remotely identify a particular structure a radar beacon (racon) and/or an Automatic Identification System (AIS) AtoN may be fitted.

3 The competent authority may consider that a group of structures located close together can be marked as one single platform or structure.

4 The competent authority may consider that buoys or beacons are placed to mark the perimeter of a group of structures, to mark channels through a group of structures, submerged structures, or to mark any fixed structure while being erected or dismantled. The characteristics of such marks shall be determined by the competent authority in accordance with the IALA Maritime Buoyage System (MBS).

5 The relevant Hydrographic Office must be informed of the marking, location and extent of any man-made structure, to permit the appropriate charting.

6 Notices to Mariners must be issued to publicise the establishment of a man-made structure(s) / field. The Notice to Mariners has to include the marking, location and extent of such structure(s) / fields.

7 The competent authority should be satisfied that the selected lighting has a suitable nominal range and sufficient autonomy to remain powered through all seasonal conditions especially in higher latitudes.

8 The aviation authorities may require additional marking of the structure(s).

The table below lists the marking recommendations and considerations for offshore structures:

Table 1 Marking recommendations and considerations for offshore structures

* = RECOMMENDED + = TO BE CONSIDERED	Lights (white)	Lights (yellow)	Subsidiary Lights (red)	Intermediate Lights (yellow)	HWS	Radar Beacon	AIS AtoN	Floating AtoN
Offshore Oil or Gas Platform – Temporary or Fixed	*		*		+	+	+	+
Floating Production Storage Offloading	*		+		+	+	+	
Floating Petrochemical Offloading Points / Single Point Mooring	*		+		+	+	+	
Aquaculture		*				+	+	*
Meteorological Mast	*				+	+	+	+
Minimum Facility Platform	*		+		+	+	+	+
Offshore Docks / Loading Islands	*		*		+	+	+	+
Underwater Infrastructure (eg pipelines, manifolds, cables)	+	+					+	+
Isolated Tidal / Wave Generator	*		+		+	+	+	+
Tidal/Wave Generator Field		*			+	+	+	*
Offshore Wind Farm		*		+	+	+	+	+
Isolated WTG	*				+	+	+	+
Isolated OWF Transformer / Sub-Station (See 2.4.3)	*		*		+	+	+	
Other Infrastructure (eg Ocean Clean Up)		*			+	+	+	+

2.1.3. CONSIDERATIONS PRIOR TO CONSTRUCTION AND DECOMMISSIONING

Competent authorities should engage with their national planning system to ensure any AtoN requirements are secured within any consents for the development. It may be a national requirement for developers to produce a navigational risk assessment on how the activity will affect shipping and navigation. It is recommended competent authorities should also engage with this process.

To ensure the requirements for AtoN are clearly stated and understood and have been assessed using all available data on activity in the area, it is highly recommended that competent authorities engage with developer/operators of Offshore sites and structures at the earliest stages of planning.

This could include an agreed formal document stating the AtoN required at all phases (construction, operation and decommissioning), the availability requirements for these AtoN and mitigation required if the AtoN fail. It is recommended that competent authorities reserve the right to change the AtoN for any development if future activity in the area changes the risk and mitigation required for that development.

As the developments are planned for long periods of time, and recognising AtoN technology is advancing, it may not be appropriate to state AtoN for decommissioning. In this case competent authorities and Operators should agree to discuss these well in advance of the decommissioning activity.

2.1.4. CONSIDERATIONS DURING CONSTRUCTION AND DECOMMISSIONING

It is essential to consider the marking of manmade structures during the different phases of their existence, i.e., construction, operation and decommissioning, when the structure may be a hazard to navigation.

During the construction and decommissioning of man-made structures, it is recommended that working areas are established and marked as appropriate. Competent authorities shall also consider the promulgation of maritime safety information, use of guard ships, use of existing VTS in the area or temporary VTS, or the establishment of temporary work vessel routes in areas of high traffic density.

When considering the AtoN required for marking any working area competent authorities should take in to account all factors including current shipping activity. As construction areas become larger the spacing between AtoN, and ranges of any lights on AtoN, needs to be assessed so that it is readily apparent to the marine user that the AtoN are marking a zone. As these areas move further offshore AtoN with higher focal planes and ranges of lights should be considered. In general the distance between AtoN marking a work area should, as a maximum, be the same as that stated in 2.4.3 for significant and intermediate peripheral structures.

When assessing the AtoN required to mark the perimeter of the work area during construction/decommissioning of a site consideration may need to be given to the anchor patterns of equipment being used and access to the site by vessels of varying sizes.

Marking of individual structures within the development area should be considered until construction is completed and any permanent AtoN are operational. This may include the use of low range yellow special mark lights.

MSI must be promulgated in advance of and during any man-made structure / field construction or decommissioning. This is to ensure the relevant Hydrographic bodies can chart the works accordingly. Additionally, “As-Built” information should be provided to relevant Hydrographic bodies to ensure accurate charting.

When decommissioning such devices, it is recommended that the competent authority (AtoN) ensures that the operator / contractor remove all obstructions, so that the seabed is verified as being returned to its original depth and topography.

In the event that an obstruction remains which constitutes a danger to navigation, then it is recommended to mark the location based on risk assessment.

2.2. MARKING OF CABLES AND PIPELINES

Power cables and pipelines between offshore structures, and between the offshore structure and the shore, should be sufficiently trenched to avoid exposure from erosion, sand migration, trawling or other activities.

Where burial depths are not achieved, or the cable / pipeline becomes exposed, additional mitigation by the operator may be required and could include the use of rock armour and concrete mattresses. The competent authority should assess the reduction in navigable depth created by any cable/pipeline protection for the risk presented. After suitable risk assessment competent authorities may consider additional mitigation required and this could include MSI, enhanced charting, and possibly additional AtoN. These will vary on the depth of water and marine activity in the area.

In areas of high seabed mobility competent authorities should consider a placing a requirement on the operators to monitor their cable / pipeline at frequent intervals to ensure the mitigation required at installation remains applicable, and any exposure is identified.

During the planning phase of any cable/pipeline national authorities, port authorities, or competent authorities should consider providing guidance to developers/operators on the depth reduction to navigable waters acceptable by the placement of protection materials.

2.3. MARKING OF OIL AND GAS PLATFORMS

This section supplements the general rules for marking defined in section 2.1 and must be read in conjunction with it.

The offshore structures mentioned in this section are recommended to be marked as a single unit, a block or field, as appropriate, as follows:

1 Ideally lights are located not less than six metres and not more than 30 metres above Highest Astronomical Tide (HAT).

2 Have a vertical divergence of the projected beam such that the light will be visible from the immediate vicinity of the structure to the maximum luminous range of the light.

3 Any structure shall be marked at night by one or more white lights so constructed and fixed as to ensure that at least one light is visible upon approaching the structure from any direction. Minimum nominal range is recommended to be 10 Nautical miles or as directed by the competent authority (AtoN).

4 Subsidiary red flashing lights shall also be provided and show the same characteristics as the main white lights, i.e., synchronized Mo (U) R ≤15s. These are to be located to mark the horizontal extremities of the structure, excepting those marked with white lights, as well as interconnecting bridges. Minimum nominal range is to be three nautical miles.

5 Each structure, where practicable, displays identification panels with black letters or numbers one metre high on a yellow background visible in all directions. These panels shall be easily visible in daylight as well as at night, either by using appropriate illumination or retro-reflecting material.

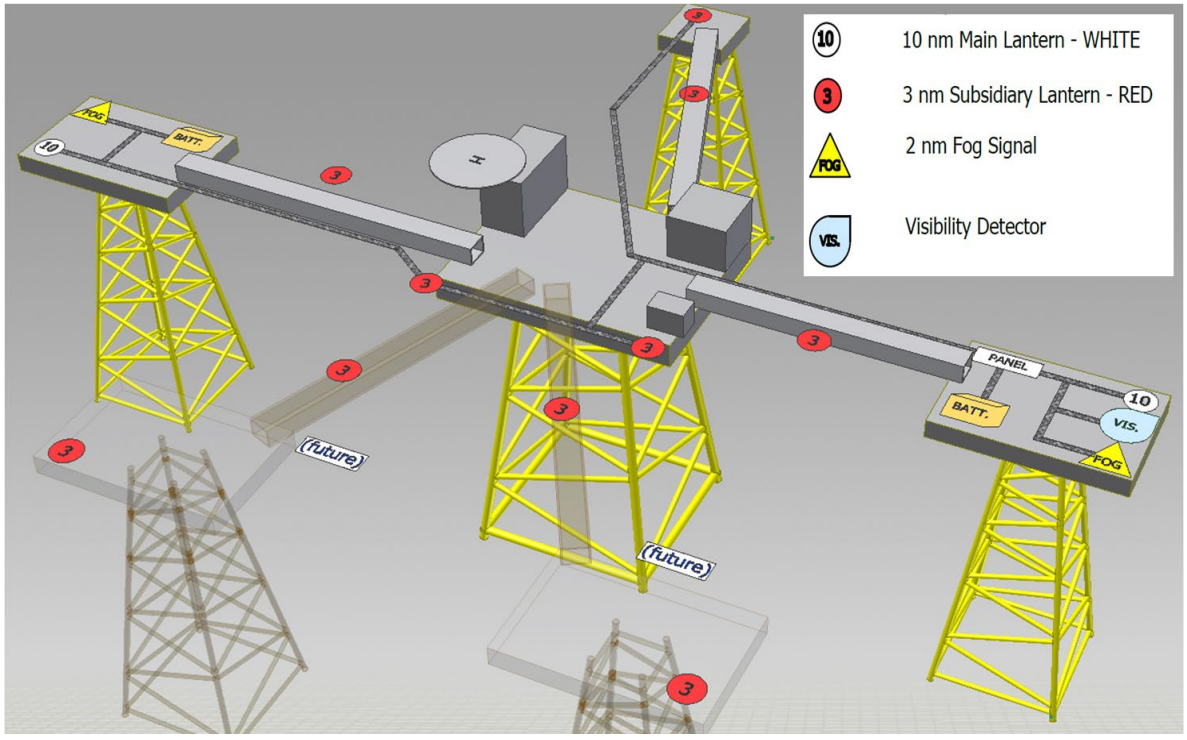

Figure 1 Sample marking of an offshore oil or gas Installation

2.4. MARKING OF OFFSHORE WINDFARMS

This section supplements the general rules for marking defined in section 2.1 and must be read in conjunction with it.

When mentioning offshore wind Farms (OWF), the following are included: meteorological mast, wind turbine generator (WTG) and offshore transformer / sub-station.

It is recommended that each structure, where practicable, displays identification panels with black letters or numbers one metre high on a yellow background visible in all directions. These panels shall be easily visible in daylight as well as at night, either by using illumination or retro-reflecting material. If illuminated the light should be of an intensity which will not obscure AtoN or affect navigation in the vicinity. Competent authorities may consider restricting the range that the identification panels need to be seen and adjusting the size of the lettering as they consider appropriate. The font used for identification panels should give clear distinction between letters and numbers (e.g., "O" and "0" or "I" and "1") and should be consistent in height. Examples of fonts used are UK Transport Heavy and DIN 1451/1.

In larger windfarms consideration should be given to marking the turbines with directional arrows to show vessels the quickest way out of the windfarm. Some competent authorities recommend using "Exit →" in black letters on a yellow background.

Fixed structures should be painted yellow all around from the level of HAT up to at least 15 metres. On a case-by-case assessment alternative marking, where applicable, may include horizontal yellow bands of not less than two metres in height and separation. The addition of yellow retro-reflective material may be considered (see figure 2).

When using working lights, such as down lighting on ladders and access platforms, they must not reduce the conspicuity of marking lights. It is recommended these are extinguished when personnel are not working on, or at, the structure.

Competent authorities should consider that:

1 OWF structures may affect shipborne and shore based radar systems, which in some cases through inherent system limitations, cause interference strong enough to produce significant degradation of the radar display.

2 Passage close to an OWF boundary, or within the OWF itself, could affect vessels' capability to manoeuvre.

3 The safety of navigation shall be ensured when approving an OWF.

4 Marking lights should be visible to the mariner from all directions in the horizontal plane.

Consideration may also be given to the provision of hazard warning signals where appropriate, taking into account the prevailing visibility and vessel traffic conditions. The range of such a hazard warning signals should not be less than two nautical miles.

2.4.1. MARKING OF ISOLATED WIND TURBINE GENERATORS (WTG), METEOROLOGICAL MASTS AND OTHER INDIVIDUAL STRUCTURES

It is recommended that these structures:

1 Are marked with a white light flashing Mo (U) ≤15s, and with a nominal range of 10 Nautical miles.

2 Have AtoN mounted below the lowest point of the arc of any rotor blades. They shall ideally be located at a height of at least six metres above HAT.

3 Have AtoN that comply with IALA recommendations and have an availability of not less than 99.0% (IALA Category 2).

4 Isolated offshore substations should be marked the same as isolated oil and gas platforms as stated in Sec 2.3.

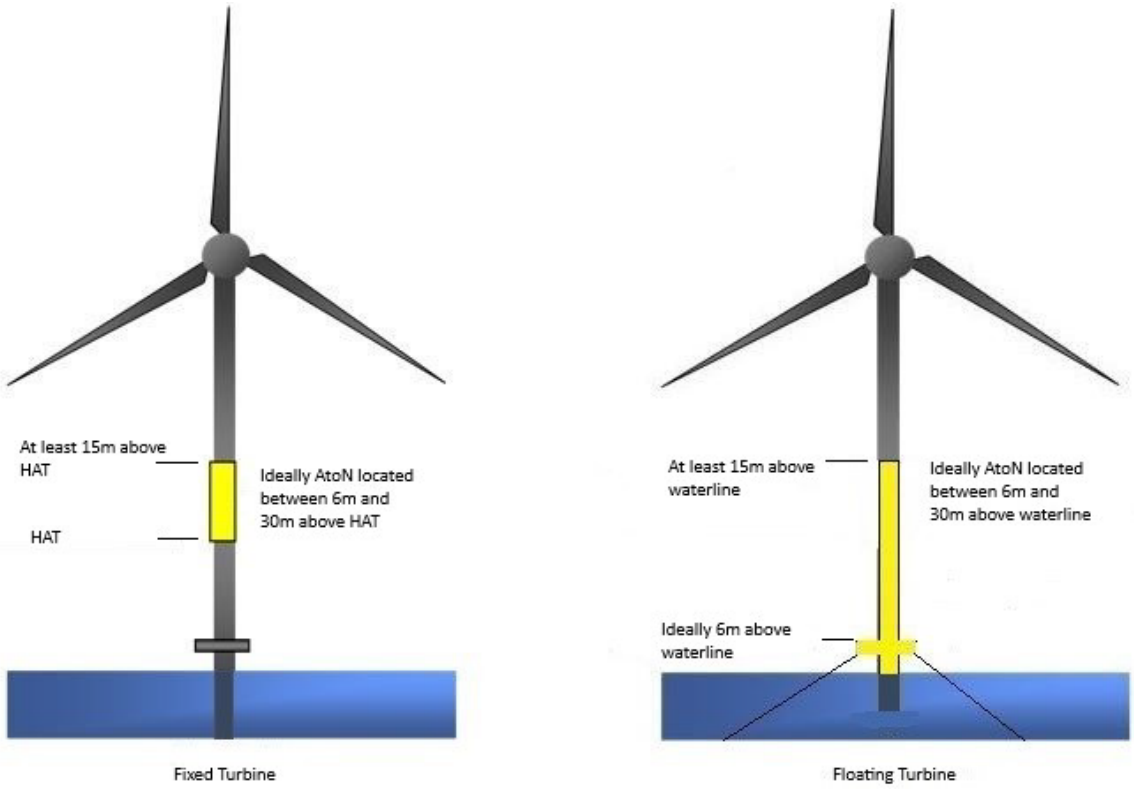

Figure 2 Sample marking of an individual wind turbine

2.4.2. MARKING OF FLOATING WIND TURBINE STRUCTURES

Due to the specific movement of the floating wind structures and that some floating turbines can float where the turbine is not vertical by reportedly up to 6°, it is recommended that:

1 Competent authorities take into account the interaction between aviation lights and the shipping in the area.

2 Ideally lights are located not less than six metres and not more than 30 metres above HAT.

3 The marine lights should have a large vertical divergence, in order to maximize visibility at range to the mariner. The divergence should enable the AtoN to be visible to mariners from the immediate vicinity of the structure to the maximum luminous range of the light. IALA Guideline *G1065* gives advice on the vertical divergence of lights.

4 The structures should be painted yellow all round from the waterline to a height of 15m

5 The mooring system may require additional buoyage to mark the hazardous limits.

2.4.3. MARKING OF GROUPS OF STRUCTURES (OFFSHORE WIND FARM)

A significant peripheral structure (SPS) will include the structures on the corners and other structures on the periphery of the OWF as decided by the competent authority (AtoN). It is recommended that:

1 These lights display a Special mark characteristic, flashing yellow, with a minimal nominal range of five nautical miles.

2 The competent authority (AtoN) may consider the synchronization of all SPS of the same light characteristic.

3 In the case of a large or extended OWF, the distance between SPS should not normally exceed three nautical miles.

4 On large windfarms consideration should be given to using different light characteristics for marking SPS on corners of windfarms to those marking structures along the periphery of the windfarm.

Competent authorities could consider intermediate peripheral structures (IPS) selected on the periphery of an OWF:

1 Are marked with flashing yellow lights;

2 The flash character of these lights shall be distinctly different from those displayed on the SPS, with a nominal range of two nautical miles;

3 Have a lateral distance between IPS or the nearest SPS which will not normally exceed two nautical Miles.

SPS - lights visible from all directions in the horizontal plane. It is recommended to synchronize these lights in order to display a Special mark characteristic, flashing yellow, with a range of not less than five nautical miles

IPS - Intermediate structures on the periphery of an OWF other than the SPS - marked with flashing yellow lights which are visible to the mariner from all directions in the horizontal plane with a flash character distinctly different from those displayed on the SPS and with a range of not less than 2 Nautical miles.

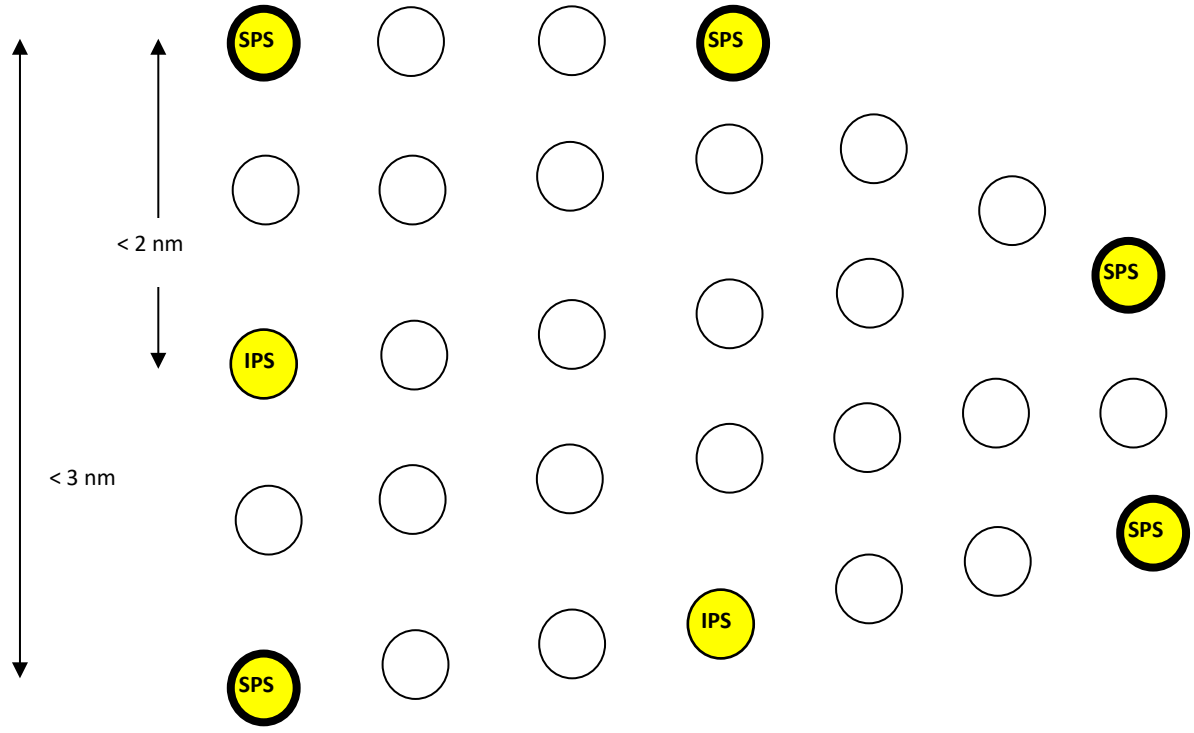

Figure 3 Sample marking of an OWF

Depending on the marking, lighting and lateral separation of the peripheral structures, the additional marking of the individual structures in general within an OWF may be considered as follows:

- Lighting or marking of each structure
- Unlit individual structures can be made more conspicuous with illumination and retro-reflecting material.
- Use of flashing yellow lights with a nominal range of two nautical miles
- Racons
- AIS AtoN

An offshore transformer / sub-station or a meteorological mast, if considered to be a composite part of the OWF, shall be included as part of the overall OWF marking. If not considered to be within the OWF block it shall be marked as an isolated offshore structure.

2.4.4. MARKING OF IRREGULAR LAYOUT OFFSHORE WINDFARMS

Competent authorities must be aware that not all OWF are constructed on a regular grid pattern. The final arrangement of structures in an OWF depends on numerous factors including bathymetry and geographical conditions. This can result in large gaps between structures on the periphery which, after a risk assessment, may require additional floating AtoN to mark the outer limits of the OWF. Consideration could be given to using lighted Special mark buoys of an appropriate size and nominal range so as to maintain an apparent linear boundary of the windfarm when viewed by the mariner.

2.4.5. MARKING OF ROUTES BETWEEN OR THROUGH OFFSHORE WINDFARMS

As offshore windfarms get larger and closer together, there may be a need for the competent authority to mark a route between adjacent windfarms. The competent authority may also need to consider marking a route through a windfarm as the spacing between individual turbines increases, the mariner may decide to navigate through it.

When considering the marking of a route through a windfarm the AtoN required could include additional lights, AIS AtoN, racons, and/or buoys. IALA Guideline *G1078 The Use of AtoN in the Design of Fairways and Channels* should be referred to.

The width of any route through a windfarm should comply with any national requirements.

The competent authority may consider an AtoN scheme to mark a route through a group of structures. Considerations for the scheme could also take into account:

- Distance between the turbines and any lines of orientation of the structures.
- Depth of water available between the turbines.

2.5. MARKING OF WAVE AND TIDAL ENERGY DEVICES

This section supplements the general rules for marking defined in section 2.1 and must be read in conjunction with it.

Wave and tidal energy devices can include tidal generator, tidal generator fields, wave generator, wave generator fields, and other devices.

It must be borne in mind that many wave and tidal devices are low freeboard floating structures moored to the seabed. They may be moored in deep or shallow water and some may be located on the seabed or just below the surface. Surface piercing and subsurface elements may extend laterally beyond the surface elements. This could include shared moorings and mid-water connections between units that may also carry electricity, control signals, hydraulics or pneumatics associated with the units.

When identifying the marking requirements, it must be taken into consideration that some tidal devices:

- have fast-moving sub-surface elements such as whirling blades; and
- do not allow for safe under keel clearance (UKC).

The level of marking should be decided after a risk assessment has been conducted.

2.5.1. MARKING

Wave and Tidal energy extraction devices should be marked as a single unit or as a block or field as follows:

1 When structures are fixed to the seabed or in the water column and extend above the surface, they shall be marked in accordance with the guidance contained in Section 2.4.

2 It is recommended that:

a Subject to the proper risk assessment, areas containing on surface or sub-surface wave or tidal devices are marked by appropriate AtoN. In addition, radar reflectors, retro-reflecting material, racons and / or AIS transponders should be considered where the level of traffic and degree of risk requires.

b The AtoN must be visible to the mariner from all relevant directions in the horizontal plane, by day and lighted at night.

c Taking the results of a risk assessment into account, lights must have an appropriate nominal range and vertical divergence and may be synchronized.

d Individual wave and tidal energy devices within a site that extends above the surface are painted predominantly yellow above the waterline and have yellow retro-reflective tape as required by the competent authority. If navigation is permitted within site, marking of individual devices may be required.

e If marked, the individual devices should have flashing yellow lights. The flash character of such lights must be sufficiently different from those displayed on the boundary lights with a nominal range of not less than two Nautical miles.

f Floating AtoN could be located outside the moorings of the floating structures.

3 Based on risk assessment, a single wave or tidal energy extraction structure, standing alone, may be marked as follows:

- isolated Danger mark; or
- special mark.

4 The AtoN described herein should comply with IALA recommendations and guidelines, and have an appropriate availability normally not less than 99.0% (IALA Category 2).

Recommended principles for marking of area for wave energy devices are referred to in the figure below. The competent authority may consider the distances between lit and unlit special marks on a case by case basis and on a risk assessment.

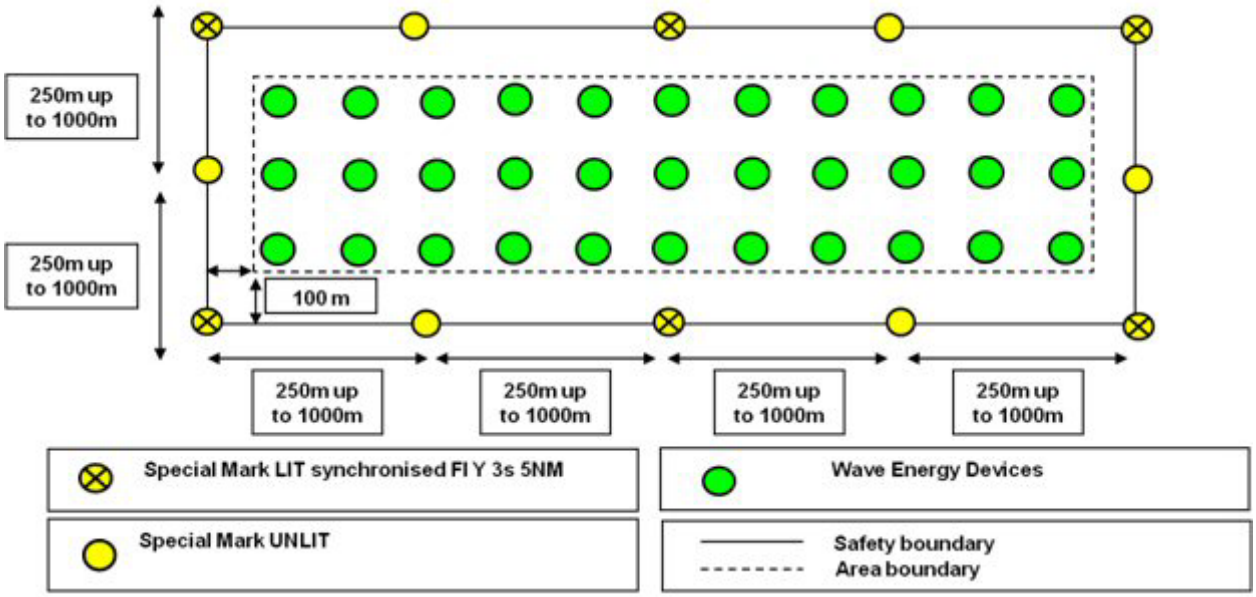

Figure 4 Marking of wave and tidal devices

2.6. MARKING OF AQUACULTURE SITES

This section supplements the general rules for marking defined in section 2.1 and must be read in conjunction with it.

Aquaculture farms include fixed and floating fish farms, shellfish farms, seaweed and algae producing units.

The farm, or group of farms, should be marked depending on their size, extent and location. In some cases, it may be sufficient to mark only the perimeter, part of the perimeter, or the centre. The use of racons and/or AIS AtoN may also be considered.

Guidance for marking of different shapes and sizes of aquaculture farms are provided in table 2 below. Competent authorities may consider the distances between lit and unlit special marks, on a case by case basis, based on their own risk assessment.

Many aquaculture farms are low freeboard, floating structures that are moored to the seabed. They may be moored in deep or shallow water and some may be located on the seabed or just below the surface. Surface piercing and subsurface elements may extend laterally beyond the surface elements. This could include shared moorings and mid-water connections between units that may also carry electricity, control signals, hydraulics or pneumatics associated with the units.

The competent authority should bear in mind that the marking guidance herein may be adjusted in consideration of traffic density, proximity to ports, proximity to dangers, tidal considerations and other factors.
Offshore aquaculture farms should be marked as follows:

1. Aquaculture farms are normally marked by Special marks.
2. If there is a requirement for vessel to transit between aquaculture farms, then such channels are normally marked as defined in IALA Guideline *G1078*.
3. If the prevailing situation warrants, Cardinal marks alone may be used to direct vessel traffic away from the aquaculture farm(s).
4. It is recommended that areas of aquaculture farms are marked by appropriate AtoN. In addition radar reflectors, retro reflecting material, racons and AIS AtoN may be considered.

5. To improve the effectiveness of marking and taking into account any background lighting, synchronization of the lights is recommended. The results of a risk assessment will dictate the appropriate nominal range;
6. The AtoN described herein should comply with IALA guidance and have an appropriate availability, normally not less than 99.0% (IALA Category 2).

2.6.1. MARKING EXAMPLES

Examples can be found in the following tables and figures that illustrate the minimum recommended marking arrangement with Special marks.

- It is recommended that rectangular aquaculture arms are marked according to the length of their sides.

Table 2 Marking requirement of aquaculture sites depending on size

Example	X Axis (m)	Y Axis (m)	Area (m^2)	Minimum Marking Requirements
A	≤ 500	≤ 500		One light in centre of farm (consider radar reflector…and/or AIS AtoN …for all instances below)
B	≤ 2500	≤ 500		One light on each sea corner; one daymark on each coast corner (consider radar reflector)
C	≤ 500	≤ 2500		One light on one sea corner; one light on the diagonally opposite coast corner; one daymark on one sea corner and one daymark on the diagonally opposite corner (consider radar reflector)
D	> 500	≤ 2500	≤ 1250000	One light on diagonally opposite corners; daymark on diagonally opposite corners (consider radar reflector)
E	> 900	≤ 2500	> 1250000	One light on each corner (consider radar reflector)

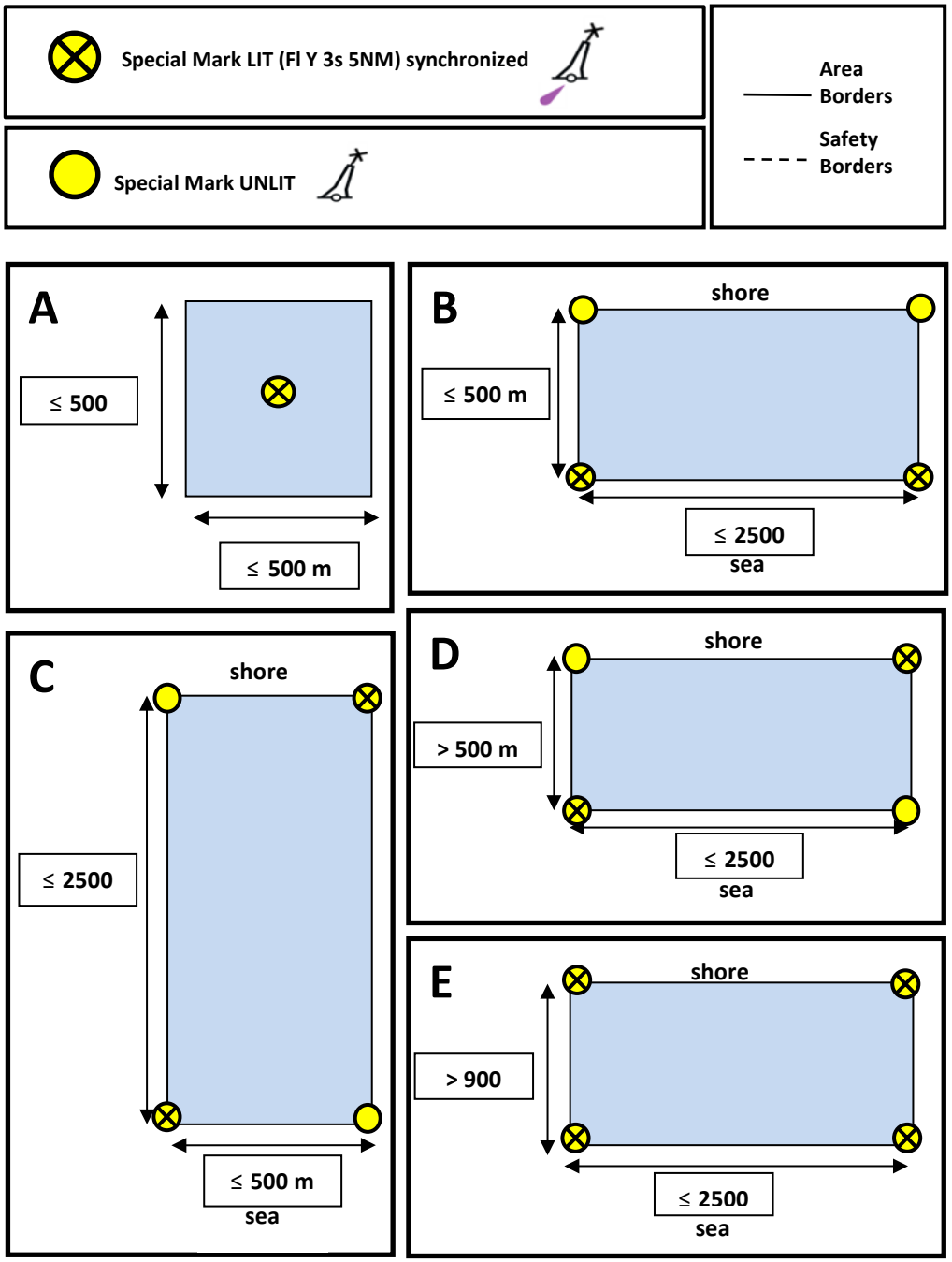

Figure 5 Rectangular aquaculture farms

- Circular Aquaculture Farms should be marked according to their diameter.

Table 3 Marking of circular aquaculture farms depending on diameter

Example	Diameter (m)	Diameter (m)	Minimum Marking Requirements
F		≤ 500	One light in centre of farm (consider radar reflector)
G	> 500	≤ 1000	Two lights 180° apart on the circumference; two daymarks positioned 90° to the lights (consider radar reflector)
H	> 1000	≤ 2000	Three lights 120° apart on the circumference (consider radar reflector)
I	> 2000		Three lights 120° apart on the circumference, three daymarks positions 60° to the lights (consider radar reflector)

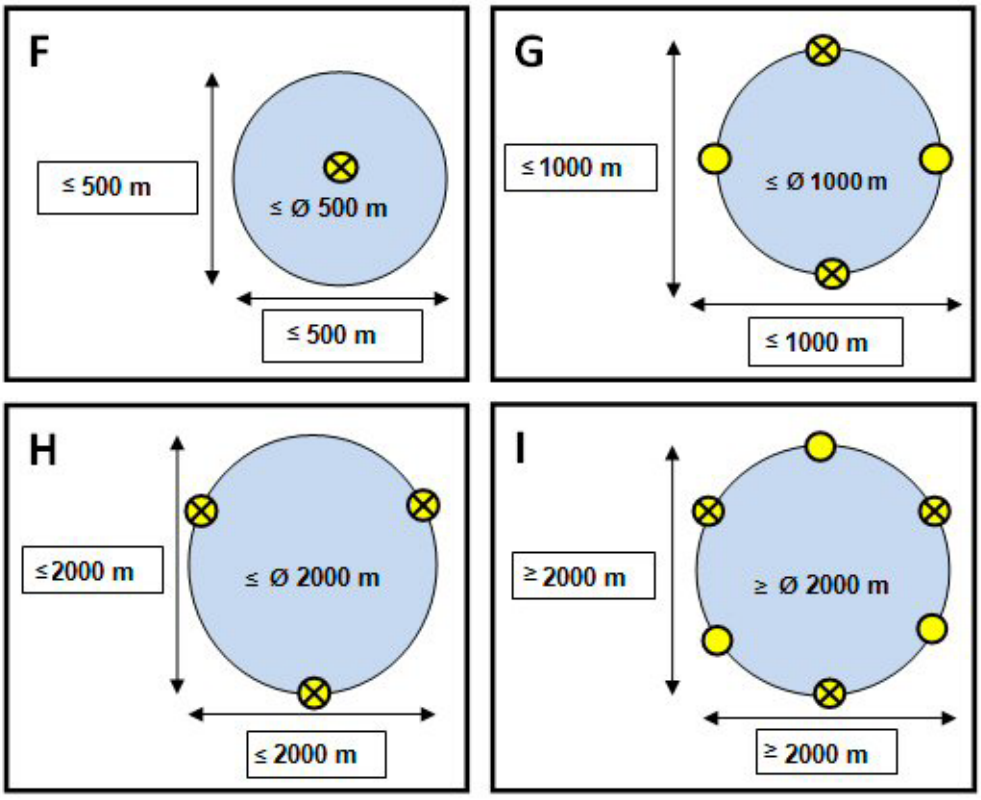

Figure 6 Circular aquaculture farms

2.7. MARKING OF OTHER FLOATING INFRASTRUCTURE

IALA are aware of the advancements of technology and the novel uses of floating infrastructure in the marine environment. An example being the Ocean Cleanup project. This sort of floating infrastructure poses a risk to the mariner but is not easily categorized to fit with other areas of this Guideline. When deciding on the marking of floating infrastructure, the competent authority will need to assess the risk posed to mariner and the AtoN required to best mitigate this risk.

This could include, but not be limited to:

a. Yellow Marine Lights with a recommended minimum range of five nautical miles of a characteristic appropriate to the area or use.

b. Yellow painting of all or part of the structures to be highly visible to mariners.

c. Radar Reflectors mounted on the structure.

d. AIS AtoN

e. Racon

Maritime safety information on these structures should be fully promulgated through correct charting and safety broadcasts as appropriate.

3. FUTURE REQUIREMENTS

IALA is aware that there is an increasing quantity of energy devices and structures already in place and many more planned that may affect shipping.

It is therefore recommended that competent authorities continuously monitor developments to ensure that any navigational problems caused by offshore structures are solved in a satisfactory manner.

As maritime autonomous surface ships (MASS) develop AtoN requirements at man-made structures may change and the competent authority will need to review them.

4. DEFINITIONS

The definitions of terms used in this Guideline can be found in the *International Dictionary of Marine Aids to Navigation* (IALA Dictionary) at http://www.iala-aism.org/wiki/dictionary and were checked as correct at the time of going to print. Where conflict arises, the IALA Dictionary should be considered as the authoritative source of definitions used in IALA documents.

In addition, for this document:

Competent authority – the regulatory body for AtoN marking of offshore structures.

Highest astronomical tide (HAT) - is the highest level that can be expected to occur under average meteorological conditions and under any combination of astronomical conditions. HAT is not an extreme level, as certain meteorological conditions can cause a higher water level.

Nautical mile – 1852m.

Offshore structure **-** Within this Guideline the term “offshore structure” refers to any man-made infrastructure placed in the marine environment separated from the coastline of a state.

Significant peripheral structure (SPS) – the corner wind generator on a rectangular OWF or other structure on the periphery of an OWF.

Usual range – the usual range of the HWS signal shall be calculated in accordance with IALA Recommendation *R0109 The Calculation of the Range of a Sound Signal.*

Subsidiary Light – additional red light(s) located on offshore platform(s) used to mark the extremities of extensive installations and their interconnecting bridges.

Promulgation – to make known by open declaration; publish; proclaim formally or put into operation (a law, decree of a court, etc.).

5. ABBREVIATIONS

AIS	Automatic Identification System
AIS AtoN	AIS as a Marine Aid to Navigation
AtoN	Marine Aid(s) to Navigation
HAT	Highest Astronomical Tide
HWS	Hazard Warning Signal (Fog Signal)
IPS	Intermediate Peripheral Structure [OWF]
MASS	Marine Autonomous Surface Ship
MBS	IALA Maritime Buoyage System
MHWS	Mean High Water Springs
MSI	Maritime Safety Information (e.g., NAVTEX, Notices to Mariners)
OREI	Offshore Renewable Energy Installation
OWF	Offshore Wind Farm(s)
SOLAS	Safety of Life At Sea [convention].
SPS	Significant Peripheral Structure [OWF]
UKC	Under Keel Clearance
WTG	Wind Turbine Generator

6. REFERENCES

[1] IALA. Standards

[2] IALA. Navguide

[3] IALA. Recommendation R1001 IALA Maritime Buoyage System

[4] IALA. Recommendation R0130 Categorization and availability objectives for short range AtoN

[5] IALA. Guideline G1134 Surface colours used as visual signals on AtoN

[6] IALA. Guideline G1065 AtoN Signal Light Beam Vertical Divergence

[7] IALA. Guideline G1073 Conspicuity of AtoN lights at night

[8] IALA. Guideline G1121 Navigational safety within marine spatial planning

[9] IALA. Guideline G1090 Use of audible signals

[10] IALA. Guideline G1078 The Use of AtoN in the design of Fairways and Channels

[11] German Federal Waterways and Shipping Administration (WSV) Technical Document TF13

[12] United Kingdom MCA. Document MGN 654

7. FURTHER READING

[1] PIANC. (2018) MarCom Wg 161 Interaction Between Offshore Wind Farms and Maritime Navigation.