TRAFICOM/575684/03.04.01.01/2023
VÄYLÄ/7167/07.01.00/2023

Issued:	Entry into force:	Validity:
7 Nov. 2023	7 Nov. 2023	Until further notice

Legal basis:
Act on the Finnish Transport and Communications Agency (935/2018)
Water Traffic Act (782/2019)
Vessel Traffic Service Act (623/2005)
Act on the Finnish Transport Infrastructure Agency (862/2009)
Act on the Ice Classes of Ships and Icebreaker Assistance (1121/2005)

Modification details:

Coordinating offshore wind power, maritime transport and maritime transport infrastructure

Foreword

This guideline has been drawn up in cooperation between the Finnish Transport and Communications Agency Traficom as well as the Finnish Transport Infrastructure Agency. The guideline discusses issues to be taken into account in the coordination of maritime transport and wind farms, in which the roles of Traficom and the Finnish Transport Infrastructure Agency involve issuing statements or instructions and advice related to the matter as authorities, as well as cooperation with other authorities and interest groups.

The aim of the guideline is to describe the procedures of Traficom and the Finnish Transport Infrastructure Agency during the land use planning, assessment and permit processes of planned offshore wind farm projects and provide background for the requirements of the agencies on taking maritime transport and its infrastructure into account in wind power projects.

Due to the close cooperation between Traficom and the Finnish Transport Infrastructure Agency in offshore wind power projects, and because the instructions and statements by the agencies are closely interlinked, a decision has been made to compile the instructions and views of the agencies into joint instructions so that key issues concerning the coordination of maritime transport and wind farms are available for parties such as land use planners and wind power developers in a single set of instructions.

The guideline also takes account of issues related to matters such as maritime safety, maritime search and rescue and measures to combat environmental damage that are essential from the perspective of the Finnish Border Guard, as well as observations of the rescue services regarding emergencies and dangerous situations. The Finnish Border Guard issues independent statements in the land use planning, assessment and permit processes of wind farm projects in accordance with its mandate.

TRAFICOM/575684/03.04.01.01/2023
VÄYLÄ/7167/07.01.00/2023

Table of contents

General

There are more than 10,000 km of public channels on the Finnish coast, of which merchant shipping lanes constitute nearly 3,500 km. There are more than 16,300 aids to navigation in the coastal channels in total. Safely and smoothly operating maritime transport both in the channels as well as the sea areas outside channels is especially important to Finland, because most of the streams of goods in Finland's foreign trade are transported by sea. Among other things, the channels serve approximately 50 merchant shipping ports, spread out over the Finnish coast. The ports, merchant shipping lanes and ice breaking in winter navigation, including areas outside the territorial waters but within Finland's exclusive economic zone, serve Finland's foreign trade. Over 90% of Finnish foreign trade travels by sea, and due to the changes in the geopolitical situation, the share continues to grow.

Due to the existing widespread network of routes and the limited number of sea areas suitable for the construction of wind farms, the planned wind farms have typically been located close to the channels. The technological development of the wind farms has also increased the interest of wind power developers in Finland's exclusive economic zone, where large wind power production areas can be implemented.

When wind farms are located close to channels or vessel traffic areas, they can hinder the smooth operation of maritime transport, the positioning and radar systems of vessels, maritime wireless communication networks as well as the radar surveillance of vessel traffic management or cause danger to navigation and the safe use of channels. In principle, wind farms planned for the open sea are larger than wind power projects planned and already implemented near the coast. As a result, wind farms in the open sea may have, in addition to the impacts mentioned above, a significant impact on the routes used for navigation in the area as well as winter navigation, due to both the reduction of the area available for operation by icebreakers and merchant shipping as well as the increase of rescue assignments due to the reduction in potential operative area.

In the open sea, maritime transport is not focused on narrow and marked fairway areas like the traffic in coastal channels; instead, it is spread over wider areas, in which the routes of the vessels in open water conditions are determined by their destination. Ice conditions have a significant impact on navigation, because the winter navigation routes are determined based on the ice situation at the time. Climate change will not bring immediate relief for the ice conditions, because the changing wind conditions will increase the creation of ice banks and further hinder the ability of merchant vessels to pass through ice fields. In the Gulf of Bothnia, winter traffic is managed in cooperation with Sweden so that it passes through the area with the easiest ice conditions, because even merchant vessels with a high ice class cannot always pass through heavy belts of slush and zones of pack ice, not even assisted by icebreakers.

Due to the above, wind power projects planned for the open sea may have a significantly larger impact on the operating conditions of navigation than projects located near the coast, the impact of which is typically focused on the port or set of routes within the project area. There are not enough data available on the impact of wind farms on ice fields, but when they are located in the zone of moving pack ice outside the fast ice, it is possible that they may further increase the formation of both ridges of ice as well as areas with slush belts.

It is important that wind power developers recognise the importance of coordinating the planned wind farm, maritime transport and its infrastructure already during the project's preliminary planning stage in order to ensure that the project planning and permit processes go as smoothly as possible and avoid unnecessary sea floor studies.

Wind power construction may also have a major impact on the operation of maritime search and rescue. Decentralised wind turbines and large wind farms in particular may prevent the implementation of search or rescue flights on low altitudes completely. When visibility is poor and the cloud ceiling is low, instrument flight regulations are followed in sea areas. Approaches are carried out with the help of radar, and minimum distances to obstacles increase to several kilometres. As a result, in the worst case scenario, wind turbines may completely prevent the use of helicopters in urgent, life-saving emergency missions in large areas, even during good conditions.

The purpose of the wind power instructions by Traficom and the Finnish Transport Infrastructure Agency (later referred to as the "agencies") is to safeguard the operating conditions of Finnish merchant shipping and ensure safe navigation so that the current risk level of navigation will not increase significantly due to wind farms built close to channels, vessel traffic areas, aids to navigation, or maritime radar or radio stations.

1 KEY CONCEPTS

1.1 Channel

A channel is a continuous route between its end points through a water area, marked on a map and in the terrain. According to the Water Act (587/2011), a public channel means a channel in a water body, designated as a public channel or public local channel under the provisions of the Act. Public channels are marked on a nautical chart maintained by the Finnish Transport and Communications Agency. (Traficom, *Vesiväyliin liittyvät käsitteet* ('Channel-related definitions', in Finnish), Doc. no 552253/03.04.01.01/2021)

1.2 Navigation line

Navigation line is a planned line indicating how a vessel should navigate through the channel. The navigation line does not necessarily pass through the centre of the fairway area. The channel line is presented as a continuous line on the nautical chart. (Traficom, *Vesiväyliin liittyvät käsitteet* ('Channel-related definitions'), Doc. no 552253/03.04.01.01/2021)

1.3 Fairway area

Fairway area is an area intended for the use of waterborne traffic delimited by the channel's edge lines. The fairway area also includes any special seafaring areas that are designed to exist in connection with the channel, such as waiting, encounter and swinging areas. The fairway area is unambiguously defined by means of coordinates in the waterway design documents and on the waterway chart submitted to the Regional State Administrative Agency in connection with an application to establish a public channel pursuant to the Water Act. In older decisions, the fairway area is not always indicated. In such cases, an area determined based on the channel markings, the verifying measurements conducted and the general fairway area design criteria is interpreted as the fairway area. In some channels, the fairway area is shown on the nautical chart. The edges of a fairway area are marked by spar buoys, buoys and edge marks. Not all break points of the fairway area are necessarily marked. (Traficom, *Vesiväyliin liittyvät käsitteet* ('Channel-related definitions', in Finnish), Doc. no 552253/03.04.01.01/2021)

1.4 Approaches to channels

The front of the outer end of the channel, through which maritime transport enters the channel and exits the channel towards its destination.

1.5 Aid to navigation

Aids to navigation are physical structures and devices located in the water or on shore to mark channels or otherwise guide and safeguard waterborne traffic. Aids to navigation can also be virtual presentations of such devices, or a combination of physical and virtual. Physical aids to navigation can be fixed or floating. (Traficom, *Vesiväyliin liittyvät käsitteet* ('Channel-related definitions', in Finnish), Doc. no 552253/03.04.01.01/2021)

1.6 Anchorage area and anchorage

The anchorage area is a dedicated area for anchoring with defined limits, indicated on the nautical chart and also marked at sea if necessary. The anchorage area can be an area adjacent to the fairway area or one separate from the actual channel, for example in off-shore areas beyond the outer reaches of the channel. Nautical charts include so-called recommended anchorages with no defined limits. (Traficom, Vesiväyliin liittyvät käsitteet ('Channel-related definitions', in Finnish), Doc. no 552253/03.04.01.01/2021)

Preparations must be made for establishing new anchorage areas or anchorages especially in channels located in the Gulf of Bothnia as well as in front of channels, where they have not been established or assigned yet. In their instructions and statements, the agencies also take the planned anchorage areas and anchorages into account.

1.7 Designated areas for ship-to-ship oil cargo transfer operations between oil tankers

In its regulation (Designated areas for ship-to-ship oil cargo transfer operations between oil tankers in Finnish waters and Finland's exclusive economic zone, Doc. no TRAFICOM/326360/03.04.01.00/2021), the Finnish Transport and Communications Agency has specified the areas in Finnish waters and Finland's exclusive economic zone in which cargo transfers and fuel deliveries can be carried out. The areas and their coordinates are presented in the annexes to the regulation in question. The cargo transfer areas must be taken into account in planning the location of wind power areas in the same way as other areas allocated to maritime transport.

So far, only one cargo transfer area has been assigned in the Gulf of Bothnia, and therefore it is possible that new cargo transfer areas will be assigned in the region. In their instructions and statements, the agencies also take the planned new cargo transfer areas into account.

1.8 Place of refuge

An area identified by the Finnish Transport and Communications Agency for accommodating ships in distress. (Vessel Traffic Service Act (623/2005) section 2, paragraph 14). Places of refuge are not public information, and they are not marked in nautical charts. At the start of land use or project planning, Traficom will instruct the land use planner or wind power developer in taking places of refuge into account.

1.9 Routeing system

The purpose of the routeing system is to promote the safety, smooth operation and sustainability of vessel traffic in international seas. The routeing system can include traffic separation schemes (TSS), two-way routes, recommended routes, areas to be circled and avoided, coastal traffic zones, roundabouts, safety areas and deep water routes. A suitable system solution and its specific characteristics are always determined on a case-by-case basis, often by taking advantage of a risk assessment based on IMO's Formal Safety Assessment (FSA).

According to the SOLAS Convention, international routeing systems are always confirmed by the International Maritime Organisation, IMO. The IMO has also adopted a

resolution on the establishment of systems with general instructions on how to comply with the requirements presented there. In addition, international regulations have been issued on the operative use and monitoring of routeing systems. In Finland, the international regulations on a routeing system have been enacted through national regulation.

Especially in the southern sea area, where the ice conditions do not usually hinder the operation of maritime vessel traffic significantly, establishing a routeing system can be a safe way to arrange maritime transport in an area in which wind farms are placed on both sides of a heavily trafficked vessel traffic area. Because vessels must travel a specified route, solutions such as establishing a traffic separation scheme (TSS) in the northern sea area are unlikely to be appropriate, because there the ice conditions have a major impact on the routes used for navigation.

For example, traffic separation schemes have been established in both the Gulf of Finland and the Gulf of Bothnia. At their widest, the traffic separation schemes in front of Finland are over ten kilometres wide. Even in these areas, the use of traffic separation schemes is interrupted temporarily by the decision of an authority, if the ice situation requires it. In Finland, these areas are monitored by Fintraffic Vessel Traffic Management.

1.10 Vessel traffic reporting system

The reporting system is an important part of the operation, monitoring and flow of information of the routeing system. It refers to the mandatory registration with and reporting of vessels to the VTS centre when the vessel arrives in an area covered by the routeing system. After registration, the vessel is constantly monitored by the VTS centre.

Establishing a vessel traffic reporting system makes it possible to improve the safety of navigation in the vicinity of wind farms, and it is justified especially in sea areas in which wind farms focus maritime transport into a narrow sea area, or the construction of wind farms creates traffic channels and intersections in the sea area.

The regulations on the reporting system are based on the SOLAS Convention that always requires approval by IMO. In Finland, the international regulations on the reporting system have been implemented in national regulations.

In the Gulf of Finland, there is a mandatory reporting system established through international cooperation, the GOFREP (Gulf of Finland Reporting). For Finland, the area is monitored by Fintraffic Vessel Traffic Management.

Maritime transport monitoring and surveillance devices as well as communications networks that play a central role in maintaining the safety and smooth operation of maritime transport in the vicinity of wind farms have been described in more detail in sections 2.12– 2.15.

1.11 Vessel traffic area

A vessel traffic area is a continuous area located outside channels and the routeing system that has a high traffic volume or that is regionally important. The most central vessel traffic areas must be kept free in order to preserve the operating conditions of navigation and the security of supply. The impact of route changes caused

by wind power projects and the lengthening of distances navigated by vessels as a result in addition to the increased frequency and intersections of traffic must be taken comprehensively into account.

The vessel traffic areas used in maritime transport are mapped and generated based on information on the routes travelled by vessels according to the existing data from the AIS (Automatic Identification System) system of vessels. For example, the "seafaring area" indicated in the Finnish maritime spatial plan is based on AIS data, among other things. However, regarding AIS data it must be noted that traffic along direct lines during the period of open water emphasises the proposed routes for vessels, whereas winter traffic is distributed over a wide area depending on the ice situation.

When determining the vessel traffic areas in the vicinity of a planned wind power project, a good starting point is to investigate the location of the "seafaring area" indicated in the Finnish maritime spatial plan in relation to the planned wind power area. As the design project progresses, the vessel traffic areas must be determined in more detail, taking account of factors such as winter navigation in different ice years. When determining the winter navigation traffic areas, sometimes attention must also be paid to areas with a lower traffic volume, because under certain conditions the area may be necessary to ensure the smooth operation of winter navigation. Traficom and the Finnish Transport Infrastructure Agency will provide more detailed instructions for wind power developers on the issue.

1.12 Vessel Traffic Service

Vessel Traffic Service (VTS) means a service designed to supervise and manage vessel traffic, which has the capability to interact with traffic and to respond to changing traffic situations (Vessel Traffic Service Act (623/2005), section 2, paragraph 1). The most important piece of monitoring equipment for the Vessel Traffic Service is the VTS radar.

1.13 Radar compensation

If the wind turbine or wind farm that was constructed should prevent or hinder the provision of a Vessel Traffic Service in the area, the harm must be compensated to the VTS service provider (Fintraffic Vessel Traffic Management) with a new radar station or by agreeing on a financial compensation that the VTS service provider will use to update the VTS radar system in order to ensure that the Vessel Traffic Service is free from interference. The compensation procedure compensates for the reduction in radar performance caused by the wind farm built in the area.

If the wind farm to be constructed is located in the immediate vicinity of a central vessel traffic area, extending the Vessel Traffic Service, and therefore also increasing the radar resource, to such an area must be considered on a case-by-case basis together with Traficom, the VTS service provider as well as the keeper of the wind turbines.

Traficom and the VTS service provider will provide guidance and instructions in matters related to the radar compensation procedure as well as details related to the new radar station.

1.14 Ice situation monitoring cameras and radar

The radar mentioned in section 1.13 above are also used to monitor the ice situation in Finnish territorial waters and the exclusive economic zone. If the wind farm that was constructed should affect the winter navigation or its arrangement in the area, adding cameras and/or radar equipment suitable for monitoring the ice situation and the movement of ice to the structures of the wind turbines will improve the monitoring of the overall ice situation as well as the assignment of icebreaking assistance in the area at the right time. The potential acquisition of cameras and/or radar equipment suitable for monitoring the ice situation and the movement of ice must be agreed on a case-by-case basis between the keeper of the wind turbines as well as the Finnish Transport Infrastructure Agency. The keeper of the wind turbines must be prepared to take responsibility for all of the costs of purchasing and installing the cameras and radar equipment.

The Finnish Transport Infrastructure Agency will provide instructions and guidance in matters related to the monitoring cameras.

1.15 Turku Radio and maritime wireless communications networks

According to international conventions, every coastal state must have a coast radio station responsible for maritime safety radio traffic. Turku Radio is the national Finnish coast radio station that is responsible for the coastal safety radio communication in Finland; in the winter season, it also transmits the vessel and route information of icebreakers on the VHF channels it uses. Location and identification data sent by vessels are received via the AIS base station network operating on VHF frequencies; they can be used in several different systems to monitor vessel traffic. Via the base station network, vessels can also be sent messages to support navigation, such as information on the weather and aids to navigation. The information in the AIS system is used by e.g. coastal VTS centres in monitoring vessel traffic, and its operation free from interference is a key part of maintaining the safety of navigation.

The structures of a wind turbine may affect the progress of VHF waves and cause connections to break. If a wind farm that has been constructed causes interference or harm to the maritime wireless communication networks, the harm must be compensated by adding base stations to the area so that the interference or harm caused by the wind farm to wireless communications networks is removed. The compensation procedure is used to compensate for the harm or interference caused to wireless communications networks by a wind farm built in the area. The keeper of the wind turbines must be prepared to take responsibility for all costs of purchasing and installation related to the maritime wireless communications networks.

Traficom, the Finnish Transport Infrastructure Agency and the VTS service provider provide instructions and advice in matters related to the maritime wireless communication networks.

1.16 Open sea

In this guideline, open sea refers to the open and often deep sea area in Finnish territorial waters and the exclusive economic zone outside the coast and islands, where in principle there are no channels. However, vessels coming from and entering channels require sufficiently large and safe approaches to channels in the open sea, too.

2 WIND TURBINE DISTANCE REQUIREMENTS FROM CHANNELS AND VESSEL TRAFFIC AREAS

Public channels are allocated to the use of maritime transport with an order of the permit authority in a procedure in accordance with the Water Act, and they must be kept open for navigation. The accessible use of channels also requires a free passage for navigation in the sea area between the open sea and the channel (vessel traffic area). According to article 60, paragraph 7 of the United Nations Convention on the Law of the Sea (50/1996), artificial islands, installations and structures and the safety zones around them may not be established where interference may be caused to the use of recognised sea lanes essential to international navigation. When wind farms are located close to channels or vessel traffic areas, they can interfere with the positioning and radar systems of vessels, maritime wireless communication networks as well as the radar surveillance of vessel traffic management, or cause danger to navigation and the safe use of channels or harm the operating conditions of navigation e.g. during ice cover. Large wind farms in the open sea may also affect the accessibility of ports and the operating conditions of navigation more extensively, because wind farms may have a significant impact on routes used for maritime transport as well as winter navigation routes that are implemented depending on the ice situation at the time, in addition to the need of merchant vessels for ice-breaking assistance.

The report 'Wind farms' influences for traffic safety' of the Ministry of Transport and Communications (Publications of the Ministry of Transport and Communications 20/2012, in Finnish) examined, among other things, the international recommendations for the distances between offshore wind farms and maritime transport routes. The starting point for the recommendations is compliance with the international navigation regulations, of which significant in this context are especially the International Regulations for Preventing Collisions at Sea (1972) by IMO, the General Provisions on Ships' Routeing as well as ship manoeuvring standards, in addition to the UNCLOS regulations concerning the safety zones of maritime structures. As a summary of the report, it has been stated that in the risk assessments conducted, approximately 1–2 nautical miles (1.8–3.6 km) has generally been considered a safe distance between wind turbines and vessel routes, but occasionally there is a need for an even longer distance. Annex 1 includes an example of these design parameters and their practical implementation. In Finland, the risk assessment is conducted on a project-specific basis; one of the key points is the assessment of a sufficient distance between channels, vessel traffic areas and wind turbines.

International recommendations on the distance between wind turbines and vessel traffic areas are not suitable for Finland as is, because the Finnish coast and winter conditions differ significantly from the areas in which offshore wind farms are typically built around the world. In Finland, the risk of a vessel collision with a wind turbine near the coast is relatively low, because most of the Finnish channels have been dredged and they pass through fairly shallow waters. In contrast, wind turbines in the open sea are mainly located in deep water areas in Finland, too. Maritime transport in the open sea is not focused on narrow, marked and dredged fairway areas like the traffic in coastal channels; instead, the routes of the vessels are determined by their destination. In the open sea, too, a sufficient distance between the vessel traffic area and wind farms is needed, not only to ensure the freedom from interference of maritime positioning and radar systems as well as maritime wireless

communication networks in the same way as for wind farms located along the channel, but also to ensure the operating conditions of winter navigation. The smooth operation of winter navigation requires sufficiently clear traffic areas and enough distance to wind farms.

2.1 Special characteristics of winter navigation and taking them into account

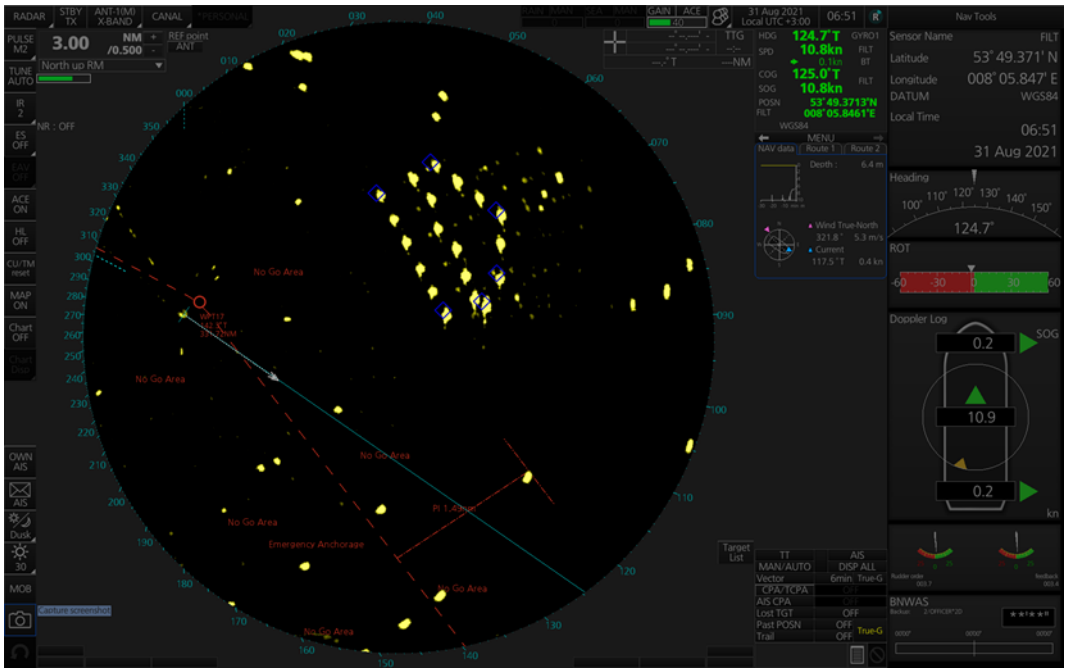
Unlike the fast ice in the archipelago, the ice in the open sea moves and creates ice banks and heavy slush belts especially at the edges of the zone of fixed ice, extending often as far as dozens of kilometres outward from the fixed ice. The challenging ice formations that are created by the movement of ice also travel dozens of kilometres during the winter. The winter navigation routes are realised depending on the ice situation at a given moment, so the aim is usually to follow the easiest route during the prevailing ice conditions; as a result, the winter navigation routes may differ significantly from the direct travel between the channel and the open sea during open waters. 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, too.

In winter navigation in the Gulf of Bothnia, vessel traffic is guided jointly by Finland and Sweden to pass through the areas with the easiest ice conditions, regardless of the port of departure or destination of the vessels. Large wind farms placed in front of channels and vessel traffic areas increase the need for assistance during winter navigation, because it is not possible to leave vessels waiting for assistance in moving ice in front of wind turbines or let them pass between large wind farms or through their immediate vicinity without assistance in order to ensure the safety of navigation. Due to wind farms that are large or placed next to each other, it may be necessary to allocate safe waiting areas suitable for vessels especially in the Bay of Bothnia a considerable distance away in an open sea area; for its part, this also ties the capacity of icebreakers to increasingly longer trips to provide assistance. As the masses of ice move, the ice may push the vessel towards a wind farm, and in the worst case, the ice may cause the vessel to collide with a wind turbine. This may lead to human lives being endangered and potentially also environmental damage.

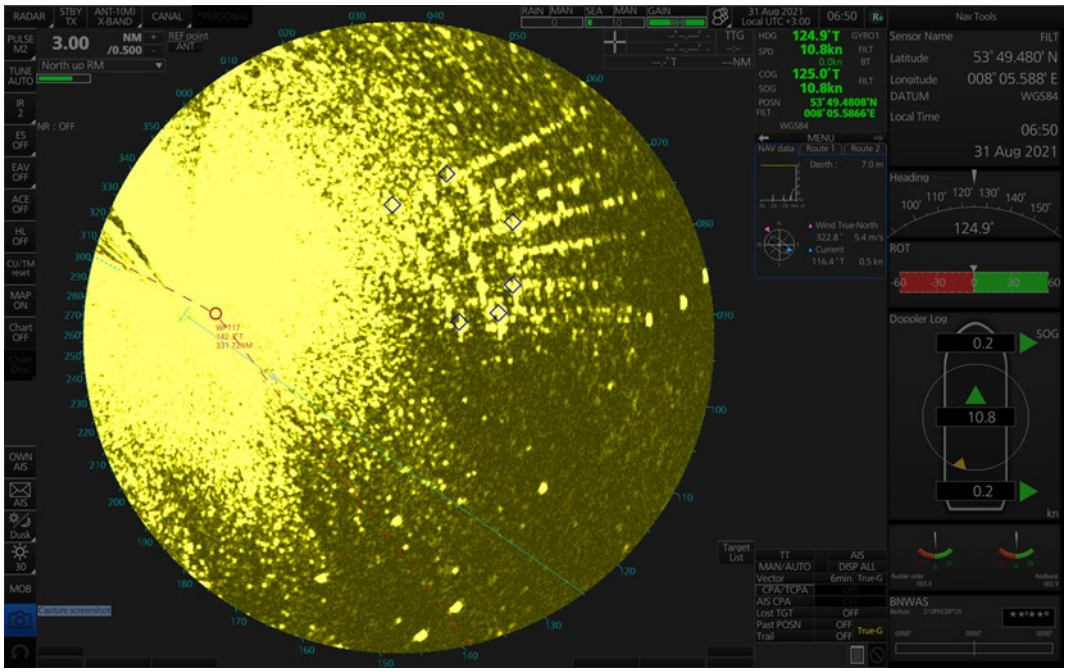
The construction of large wind farms in the sea area will likely increase the additional need for icebreaker capacity compared to the current situation. The smooth operation of winter navigation in front of a wind farm can be improved by means such as adding cameras and/or radar equipment suitable for monitoring the movement of ice to the structures of wind turbines to improve the monitoring of the overall ice situation and the assignment of icebreaking assistance in the area at the right time.

Wind farms may affect route choices during winter navigation, if using the most suitable and economical routes is not possible and ice must be broken in areas that are less optimal for icebreakers, which will slow down the work of icebreakers and increase both their fuel consumption as well as that of the assisted vessels. It also increases the risk of damage to the vessels. The reduction in the area of operation of icebreakers may also make winter navigation more vulnerable to disturbances especially during difficult winter conditions when the number of suitable routes is reduced.

The radar usage and settings during winter navigation differs from the period of open waters, which means that the potential radar interference by wind farms may be different for ice and open water navigation. In winter navigation, the use of radar requires receiving a reflection from the ice in order to find a navigable route, while during the open water season, radar is used to detect objects around the vessel.



Picture 1 Radar image of the vicinity of a wind power area with open water navigation settings (ESL Shipping, M/V Viikki)



Picture 2 Radar image of the vicinity of a wind power area with ice navigation settings (ESL Shipping, M/V Viikki).

Further information on the special characteristics and routes of winter navigation and the boundary conditions it sets for e.g. wind power projects is available from the Finnish Transport Infrastructure Agency.

2.2 Distance requirements, dimensioning principles and the placement of wind turbines

In principle, a safety distance of at least 1.5 km must be left between wind turbines and channels (fairway areas), anchorage areas and places of refuge, if the effects of the wind turbine on navigation, the use of channels or the maritime positioning and radar systems and maritime wireless communication networks have not been investigated. In areas known to be difficult for winter navigation, a safety distance longer than the default 1.5 km may be needed. Based on the appropriate reports, Traficom and the Finnish Transport Infrastructure Agency can assess potential changes in the safety distance if, based on investigation and a risk assessment by maritime transport operators, it is possible to be sufficiently certain that the wind power project will not endanger the safety of navigation or the use of channels, interfere with or endanger the positioning and radar systems of vessels and maritime wireless communication networks or the radar surveillance of vessel traffic management, or harm the operating conditions of navigation e.g. during ice cover.

In the open sea, the recommended distance proposed in the PIANC report no: 161 is followed, when applicable, for distances between vessel traffic areas, the approaches to channels as well as routeing systems and wind power production areas, so that the distance between the areas mentioned above must be 1–3 nautical miles. A longer safety distance may also be needed especially in areas known to be difficult for winter navigation, such as in the drift ice and pack ice zones of the Bay of Bothnia as well as areas with hummock ice. The more specific safety distances suitable for the area must be determined on a case-by-case basis, based on factors such as

the location of the project area, ensuring the operating conditions of winter navigation, the appropriate reports drawn up on the project, and risk assessments by maritime transport operators, as well as by taking account of the combined effects of potential other wind power production areas on navigation in the area.

In the vicinity of fairway areas and route systems, the safety distance is measured from the edge of the fairway area or the routeing system (e.g. a traffic separation scheme) to the closest point of the arc of the wind turbine rotor blades. If no fairway area has been specified for the channel, the area is determined based on the channel markings, the verifying measurements carried out and the general fairway area design criteria. The boundary lines of vessel traffic areas in the open sea must be determined on a case-by-case basis, and the safety distance is measured in the same way as in the fairway areas and routeing systems.

In the open sea, in water areas outside the channels, general information on the vessel traffic areas can be found based on the "seafaring area" markings of the Finnish maritime spatial plan. Vessel traffic areas can be specified in more detail based on e.g. the traffic flow information collected over different years and seasons and the traffic density maps compiled based on them. When examining traffic flow information, it is important to be aware of the differences between navigation during ice cover and in open waters. During the period of open waters, maritime transport usually moves towards the destination in a direct line, while during ice cover the easiest route in the prevailing ice conditions is chosen, which means that the routes wind their way around difficult ice conditions. However, these longer routes are faster and consume much less energy compared to passing through heavy ice conditions. The most difficult ice conditions cannot be breached even with assistance from icebreakers.

Clearly delineating the outer boundaries of wind farms and placing wind turbines in regular patterns is recommended from the perspective of safety at sea. In wind farms, placing the outer boundaries of wind turbines in a straight line in the same direction as the channel or vessel traffic area next to it makes it easier for seafarers to observe the boundaries of the wind farm. Placing wind turbines in a regular pattern (diagonal) while taking account of the appropriate flight corridors within the wind farm makes rescue activities in the wind farm easier. In addition, the measures mentioned above enable passing through in an aircraft quickly, if necessary. As a rule, rescue activities using aircraft within a wind farm are not possible when it is dark or in poor weather conditions. As a rule, wind farms will hinder and slow down maritime search and rescue assignments, especially those carried out with aircraft. If areas free from wind turbines must be reserved in the wind farm to be constructed in order to enable maritime traffic through the wind farm, the suitability of the open corridors for the aircraft of maritime search and rescue services should also be investigated at the same time.

When assessing the safety distance between channels, anchorage areas, places of refuge, vessel traffic areas and wind turbines, account must also be taken, if necessary, of the wind turbines located on the outer edges of wind farms in addition to ice coming loose from the structures of wind turbines or the structures themselves breaking or coming loose, because they may cause a safety risk to maritime transport. The risk factors mentioned above and potential methods for mitigating them must be studied in the risk assessment of the project.

3 WIND FARMS AND AIDS TO NAVIGATION

A wind turbine must not cover or obstruct the visibility of aids to navigation for seafarers. Disturbances may be caused if the lights of a wind turbine and aids to navigation are confused with each other or if the aid to navigation is covered by the structures of the wind turbine. Wind turbines and a wind farm consisting of several wind turbines may also interfere with the visibility of radar reflectors of aids to navigation or the radar beacons of fixed aids to navigation on the radar of vessels. The sufficient distance of a wind turbine from an aid to navigation or its placement in relation to the aid to navigation must be considered on a case-by-case basis and, if necessary, a simulation model can be used that makes it possible to estimate the impact of the wind turbine on what is visible to seafarers. A simulation study must be carried out at different sections of the channel and at different heights of inspection in order to determine any potential interference. The simulation study has been presented in more detail in section 10.

In addition to changing the location of the wind turbine, the risk of confusing the light markings of the aids to navigation and wind turbines with each other can be reduced by means such as sufficiently easily distinguishable light markings or changing the luminosity of the lights within the limits permitted by the instructions of the authorities.

4 MARITIME RADAR AND POSITIONING SYSTEMS AS WELL AS WIRELESS COMMUNICATIONS NETWORKS

The use of radar as the main navigation and collision prevention tool for vessels and its central importance for winter navigation and traffic management must be taken into account in the wind farm location planning. Wind turbines may cause either shadows or reflections in maritime radar that, at their worst, make it more difficult to interpret radar signals. Wind turbines may also interfere with the detectability of radar beacons, or racons, with maritime radar.

In addition, wind turbines may affect the GNSS (Global Navigation Satellite System) systems or satellite navigation of vessels so that the satellite signals are reflected through wind turbines, causing a navigation error for the vessel using the system.

The reliable operation of radar systems is an integral part of maintaining the overall safety of navigation. The impact of wind turbines on the operation of radar, radio navigation equipment, maritime wireless communication networks and other similar radio equipment important to navigation and traffic management must be assessed in connection with the wind power project, and the potential interference on radar caused by wind turbines must be investigated further, if necessary. The detectability of racons (radar beacons) can be improved either by placing them elsewhere or installing new racons in locations where wind turbines do not interfere with their detectability.

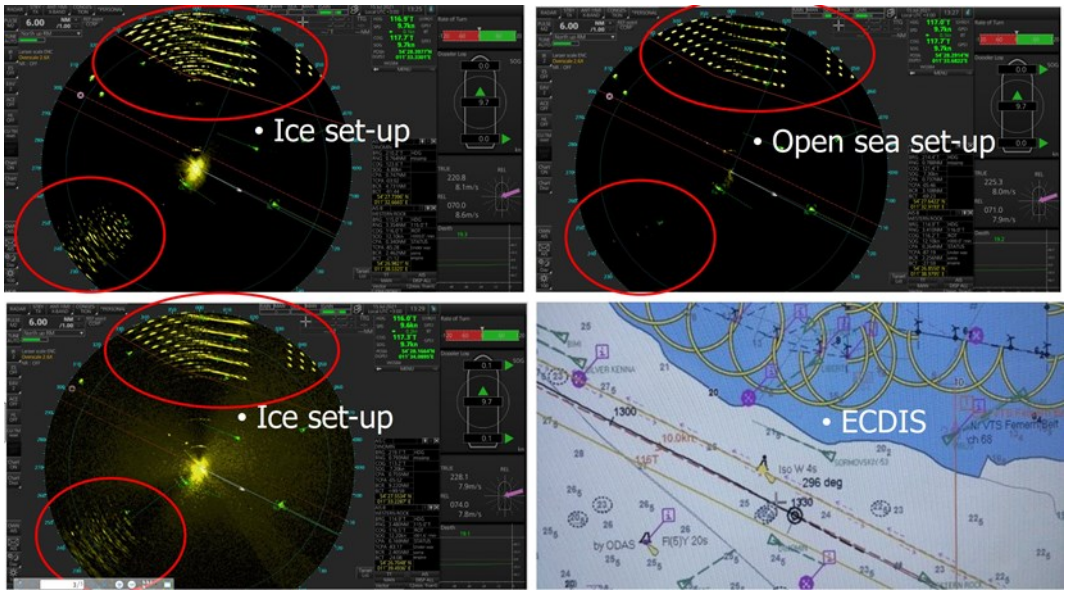
When assessing the impact of wind turbines on the radar systems of vessels, attention must be paid to the different ways of using radar during the open water season and the period of ice cover; it has not been necessary to take this into account in most of the international research already conducted, for example, because the projects have been located in sea areas that never freeze.

4.1 Vessel radar

Each merchant vessel has a radar system that is used for navigation and detecting objects around the vessel. A vessel radar that functions free from interference does its part to ensure the safety of navigation.

Wind farms located on both sides of a channel or traffic area or placed close to the channel or traffic area may cause unforeseen radar reflections and interfere with the operation of maritime radar. In addition, wind farms placed in the intersections of channels or vessel traffic areas may cause shadows that obstruct the visibility of the neighbouring channel or traffic area to the maritime radar of vessels.

The equipment-specific differences between vessel radar systems in interpreting the interference caused by wind turbines may be significant, and as a result, a study/report on the effects of wind turbines on maritime radar systems should be implemented using different radar systems to ensure a sufficiently comprehensive overview. When studying the impact of wind farms on the radar systems of vessels, special attention must be paid to the radar settings and the use of radar during winter navigation that differ from the period of open water.



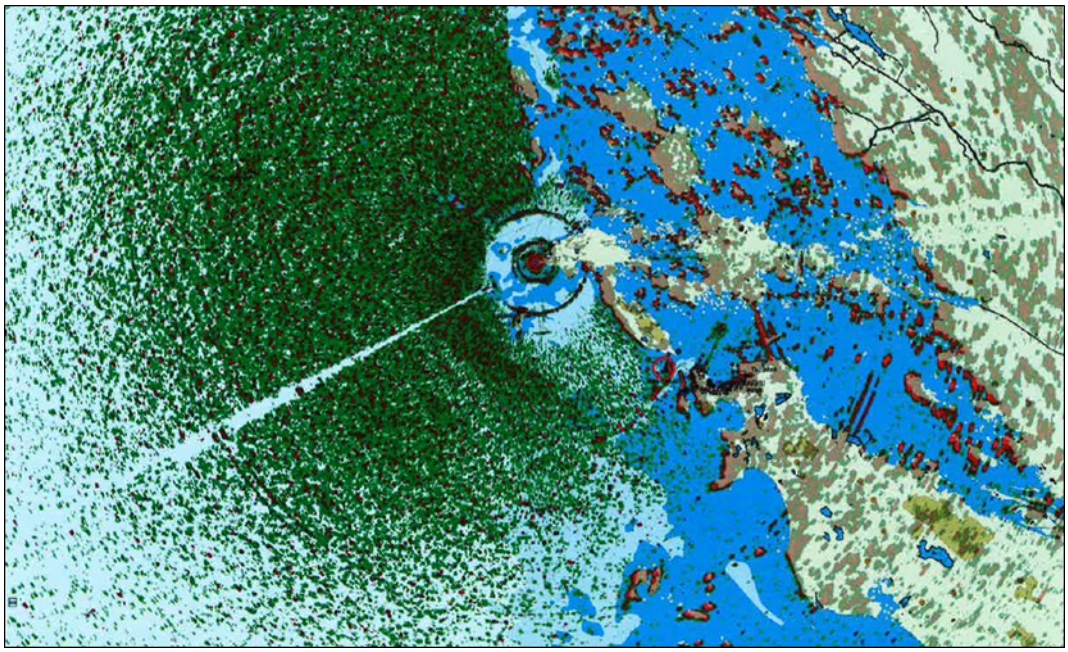
Picture 3 Radar display with different settings in the vicinity of wind power areas (Neste M/T Lunni).

4.2 VTS radars in traffic management

The key observation method in traffic management is radar, and it must have an unobstructed view of the monitoring area. All merchant shipping lanes in Finland are within the scope of traffic management, and they are monitored by approximately 100 VTS radars. The radars are placed at a height of roughly 25–50 metres, and monitoring sectors have been specified for each radar. In principle, the existing VTS radars and their structures must not be moved. If radar visibility must be increased due to the construction of a wind turbine or farm, the new radar station must be placed so that traffic management has an unobstructed view of the whole monitoring sector.

Picture 4 VTS radar at the Port of Rauma (Finnish Transport Agency).

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.



Picture 5 An example of a blind spot on VTS radar caused by wind turbines (Finnish Transport Agency).

Interference with VTS radar can be prevented by the placement of wind turbines, ensuring that the existing VTS radar has an unobstructed view over its surveillance sector, and by placing the wind turbines or wind farm sufficiently far away from the VTS radar. The interference can also be compensated by adding a new VTS radar in a location, in which the radar has an unobstructed view of the surveillance sector and it is at a sufficient distance from the wind turbine or farm to minimise potential reflections. The radar compensation procedure has been presented in more detail in section 9.

VTS radars are also used to monitor the ice situation and movement of ice on the coast and in the approaches to channels. Wind turbines must not interfere with these purposes.

The current radar network on the coast has been constructed during a time when there was hardly any activity in the sea area apart from navigation. Wind farms located in the vicinity of vessel traffic areas increase the need for radar monitoring and surveillance, and a more extensive radar network can improve the safety and smooth operation of navigation significantly.

4.3 Other wireless communications networks

When planning wind power construction, the impact of wind turbines on radio systems must also be taken into account. In many cases, it has been found that wind turbines have affected the quality of TV reception in terrestrial TV broadcasting networks. Wind turbines also affect the strength of the mobile network coverage and the quality of the signal. As for the operation of a radio link, it requires an area with no obstacles whatsoever between the transmitter and the receiver.

It is recommended that the parties responsible for wind power projects contact the owners of all known radio systems in the area. Approximately 30 kilometres has been considered a sufficient coordination distance. The users of radio positioning systems and radio links as well as telecommunications operators should always be informed of wind power projects.

4.4 Investigating interferences

The potential interference caused by a planned offshore wind farm to maritime radar systems, satellite positioning and radio navigation equipment as well as maritime wireless communication networks must be determined with a comprehensive study, if the planned wind farm is located at a distance of less than 1.5 km from the fairway area. For justified reasons, such as if there are large wind power areas on both sides of the fairway area, determining the interference on a case-by-case basis may also be necessary for distances greater than 1.5 km. If the planned wind farm is located next to a routeing system, a vessel traffic area or an approach to a channel in the open sea, the need to determine the impact of the project on radar and positioning must be assessed on a case-by-case basis. For VTS radars, the location of the radar stations and their surveillance area must be taken into account. Fintraffic Vessel Traffic Services Ltd is responsible for the VTS radars.

The wind power developer is responsible for ordering the necessary research as well as the costs incurred due to it. A more specific agreement on the details of the research must be made in cooperation with Traficom and the Finnish Transport Infrastructure Agency.

With regard to radar, attention should be paid to at least the following issues in the research:

- Will the wind turbines cause interference in the radar image at a distance of less than 1.5 km from the channel, and if so, what kind of interference?
    - Visual specification of what the interference looks like in the radar image
- Will the wind turbines cause interference in the radar image when the vessel passes through the routeing system, a vessel traffic area or the approach to the channel, and if so, what kind of interference?
    - Visual specification of what the interference looks like in the radar image
- Will the planned wind turbines cause flashing effects at the narrowest areas or when "winter settings" are selected on the vessel radar, i.e. passing through an ice chute (ice chute settings: "MAX GAIN" and "NO SEA CLUTTER REDUCTION")?
- Will the turbines planned closest to the channel or the vessel traffic areas cause superbroadening of the echo, i.e. will they make the echo twist around the whole wind farm in the radar image? Radar echoes from land areas and other objects are common, in which case dots turn into a broader echo, but they should not extend over the edges of the real echo object.
    - In addition, a visual specification of what the interference looks like in the radar image

Based on the information in the study, Traficom and the Finnish Transport Infrastructure Agency receive information on the effects of the planned project on e.g. maritime radar systems and satellite navigation, which makes it possible to specify the distance requirement and possible changes to it. The final distance requirement is based on the view of navigation operators in the area (e.g. Traficom, the Finnish Transport Infrastructure Agency and Finnpilot), in which the report on radar and satellite navigation is taken into account as one factor, but the distance requirement must also take account of issues such as the operating conditions of navigation during ice cover in particular.

5 PRINCIPLES OF THE PROCEDURE IN THE LAND USE PLANNING, ASSESSMENT AND PERMIT PROCESSES OF WIND FARMS

From the perspective of navigation, wind farms planned for a sea area may affect matters such as the functioning of the transport system, maritime radar and radio systems as well as the safety of navigation, in which Traficom plays a central role (Act on the Finnish Transport and Communications Agency (935/2018), Vessel Traffic Service Act (623/2005)). In addition, in accordance with the Water Traffic Act (782/2019), an application must be submitted to Traficom regarding e.g. confirmation of changes related to the route that may be required due to the planned offshore wind farm.

The Finnish Transport Infrastructure Agency plays a major role in wind power projects both as the Channel Authority of the State as well as the party ensuring the operating conditions of winter navigation and ordering vessel traffic management services (Act on the Finnish Transport Infrastructure Agency (862/2009)). The Finnish Transport Infrastructure Agency also ensures the availability of icebreaker assistance in Finnish waters when the ice conditions require it (Act on the Ice Classes of Ships and Icebreaker Assistance (1121/2005)). In order to ensure the smooth operation of winter navigation, Finland and Sweden have a convention on cooperation in winter navigation. Offshore wind farms may have a significant impact on icebreaking operations and thereby also the reliability of sea transports in foreign trade as well as the emissions from navigation when operating in ice conditions.

Traficom and the Finnish Transport Infrastructure Agency cooperate closely with parties such as the Finnish Border Guard concerning planned offshore wind farm projects. The Finnish Border Guard is the leading maritime search and rescue (Maritime Search and Rescue Act (1145/2001)) and border control authority that coordinates the activities of other authorities that participate in border control in passenger traffic (Border Guard Act (578/2005)). In addition, the Finnish Border Guard takes care of rescue activities in case of oil spills from vessels and chemical accidents in Finnish territorial waters and the exclusive economic zone and coordinates preparations for it (Rescue Act (379/2011)). According to the Act on the Exclusive Economic Zone of Finland (1058/2004), the Finnish Border Guard monitors the right of use, construction and maritime research in the exclusive economic zone referred to in sections 6–8. Systematic hydrographic surveys of planned wind power areas in Finnish territorial waters require permission from Defence Command Finland (Territorial Surveillance Act (755/2000)).

Other key maritime operators include Fintraffic Vessel Traffic Services Ltd and Finnpilot Pilotage Ltd, with which Traficom and the Finnish Transport Infrastructure Agency cooperate closely in connection with wind power projects.

Traficom and the Finnish Transport Infrastructure Agency participate in the land use planning of offshore wind power projects, the environmental impact assessment (EIA) procedure, the permit procedure in accordance with the Water Act, and the permit procedure for wind power projects in the exclusive economic zone with the statements they draw up, by participating in negotiations on the project and instructing the wind power developer in negotiations together. In the instructions and statements they provide, the agencies also take account of the known wind power areas outside the project area, ensuring continuous navigation routes appropriate for

the purpose both in the open sea as well as between the open sea and fairway areas, in addition to the assessment of the combined effect of wind power areas on navigation.

When mapping areas suitable for wind power production, it is important to take into account that in the open sea, the routes of the vessels are determined based on a straight line to their destination. In the narrows (Northen Quark and the Sea of Åland) and busy areas (the Gulf of Finland), traffic is directed to use the traffic separation schemes approved by the decision of the International Maritime Organization IMO. According to the rules of the road at sea, vessels must use them while navigating through water areas, and movement on them cannot be restricted.

In order to ensure the operating conditions of navigation, taking the traffic separation schemes and free space for traffic used by the vessels into account when arriving in channels, ports and areas with a traffic separation scheme is of primary importance when planning areas suitable for wind power production.

When investigating potential new sea areas for wind power production, it is recommended that the wind power developer contact Traficom and the Finnish Transport Infrastructure Agency already before the planned project reaches the public processing stage, so that navigation and its infrastructure are taken into account as a key issue already during the project's preliminary planning stage in order to ensure that the land use planning, assessment and permit processes go as smoothly as possible.

From the perspective of maritime transport authorities, offshore wind power projects located in Finnish territorial waters or the exclusive economic zone and their instructions do not differ significantly from each other. The clearest differences between the projects mainly focus on the different permit practices and the scale and impact of the projects.

In Åland, activities are guided by the Act on the Autonomy of Åland (1144/1991); within its framework, the region has legislative power in issues regarding e.g. water law and land use planning. The Region of Åland is also responsible for the maritime spatial planning of its own water area. However, the Finnish Transport Infrastructure Agency is responsible for the maintenance and development of merchant shipping lanes in the region, while the regional administration is responsible for the other channels. The procedures and measures described in this guideline can also be applied to the wind farms planned within the Region of Åland, where relevant.

Due to the Convention on Environmental Impact Assessment in a Transboundary Context, also known as the Espoo Convention, Finland can also participate in e.g. some of the EIA procedures of wind power projects planned in Swedish waters.

5.1 Land use planning phases

The Land Use and Building Act (132/1999) controls land use planning and construction, and it has a major impact on offshore wind power construction. In Finnish territorial waters, the implementation of wind farms must be based on land use planning in accordance with the Land Use and Building Act, in which areas suitable for wind power construction are specified. However, the Land Use and Building Act does not apply to wind farms located in the exclusive economic zone.

The Finnish land use planning system has three levels: the regional land use plan, the local master plan and the local detailed plan. Each stage includes an opportunity for interaction with the stakeholders, in which Traficom and the Finnish Transport Infrastructure Agency participate. In practice, the land use planning of wind power projects planned for Finnish territorial waters is implemented via the regional land use plan and the local master plan.

Usually only the navigation lines of channels passing through the land use planning area are shown on the planning map, but the distance of wind power areas and channels or anchorage areas presented on the map must be measured from the border of the proposed wind power area to the border of the adjacent channel or anchorage area. Correspondingly, other areas related to maritime transport, too, such as places of refuge, approaches to channels and traffic separation schemes or vessel traffic areas, must be taken into account. Traficom and the Finnish Transport Infrastructure Agency instruct the land use planner on how to take the areas mentioned above into account during the initial phase of land use planning.

Indicating the land use planning area on a nautical chart is recommended at the participation and assessment plan (OAS) stage of a wind power project, for example, or in an attachment providing background information during later land use planning stages, because a nautical chart is the most informative and illustrative map of a water area, as it also includes depth and bottom information on the area.

5.1.1 Regional land use plan

The regional land use plan is a general plan for land use, and for its part, it guides the more detailed land use planning and wind power construction as a whole.

The regional land use plan is a general plan presented on small-scale maps. The wind power areas indicated on the land use plan become more specific as the land use and project planning progresses. A more detailed plan cannot conflict with the regional land use plan. Indicating the wind power areas in regional land use plans is required for sets of at least 8–10 wind turbines or projects with regional importance. In practice, the offshore wind farms that are currently being planned consist of several dozen or even hundreds of wind turbines.

5.1.2 Statement issued on the regional land use plan and other measures at the land use planning stage

Traficom and the Finnish Transport Infrastructure Agency participate in the negotiations on the regional land use plan and instruct the land use planner in how to obtain reports and background materials related to maritime transport.

Because the regional land use plan is general, the statements and opinions of the agencies regarding the plan are also general and will be specified further as the land use planning progresses.

In their statement on the regional land use plan, the agencies assess the sufficient distance between channels and vessel traffic areas as well as the wind power areas shown in the land use plan. The default distance requirements and their application principles for different areas have been presented in detail in section 2.2.

In their statements, Traficom and the Finnish Transport Infrastructure Agency also pay attention to the safety of navigation, its operating conditions and their protection, if the area planned for wind power is in a location that may cause difficulties for navigation or if the planned wind power area is considerably large.

The key issues in the statement at the regional land use plan stage:

- Requiring a default minimum distance of at least 1.5 km between channels, anchorage areas and places of refuge as well as the planned wind power areas shown on the land use plan to ensure the safety of navigation and the use of channels as well as the operating conditions of navigation.
- Taking the recommended distance by PIANC and its case-by-case application between the open sea vessel traffic areas, approaches to channels as well as the traffic separation schemes and the wind power areas presented in the plan.
- Assessing the operating conditions of navigation and taking them into account.

It is proposed that an overview of the safety of navigation and taking its operating conditions into account should be added to the general regulations of the land use plan:

- The potential impact of wind power on maritime positioning and radar systems, maritime wireless communication networks as well as the operating conditions of navigation and the safety of navigation and the use of channels must be investigated during the more detailed land use planning and permit stage of the wind power project.

5.1.3 Local master plan and local detailed plan

The local master plan specifies the use of the land use plan area in general terms, and it guides the drawing up of a more specific local detailed plan. The amendment of the Land Use and Building Act that entered into force in 2011 makes it possible to control wind power construction directly in the local master plan. Drawing up a local detailed plan for wind power construction is necessary in situations in which coordination with other land use is needed; in practice, this means land areas. As a result, this guideline only discusses the actions of Traficom and the Finnish Transport Infrastructure Agency during the local master plan stage, but the practices during the local master plan stage can also be applied to the local detailed plan stage, if necessary.

5.1.4 Statement issued on the local master plan and measures during other land use planning stages

Traficom and the Finnish Transport Infrastructure Agency participate in the negotiations on the local master plan and instruct the land use planner/wind power developer in how to obtain reports and background materials related to maritime transport.

In their statement on the local master plan, the agencies assess the sufficient distance between channels and vessel traffic areas as well as the wind power areas proposed in the plan. The default distance requirements and their application principles for different areas have been presented in detail in section 2.2. Based on the appropriate studies, the agencies can assess potential changes to the default safety distance on a project-specific basis.

It is recommended that the studies should already be started during the EIA stage of the project, but no later than the OAS stage of the local master plan, so that the boundary conditions that have emerged during the studies and the risk assessment of maritime operators can be taken into account in the land use map of the local master plan during the draft stage or the proposal stage at the latest.

Aids to navigation are not shown on the land use map, but the potential impact of the proposed wind power area on the visibility of aids to navigation to seafarers is estimated in the statements, if the land use plan proposes a wind power area in the immediate vicinity of an aid to navigation or so that the visibility of the aid to navigation to seafarers could be obstructed or hindered. The wind power areas shown on the map must be planned so that the wind turbines constructed will not hinder or obstruct the visibility of the aid to navigation to seafarers. Using a nautical chart to support the land use planning material is recommended.

During the local master plan stage, the agencies make a preliminary assessment of the VTS radar compensation of the project (the procedure is described in section 9) and the need for cameras and/or radar equipment suitable for monitoring the ice situation, in addition to the impact of the project on the maritime wireless communication networks and its potential need for compensation. Implementing the comprehensive risk assessment and potential simulation model required by the project in addition to other measures promoting the safety of navigation are taken into account in the statement issued on the plan on a general level.

The key issues in the local master plan statement:

- If the impact of the planned wind farm on navigation has been determined: Determining a sufficient distance between channels, anchorage areas and places of refuge as well as the planned wind power areas shown on the land use plan to ensure the safety of navigation and the use of channels as well as the operating conditions of navigation, or specifying a minimum distance, if necessary.

- If the impact of the planned wind farm on navigation has not been determined: Requiring a default safety distance of at least 1.5 km between channels, anchorage areas and places of refuge as well as the wind power areas shown on the land use plan to ensure the safety of navigation and the use of channels as well as the operating conditions of navigation.

- Taking the recommended distance by PIANC and its case-by-case application between the open sea vessel traffic areas, approaches to channels as well as the traffic separation schemes and the planned wind power areas presented in the plan.

- General notes on the reports required for navigation (e.g. a risk assessment, a potential simulation model).

- A preliminary assessment of the impact on radar and maritime communications networks and potential compensation procedures as well as the need for cameras and/or radar equipment suitable for monitoring the ice situation.

It is proposed that an overview of the safety of navigation and taking its operating conditions into account should be added to the general regulations of the land use plan:

- Wind farms must be placed so that they will not endanger the safety of navigation or aids to navigation, or hinder or endanger the positioning and radar systems of vessels, maritime communications networks or the radar surveillance of vessel traffic management. In addition, the placement of wind farms must take account of the operating conditions of combating environmental damage as well as maritime search and rescue in the wind farm area.

- If wind turbines require the placement of new aids to navigation or changes to existing aids to navigation: The placement of new aids to navigation and the relocation of existing aids to navigation in order to improve the detectability of the wind farm markings or its outer borders for seafarers or maritime radar systems must be agreed upon together with Traficom and the Finnish Transport Infrastructure Agency.

- A plan of the final locations of wind turbines must be presented to Traficom and the Finnish Transport Infrastructure Agency before their construction.

- The wind turbines that are constructed must be marked in accordance with the instructions of IALA, Traficom and the Finnish Transport Infrastructure Agency. In marking wind turbines, the instructions by Traficom for aviation 'Ohje tuulivoimaloiden päivämerkintään, lentoestevaloihin sekä valojen ryhmitykseen' ('Instructions on the day markings, aviation obstruction lights and grouping of the lights of wind turbines', in Finnish) must also be taken into account.

5.2 Maritime spatial planning

Maritime spatial planning is provided for in the Land Use and Building Act (132/1999). The purpose of maritime spatial plans is to promote the sustainable development of the different ways of using the sea area and the sustainable use of its natural resources by coordinating the needs of the different forms of use. The maritime spatial plan does not have any legal impact or binding effect on the permit procedures in accordance with other legislation. A review of whether the maritime spatial plans are up to date must be carried out at least once every ten years. The maritime spatial plan is drawn up for both the exclusive economic zone as well as Finnish territorial waters, and the regional councils in areas that contain territorial waters are responsible for drawing it up as well as its approval.

5.2.1 Statement issued on the maritime spatial plan

Because the maritime spatial plan is general, the statements by Traficom and the Finnish Transport Infrastructure Agency on the maritime spatial plan are also general. As in the regional land use plan stage, Traficom and the Finnish Transport Infrastructure Agency also assess the location of the wind power areas ("energy production area") presented in the maritime spatial plan in relation to the existing channels, vessel traffic areas, anchorage areas, places of refuge and areas within a routeing system in the statement they issue on the maritime spatial plan. Attention must also be paid to the safety of navigation, its operating conditions and ensuring them, especially if wind power areas are proposed in sea areas that are challenging for navigation (e.g. areas with a high traffic volume and difficult ice conditions), or if the size of the wind power area is significantly large.

Traffic flow information is used as a key source of information for the "seafaring area" marking in maritime spatial planning; it indicates the most important areas used for maritime transport in the sea. When gathering traffic flow information, attention must be paid to whether the information is comprehensive so that information is gathered on different years and seasons, because winter navigation routes differ significantly from the routes during the open water season.

5.3 Permit in accordance with the Act on the Exclusive Economic Zone of Finland

The permit procedure for wind power construction in the exclusive economic zone differs from the practices applied to Finnish territorial waters with regard to e.g. land use planning, because the Act on the Exclusive Economic Zone of Finland (1058/2004) applies in the zone. No land use planning with legal impact is carried out for wind farms planned in the exclusive economic zone. In contrast, wind power projects in the exclusive economic zone need a right of use granted by the Finnish Government in accordance with the Act on the Exclusive Economic Zone of Finland, in which Traficom and the Finnish Transport Infrastructure Agency are a part of the group of authorities to be heard. Wind power projects in the exclusive economic zone also require the application of an EIA procedure and a permit in accordance with the Water Act, among other things, in the same way as the wind power projects in Finnish territorial waters.

An application for a research permit for a wind power project in the planning stage must be submitted to the Government, and in connection with the processing of the permit application, the Ministry of Economic Affairs and Employment reserves parties such as Traficom and the Finnish Transport Infrastructure Agency an opportunity to issue a statement on the project.

5.3.1 Statement issued in order to carry out research based on an application in accordance with the Act on the Exclusive Economic Zone of Finland

In their statements, Traficom and the Finnish Transport Infrastructure Agency list the notifications to different authorities required by the research project and any potential need for traffic arrangements and preparations for them. If it is found that the planned project, if realised, would have a significant impact on the operating conditions of navigation or its safety, the statement notes the importance of taking navigation into account as well as the location planning of the planned wind power area while taking the navigation, traffic and amount of goods in ports in the area

into account, such as vessel traffic areas without wind turbines that enable maritime transport through the planned wind farm, or a change of the boundaries of the wind power area required in further planning.

If necessary, the statements present a negative opinion on the planned project and the related research, if the planned project is found to cause significant damage or risk to navigation, for instance, and a change in the boundaries of the planned area is not considered to change the situation.

5.3.2 Statement issued on using the Finnish exclusive economic zone based on an application in accordance with the Act on the Exclusive Economic Zone of Finland

An application for Government permission to use the Finnish exclusive economic zone is submitted either before the permit procedure in accordance with the Water Act or at the same time with it. In their statements, Traficom and the Finnish Transport Infrastructure Agency assess the impact of the planned project comprehensively with regard to the operating conditions and safety of navigation as well as its effects on the maritime transport system and its functionality. The statements also assess the impact of the project on winter navigation and arranging it in the area. In cooperation with the Finnish Border Guard, attention is paid to the effects of the placement of the planned wind turbines on the operating conditions of combating environmental damage and maritime search and rescue. The statements also note the key comments by the agencies and their requirements for the wind power developer during the different report and permit stages of the project and how they have been taken into account in the project.

5.4 Environmental impact assessment procedure

The environmental impact assessment procedure (EIA) is based on the Act on the Environmental Impact Assessment Procedure (252/2017). The Centre for Economic Development, Transport and the Environment (ELY Centre) that acts as the official point of contact is responsible for the guidance and monitoring of the procedure. The environmental impact assessment procedure (EIA) refers to a procedure in which the environmental impact of projects is determined and assessed before decision-making. In the environmental impact assessment procedure of offshore wind power projects, parties such as authorities and ports are heard in addition to those whose circumstances or interests may be affected by the project. In accordance with the Act on the Environmental Impact Assessment Procedure, the environmental impact assessment procedure applies to wind farm projects when the number of individual wind turbines is at least 10 or their total capacity is at least 45 megawatts.

5.4.1 Statement issued on the environmental impact assessment procedure

The environmental impact assessment procedure examines the environmental impact of the project and usually also the different implementation options that differ from each other regarding the boundaries of the wind farm and the maximum number of wind turbines. The project planning is still on the general level during the environmental impact assessment procedure, but Traficom and the Finnish Transport Infrastructure Agency provide comprehensive background and grounds for their statement so that the wind power developer will have extensive background information available on the navigation and maritime infrastructure in the area as well as its potential special characteristics when considering the feasibility of the different options and the details of the project.

In their EIA statements, Traficom and the Finnish Transport Infrastructure Agency assess the sufficient distance between channels and vessel traffic areas as well as the planned wind power areas. The default distance requirements and their application principles for different areas have been presented in detail in section 2.2. Based on the appropriate studies, the agencies can assess potential changes to the default safety distance on a project-specific basis.

It is recommended that the studies should already be started during the EIA stage of the project, because setting the safety distance is often one of the key topics when project planning progresses towards drawing up a local master plan in the Finnish territorial waters, or in the exclusive economic zone, towards the permit processes of the Government in accordance with the Water Act. A more specific agreement on the details of the studies must be made in cooperation with Traficom and the Finnish Transport Infrastructure Agency.

If it is estimated that once established, the planned wind power area will have an impact on winter navigation and its arrangement in the area, and/or that the planned wind power area is in a difficult location from the perspective of maritime transport, such as in a vessel traffic area or close to a channel or vessel traffic area, or if other wind power projects are also planned in the area that would centralise the traffic or cause narrow areas or intersections between the different wind power areas, or if once established, the planned wind power area would change the maritime transport routes, the potential impact of wind power on the safety, smooth operation and operating conditions of navigation and safeguarding them must be investigated sufficiently thoroughly at the EIA stage, and the impact on maritime transport must be presented in the EIA report of the project. A more specific agreement on the details of the studies must be made in cooperation with Traficom and the Finnish Transport Infrastructure Agency

During the EIA stage, the agencies make a preliminary assessment of the VTS radar compensation of the project (the procedure is described in section 9) and the need for cameras and/or radar equipment suitable for monitoring the ice situation, in addition to the impact of the project on the maritime wireless communication networks and its potential need for compensation. Implementing the risk assessment and a potential simulation model required by the project in addition to other measures promoting the safety of navigation are taken into account in the statement at the EIA stage on a general level.

The key issues in the statement at the EIA stage:

- Requiring a default safety distance of at least 1.5 km between channels, anchorage areas and places of refuge as well as the planned wind power areas to ensure the safety of navigation and the use of channels as well as the operating conditions of navigation.
- Requiring the appropriate studies for a reassessment of the default safety distance of at least 1.5 km.
- Taking the recommended distance by PIANC and its case-by-case application between the open sea vessel traffic areas, approaches to channels as well as the traffic separation schemes and planned wind power areas.

- Potential impact of wind power on the radar surveillance of vessel traffic management as well as the maritime communications network and mentioning the potential compensation procedures as well as cameras and/or radar equipment suitable for monitoring the ice situation.

- Assessing the operating conditions of navigation and taking them into account considering e.g. the traffic volumes of ports and channels.

- Requiring the appropriate reports on the impact of the project on navigation in the area and, if necessary, also the impact of the wind power projects in the vicinity of the project area, as well as requiring that the conclusions of the reports are presented in the EIA report.

- Mentions of the reports required for navigation (e.g. risk assessment, potential simulation model) and preparing for them.

5.5 Transboundary environmental impact assessment

From the perspective of navigation, large offshore wind farms may have an impact on international navigation (such as longer routes and increasing emissions of the vessels), which means that the impact crosses state borders. Due to the Convention on Environmental Impact Assessment in a Transboundary Context, also known as the Espoo Convention, the states within the scope of the Convention arrange an assessment procedure in cooperation with another state if the environmental impact of projects, plans or programmes is expected to cross state borders.

The competent authority for the Espoo Convention in Finland is the Finnish Environment Institute, which hears parties such as Traficom and the Finnish Transport Infrastructure Agency concerning offshore wind power projects outside Finland. In their statements, the agencies can present their views on matters such as the environmental impact of the project and the need for Finland's participation in the EIA procedure of the project. In wind power projects on the Swedish side of the border, the statements also highlight e.g. the convention between Finland and Sweden on cooperation in winter navigation and the functioning of the icebreaking cooperation in the Gulf of Bothnia.

5.6 Permit in accordance with the Water Act

According to the Water Act (587/2011), a water permit is required for projects that contain structures built in the water or that affect the water supply. A permit application for a water resources management project must be submitted to the Regional State Administrative Agency in the region of which the project is located. The water resources management project must have a permit issued by a permit authority if it may cause changes in the state, depth, water level or flow, shore, or aquatic environment of a water body or the quality or quantity of groundwater, and this change causes damage or harm to waterborne traffic or timber floating. In addition, closure or narrowing of a main channel or public channel or timber floating channel and placement of a device or another obstruction that hinders the use of the channel always requires a water permit. In practice, wind power projects in a water area always require a permit in accordance with the Water Act.

5.6.1 Statement issued on a water permit application

In a permit application in accordance with the Water Act, the planned wind power project is presented in detail. When the project has progressed to the water permit application stage, Traficom and the Finnish Transport Infrastructure Agency must have the reports required during the previous permit and land use planning stages of the planned wind power project available for drawing up a water permit statement. The statements of the agencies on the water permit application present the final requirements on and instructions for the wind power project. A detailed statement with grounds ensures that the permit authority and the permit applicant understand the considerations and requirements presented in the statement.

The locations of the planned wind farms are stated in the water permit application. In their statements, the agencies can propose changes to the locations of individual wind turbines if they find that the turbines pose a risk to the safety of navigation and the use of channels or that they interfere with or endanger the positioning and radar systems of vessels, the maritime communications network or radar surveillance of vessel traffic management, or that they harm the operating conditions of navigation.

A simulation model of the project and its environment makes it possible to assess the distinguishability of the lights of the planned wind turbines as well as the lights of the aids to navigation and the visibility of aids to navigation to seafarers. The simulation model can also be used in planning the location of the wind turbines as well as justifying a change in the location of a specific wind turbine, for instance.

If the statement on the permit application in accordance with the Water Act requires further measures in the project, such as the application of a compensation procedure for VTS radar or maritime communications network, procurement of cameras and/or radar equipment suitable for monitoring the ice situation or adding aids to navigation, Traficom and the Finnish Transport Infrastructure Agency as well as other maritime operators, if necessary, provide instructions and guidance for the keeper of the wind turbines as needed.

The key issues in the statement at the water permit stage:

- If necessary, instructions on the locations of individual wind turbines so that the structures of the wind turbine do not reduce the safety of navigation or its operating conditions.
- Specifying the marking of the wind farm and the individual wind turbines.
- Preparing for the potential impact of the wind power project on navigation or maritime infrastructure (e.g. changes in channels or aids to navigation) and taking the changes into account in the permit regulations of the decision, if necessary.

Taking the safety of navigation and its operating conditions into account in the permit regulations of the wind power project's water permit is presented sufficiently clearly:

- If the wind farm to be built or an individual wind turbine in it causes harm to or endangers navigation or the use of channels in the project area, or if it causes harm or radar interference in maritime radar systems so that the

safety of navigation is at risk, the keeper of the turbines must take immediate measures to prevent the harm (e.g. remote shutdown of the turbines or moving the turbines).

- If the wind farm to be built or an individual wind turbine in it causes harm or interference to the radar surveillance of vessel traffic management (VTS radar), the keeper of the turbines must compensate for the harm with a new VTS radar station that must be placed so that no blind spots remain in the radar surveillance area and the interference does not prevent traffic management. The keeper of the wind turbines must be prepared to take responsibility for all costs of purchasing and installation related to the radar. It must be possible to reach the radar station even with a smaller boat in connection with maintenance measures, if the station is in a sea area. The energy supply of the radar station and the potential need for a connection link must be taken into account.

- If the wind farm to be built or an individual wind turbine in it causes harm or interference to a maritime wireless communication network, the keeper of the turbines must compensate for the harm by adding base stations to the area so that the interference or harm caused by the wind farm to wireless communications networks is removed. The keeper of the wind turbines must be prepared to take responsibility for all costs of purchasing and installation related to the maritime wireless communications networks. It must be possible to reach the base stations even with a smaller boat in connection with maintenance measures, if the station is in a sea area. The energy supply of the base station and the potential need for a connection link must be taken into account.

- If the wind farm to be built will have an impact on winter navigation or arranging it in the area, the keeper of the turbines must be prepared to purchase cameras and/or radar equipment suitable for monitoring the ice situation and place them in the structures of selected wind turbines. It must be possible to reach the cameras and/or radar equipment even with a smaller boat in connection with maintenance measures. The keeper of the wind turbines must be prepared to take responsibility for all of the costs of purchasing and installing the cameras and radar equipment. The energy supply of the cameras and radar equipment and the potential need for a connection link must be taken into account.

- If necessary, placing radar beacons, i.e. racons, in the structures of the outermost wind turbines of the wind farm in order to improve maritime safety. Attention must also be paid to the potential addition of other aids to navigation (such as ice buoys, leading marks, sector lights) or relocating existing aids to navigation, if necessary, if channel extensions with curves through the project area are created, for example. The keeper of the wind turbines must be prepared to take responsibility for all costs of purchasing and installation costs related to the aids to navigation that result from the wind farm to be constructed. The maintenance and maintenance connections of aids to navigation must be ensured and taken into account.

- The keeper of the turbines must be prepared to implement a simulation model on the light markings of the turbines, if the visibility or distinguishability of the light markings of wind farms or aids to navigation needs to be re-examined after the construction of the wind farm. In potential changes to the lights of turbines, attention should also be paid to Traficom's instructions for aviation concerning the lights and marking of turbines ('Ohje tuulivoimaloiden päivämerkintään, lentoestevaloihin sekä valojen ryhmitykseen' ('Instructions on the day markings, aviation obstruction lights and grouping of the lights of wind turbines', in Finnish)).

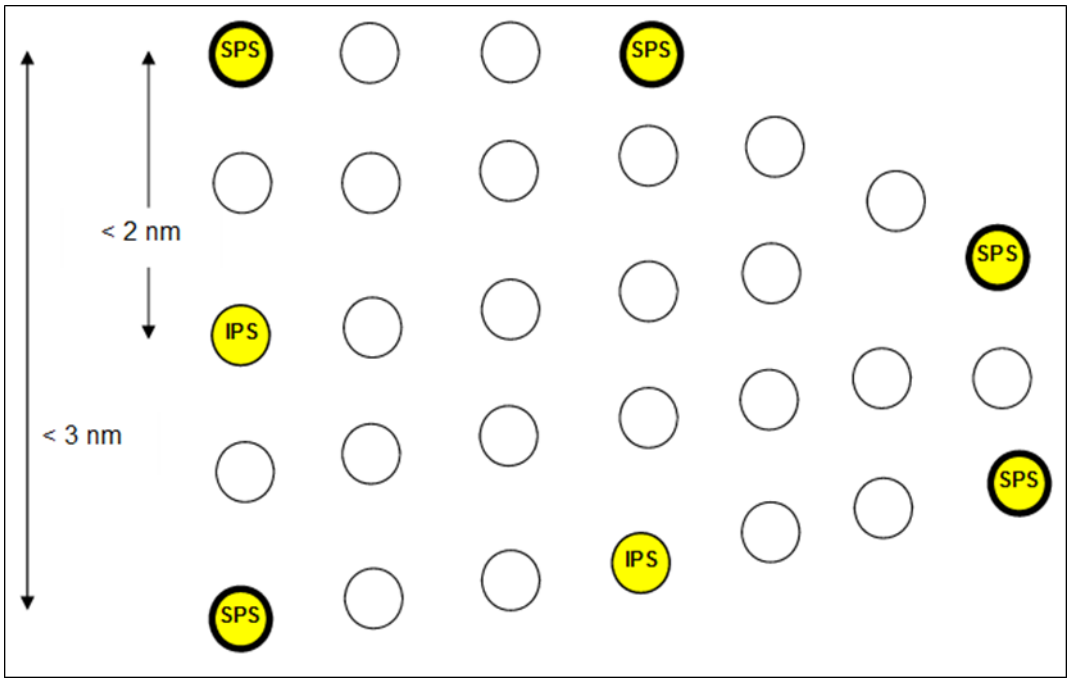
6 MARKING WIND TURBINES AT SEA WHILE TAKING INSTRUCTIONS FOR NAVIGATION INTO ACCOUNT

Offshore wind farms must be marked in accordance with the instructions of Traficom, the Finnish Transport Infrastructure Agency and IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities) (The Marking of Man-Made Offshore Structures, O-139). The lights and markings of wind turbines must not cause confusion with the aids to navigation in the area. The light markings of the lights on aids to navigation are based on IALA's 'Recommendation E-110 for the Rhythmic Characters of Lights on Aids to Navigation'.

In order to identify individual wind turbines in a wind farm, it is recommended that each wind turbine should be equipped with an identification plate with black letters or numbers on a yellow background. The plate must be visible from all directions, and it must either be made out of a material that reflects light or it must be lit so that it can be detected in the dark. In addition, in large wind farms it is recommended to mark wind turbines with an "exit" symbol and a direction arrow (such as "Exit →") that shows the fastest way out of the wind farm. The marking should be implemented by using colours corresponding to the identification plate mentioned above, i.e. with black letters on a yellow background. Including the wind turbine marking information and light markings on a nautical chart must be considered on a case-by-case basis. Especially in large offshore wind farms, the scale of the map makes it possible to mark wind turbines only in a part of the wind farms, as a result of which it is appropriate to mark wind turbines on the map with their identifying information including the lights intended for navigation. Some of the wind turbines equipped with navigation lights are nevertheless not marked on the map, if the scale of the map does not allow them to be marked clearly.

An individual tower must be painted yellow all around from the surface of the water to a height of at least 15 metres, or alternatively with 2-metre-wide yellow stripes at horizontal intervals of 2 metres. Any aid to navigation that may be located in the wind turbine tower structure must be installed below the lowest position of the rotor blades.

The lights of the wind turbine must differ sufficiently clearly from the lights of the aids to navigation in the area. Individual wind turbines must be marked so that they can be detected in the dark with a white blinking light in accordance with the recommendations of IALA (Morse code "U", Mo (U) W ≤15s), with a nominal range of 10 nautical miles. In a wind farm, the wind turbines at the outermost corners of the group must be equipped with yellow blinking light markings with a special sign (e.g. FI(4) 20s) with a nominal range of 5 nautical miles. It is recommended that the lights be synchronised with each other. Between the corner wind turbines, individual wind turbines can also be marked by using a yellow blinking light visible from all directions with a nominal range of 2 nautical miles, and an identifier (e.g. FI 10s) that clearly differs from the light markings of the corner wind turbines. The light markings of the wind turbines must be agreed upon on a case-by-case basis, and the planned marking must be examined, as needed, in a simulation model drawn up on the project.



Picture 6 Example of marking a wind farm (IALA recommendation, The marking of offshore man-made structures, 2021). In addition, individual wind turbines (IPS) can be marked between the corner wind turbines (SPS); their light markings must differ clearly from the light markings of the corner wind turbines.

If there is a risk of confusing the light marking of the wind turbine's special sign with the light markings of other aids to navigation, the light marking or luminosity of the safety equipment can also be changed in certain situations in order to improve their distinguishability. The amount of light generated by several wind turbines may make identifying the targets more difficult, and as a result, the need for navigation light on wind farms located far from the channel or vessel traffic areas, and especially concerning the wind turbines in the middle of the wind farm, must be considered carefully. Unlit individual structures can be made more visible e.g. by using reflective material.

The use of racons, i.e. radar beacons, must be considered when marking a large wind farm or a wind farm located in the vicinity of a vessel traffic area in order to improve the safety of navigation with regard to the corner wind turbines of the wind farm or other wind turbines central to navigation. Racons are used to ensure that seafarers can detect the offshore wind farm and its boundaries in all conditions.

The adjustability of the light markings of wind turbines by e.g. the channel users can improve the safety of navigation and reduce the potential harmful impact of the lights on the environment. The adjustability of the light markings requires cooperation between the Channel Authority, the authorities and the users of the channel.

7 MARKING OF WIND TURBINES, PERMISSIONS FOR OBSTACLES TO AIR NAVIGATION, HEIGHT LIMIT AREAS AND LOCATION PLANNING IN SEA AREAS WHILE TAKING ACCOUNT OF AVIATION INSTRUCTIONS AND PERMITS

In sea areas, the impact of wind turbines on air transport and on the safety of aviation must also be taken into account. As tall structures, wind turbines constitute obstacles to air navigation, and permissions for obstacles to air navigation in accordance with section 158 of the Aviation Act (864/2014) must be applied for before their construction. Applications for a permission for wind power projects in Finnish territorial waters are submitted to Traficom. The permission for obstacles to air navigation granted by Traficom specifies, among other things, the aviation obstacle lights required for the wind turbine. The requirements on lights and the colour scheme of wind turbines have been recorded in Traficom's Instructions for daytime signalling of wind turbines, aircraft warning lights and the grouping of lights.

In sea areas, the impact of wind turbines on the safety of aviation must also be taken into account. As tall structures, wind turbines constitute obstacles to air navigation, and advance permissions for obstacles to air navigation in accordance with section 158 of the Aviation Act (864/2014) must be applied for them before their construction. Applications for a permission for wind power projects in Finnish territorial waters are submitted to Traficom and a statement on obstacles to air navigation by Fintraffic Air Navigation Services Ltd must be attached to the application; with regard to offshore wind farms, a statement by the Finnish Border Guard is also required. The permission for obstacles to air navigation granted by Traficom specifies the aviation obstruction lights required for the wind turbine. The requirements on lights and the colour scheme of wind turbines have been recorded in Traficom's instructions for aviation concerning the lights and markings of wind turbines ('Ohje tuulivoimaloiden päivämerkintään, lentoestevaloihin sekä valojen ryhmitykseen' ('Instructions on the day markings, aviation obstruction lights and grouping of the lights of wind turbines', in Finnish)).

The height restriction areas around airports that ensure aviation safety must already have been established at the early stages of planning the wind farm. More detailed information on the matter is available from Fintraffic Air Navigation Services Ltd. The height restriction areas extend to the sea areas in front of the Kemi-Tornio, Oulu, Kokkola-Pietarsaari, Vaasa, Pori, Maarianhamina, Turku and Helsinki airports. Height restrictions may have a limiting impact on the permitted height of a wind turbine. The top of the arc of the blade is considered as the height of the wind turbine.

From the perspective of aviation and aviation safety, the planning of the location of offshore wind farms should take account of ports and the planned evacuation centres so that no wind turbines are built close to them. The distance to the targets mentioned above should be at least 5 nautical miles so that in case of a potential major accident, evacuation can be carried out safely and effectively with helicopters. Separately and individually placed wind turbines should also be avoided. As tall obstacles, wind turbines could interfere with aircraft carrying out radar approaches at sea.

8 PLACEMENT OF PIPELINES AND THE CABLES OF WIND TURBINES

Typically, a permit in accordance with the Water Act is applied for the construction of the power lines of a wind farm using the same permit application as for building the wind power structures.

Laying cables across channels should be avoided whenever possible. If a cable must be laid across a channel, the crossing below the channel must be as short as possible and the entire cable (including the weights) must be placed below the safe clearance depth of the channel being crossed. If the depth of the water in the fairway area is close to the safe clearance depth of the channel, the cable must be weighted down to the bottom so that it will not under any circumstances, such as due to propeller wash, rise above the safe clearance depth of the channel being crossed. It is recommended that the cable should be placed at a distance of at least 150 metres from buoys and 40 metres from spar buoys. Cables must not be placed in anchorage areas, anchorages, cargo transfer areas or places of refuge, and the alignment of a cable planned for the vicinity of the areas mentioned above must be agreed on a case-by-case basis between the party laying the cable, the party maintaining the channel and Traficom. When planning the route of the cable and its potential protection, it is important to take account of the emergency anchoring of vessels, especially in fairway areas.

Potential future changes in the channel should be taken into consideration when planning the cable routes. In the fairway area, the cable must be placed in a deep water area as far as possible, and the turning points of channels should be avoided, because they are potential locations for the placement of floating aids to navigation. The placement of cables in potential future dredging areas can be avoided by means such as placing the cable in a water area that is much deeper than the safe clearance depth of the channel being crossed.

In principle, the above recommendations also apply to pipelines built in bodies of water (e.g. hydrogen pipes), but due to the regional conditions, the construction of a pipeline may also require a more detailed study due to factors such as the safety of navigation, the channels and potential changes in the fleet.

More detailed instructions on the placement and marking of cables and pipelines in water areas are provided in Traficom's instructions 'Ilmajohtojen sekä kaapeleiden ja putkijohtojen asettaminen ja merkitseminen vesialueella' ('Placement and marking of overhead lines, cables and pipelines in water areas', in Finnish, TRAFICOM/216486/03.04.01.01/2021).

9 RADAR COMPENSATION

Traficom is the competent VTS authority in accordance with the Vessel Traffic Service Act (623/2005). The interference-free operation of radar is important to Traficom, because it supervises the VTS service provider, the maritime situation picture generated as well as its accuracy. As a part of the maritime situation picture, VTS radars are also used to monitor the coastal ice situation and determine the need for icebreaking assistance. With VTS radar and an automatic identification system (AIS), the VTS service provider generates a maritime situation picture, manages waterborne traffic and is able to offer navigation assistance to vessels.

If the wind turbine or farm that was constructed would prevent or hinder the provision of vessel traffic service and endanger the duty of providing a vessel traffic service in the area assigned to the VTS service provider in the Vessel Traffic Service Act, or if it would prevent or hinder the monitoring of the coastal ice situation with the VTS radar and determining the need for icebreaking assistance, the harm must be compensated to the VTS service provider with a new radar station, or by agreeing on a financial compensation that the VTS service provider will use to update the VTS radar system and ensure that the vessel traffic service is free from interference.

During the planning stage, the potential interference of a wind turbine or farm to VTS radar is difficult to estimate in advance, because both major and minor details (e.g. the materials used, the painted surface, the height of the arc of the blades) have an unpredictable impact on the interference to radar. However, it is important to be aware of potential interference with VTS radar already during the initial stages of wind power project planning, which makes it possible to try to prevent the impact on radar or at least prepare for potential further measures. The potential need for radar compensation is included in the statements of Traficom during the project's land use planning and EIA stages, and the radar compensation requirements are included in the statement in accordance with the Water Act, if necessary, so that the radar compensation requirement is recorded in the permit conditions of the wind power project's water permit.

When planning the location of a new VTS radar station, it must be taken into account that in order to ensure effective use, the VTS radar must be placed at a height of approximately 25–50 metres. The radar station must be equipped with a power supply cable and telecommunications connections. In order to ensure the smooth repair and maintenance measures of the radar, it should be placed in a location that is easily accessible in all weather conditions.

There are boundary conditions related to installing a VTS radar in the structures of a wind turbine, which must be taken into account in more detailed planning. The VTS radar must be installed at least approximately 5 metres below the bottom of the arc of the rotor blades and at a distance of approximately 4 metres from the body of the wind turbine. The bottom of the arc of the rotor blades of an offshore wind turbine is usually much lower than the installation height of 25–50 metres that would enable the effective use of VTS radar. The service and maintenance of VTS radar may hinder the use of the wind turbine, because the wind turbine must be stopped during maintenance. The service, maintenance and implementation of VTS radar and the accessibility of the VTS radar station must be agreed between the keeper of the wind turbines and Fintraffic Vessel Traffic Management before the implementation of the project.

Traficom and the VTS service provider provide instructions and advice to the keeper of the wind turbines in matters related to the radar compensation procedure and details regarding the new radar station.

10 SIMULATION MODELLING

The purpose of simulation is to create a model that can be used to examine the visual impact of the planned wind power structures on navigation. With a simulation model, it is possible to study the visibility of aids to navigation to seafarers and assess whether the aid to navigation and the lights of the planned wind turbines can be distinguished from each other. In order to ensure that the simulation model is as authentic as possible, the existing channel infrastructure and the planned wind power structures and their lights must be modelled accurately. However, it must be noted that the simulators used in the training and research of navigation cannot normally show the radar interference typical to a wind farm or the radar echoes of an ice field realistically.

The simulation model corresponds roughly to the authentic view. However, even a rough correspondence is usually good enough for the assessment of visual effects related to navigation. In addition, simulation modelling makes it possible to exclude potential assumptions regarding matters such as the visibility of lights or their distinguishability. Studying blackout situations involving vessels in different weather conditions is also possible in a navigation simulator. From the perspective of navigation, the information gained from a simulation model may have a significant impact on the more specific planning of the wind power project in addition to the details of the project, such as suitable locations for establishing wind turbines as well as light markings.

Implementing a simulation model is necessary, if the planned wind farm is close to public channels, vessel traffic areas or aids to navigation, or if the wind farm may have an impact on the visibility of aids to navigation to seafarers or the detectability of the other waterborne traffic and the navigation lights of vessels in the area. The wind power developer is responsible for ordering a simulation model and the resulting costs. A more specific agreement on the need for a simulation model as well as the details must be made in cooperation with Traficom and the Finnish Transport Infrastructure Agency.

Issues to be taken into account in the assessment carried out by using a simulation:

- The visual range of seafarers in the different parts of the channel or vessel traffic area and in different navigation scenarios, in which the entire channel space or traffic area is utilised.
- The visual range of seafarers must be studied when travelling in both directions of movement.
- The visual range of seafarers must be studied at different viewing heights.
- If necessary, the visual range of seafarers must also be studied when there are other vessels moving in the channel or traffic area.
- It must also be possible to study the visual range of seafarers outside the fairway area, if necessary, in order to assess what seafarers can see in situations in which the vessel has drifted outside the fairway area due to unsuccessful navigation, or estimate the visual range of icebreakers when they operate outside fairway areas.

- The visual range of seafarers must be studied when approaching a wind farm or channel.
- The visual range of seafarers must be studied in different weather and lighting conditions.

Considerations to be taken into account when building a simulation model:

- Existing channel infrastructure placed in accordance with the actual coordinates
    - navigation line
    - fairway area
    - existing aids to navigation
        - symbolism of aids to navigation (simplified model)
        - actual measurements
        - actual light heights
        - actual light types
        - actual light range
        - the different colours of each sector (sector lights)
- The planned wind farm and information according to the plan
    - simplified model of the planned wind farms
    - planned measurements of wind power structures
    - planned coordinates of wind turbines
    - planned heights of the lights (aviation obstruction lights as well as lights intended for navigation)
    - planned light types (markings) and colours
    - planned light range
- The environment
    - terrain and shoreline
    - if the environment is not a major factor, a simplified model of the environment is enough

Requirements set on the simulation model/system:

- Navigation bridge views of different types and sizes of vessels moving in the channel
- Option to navigate the channel in both directions

- Option for an automatic run along the navigation line as well as a manual review run in different parts of the channel
- Option to display the simulation and the chart template (location of the vessel on the nautical chart) at the same time
- Opportunity to create different kinds of navigation situations and views in the channel
- Opportunity to study the simulation model in different weather and lighting conditions

11 RISK ASSESSMENT

A risk assessment must always be conducted concerning an offshore wind farm that takes matters such as safety as well as environmental and logistics perspectives into account. It must be done by a professional carrying out risk assessments. In addition to the risk assessment, the Formal Safety Assessment instructions for navigation by the IMO must be used[1].

The results of a risk assessment that has been carried out at a sufficiently early stage can be applied already in the project planning. It makes it possible to identify, analyse and minimise the potential harmful impact of wind turbines to navigation, the people living on the coast and other actors. In order to ensure that the perspective is as broad as possible, as many different maritime interest groups as possible should participate in the risk assessment. Up-to-date information and previous research must also be taken into account when drawing it up.

The risk assessment must cover the entire life cycle of the wind farm, all the way from the preparatory work in the construction phase to dismantling the wind turbines. Attention must also be paid to potential changes in channels and vessels (e.g. larger vessel sizes, changing vessel types and the cargo of the vessels) and other changes in the operating environment during the life cycle of an offshore wind farm.

The risk assessment should take account of factors related to the infrastructure of the channel as well as waterborne traffic, which include at least:

- Construction time
    - traffic arrangements during construction
    - emergencies
    - underwater structures (piled masses, foundations) and their impact on waterborne traffic
- Operating period of the wind farm
    - hazards to navigation caused during the operation of the wind farm
        - general navigation safety
        - risk of collision
        - ice flying out of the rotor blades of the wind turbine
        - a rotor blade of the wind turbine coming loose or a break in the rest of the structure
        - impact on maritime radar
        - impact on the visual range of seafarers
    - marking of wind turbines
        - light equipment (risk of confusion related to the lights)

[1] MSC-MEPC.2/Circ.12/Rev.2 9 April 2018

        - identification of individual wind turbines
    - submarine cables of an offshore wind farm
        - emergency anchorage
        - anchorage of aids to navigation
        - dragging of aids to navigation
    - use of the channel during an emergency at the wind farm
        - impact on waterborne traffic
    - potential changes in the channel geometry
        - changes in the fairway area and aids to navigation
    - potential changes in waterborne traffic
        - different types of vessels and the cargo of vessels (deck cargo)
    - potential impact on the security of supply
- Offshore wind farm that is going out of use
    - underwater structures (piled masses, foundations)

In the risk assessment, attention must also be paid to well-working communication between the wind farm operator and various authorities, and an agreement must be made on drawing up clear instructions in cooperation with the authorities in case of different kinds of exceptional or dangerous situations:

- Every wind farm operator must send the authorities the up-to-date contact information of their operation centre that operates 24/7
    - ensuring communication in connection with hazardous situations that may occur inside a wind farm (including during the construction phase of the farm)
- Wind turbines are permanent structures
    - Carrying out a rescue directly from a wind turbine at sea in connection with an occupational accident, for instance, does not constitute maritime search and rescue in accordance with the Maritime Search and Rescue Act. The Maritime Search and Rescue Act applies to rescuing people in distress and danger at sea. This does not apply to permanent structures, islands or vessels attached to the shore
- Every wind farm operator must draw up and maintain rescue plans both for the construction phase and the finished wind farm

    - the plans should also include preparation for potential environmental damage

- Accidents must also be taken into account from the perspective of maritime transport
- Preventive solutions and up-to-date technology must be used in case of an accident
    - e.g. oil collecting basins and containers
- Using a consistent and standardised format for the addresses of wind farms, their numbers and coordinates is recommended for all offshore wind farms
- It may take a long time for rescue personnel to reach the wind turbines, and in difficult weather conditions, the site may not be accessible at all with the equipment of the rescue department
    - systems or technology that improve safety or the situation in case of an accident should be installed in the wind turbines

The Finnish Transport and Communications Agency, The Finnish Transport Infrastructure Agency 7.11.2023

Maarit Mikkelsson
Head of Services, Fairways

Elisa Mikkolainen
Director, Waterways Department

ANNEX 1 An illustrative presentation by the World Maritime University concerning distances between maritime transport and wind turbines as well as the related regulations to be taken into account (in Finland, the distance to a wind turbine is measured from the closest point of the arc of the rotor blades, not the foundation).