



Federal Waterways and
Shipping Administration

Federal Waterways and Shipping Directorate North-West

Federal Waterways and Shipping Directorate North

Traffic Technologies Centre

Guidelines for the Design, Marking and Operation

of Wind Generators

**in the Area of Responsibility of the Federal Water-
ways and Shipping Directorates North-West and
North**

to Guarantee

the Safety and Efficiency of Vessel Traffic

Provisional Version

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1 General remarks

Rationale

In the foreseeable future wind generators for the generation of energy are to be erected for the first time in the German Exclusive Economic Zone (EEZ) in the North Sea and in the Baltic Sea and in and along the German navigable maritime waterways (i.e. in the area of competency of the Waterways and Shipping Directorates (WSD) North and North-West).

While being important projects for energy policy, they constitute artificially created obstacles to shipping in regard to vessel navigation and maritime safety, and they, in effect, constrict the free sea area. This causes new potential hazards for the safety and efficiency of vessel traffic. The laying and operation of sea cables associated with the erection of offshore wind farms require special consideration in the areas of relevance to traffic.

The requirement to avoid impairments to the safety and efficiency of vessel traffic is regulated in international and national provisions and is an explicit part of the “Federal Government Strategy for the Use of Wind Energy at Sea” from 2002.

Pursuant to Section 1 (2) in connection with Section 3 (1) Maritime Shipping (Federal Competences) Act (SeeAufgG) and Section 24 (1) Federal Waterways Act (WaStrG), the competence both for the aversion of dangers for the safety and efficiency of vessel traffic (Shipping Police) and for the maintenance of the navigable condition of the federal waterways (Water Police), rests with the Federal Waterways and Shipping Administration (WSV).

In the EEZ the special importance of the aspect of guaranteeing the safety and efficiency of vessel traffic in the planning, erection and operation of offshore wind generators and their connections to the grid is expressed in the consent regulation of Section 6 Offshore Installations Ordinance (SeeAnIV). Accordingly, the approval of the Federal Maritime and Hydrographic Agency (BSH) is tied by the approval of the competent WSD in the region. Pursuant to Section 3 SeeAnIV, an approval should not be given if the safety and efficiency of vessel traffic is impaired or the marine environment endangered, and this cannot be compensated for by conditions and obligations.

Within the German territorial waters the interests of shipping and of the waterways are protected by the Maritime Shipping (Federal Competences) Act (SeeAufG) and by the Federal Waterways Act (WaStrG). If an impairment to the navigable status of the federal waterways or to the safety and efficiency of vessel traffic is to be expected from the erection and operation of such plants, it is necessary to obtain a water and shipping police permit (ssG) from the local Waterways and Shipping Office (WSA) competent for the area under consideration pursuant to Section 31 WaStrG. If the above mentioned impairments cannot be compensated for by conditions and obligations, an ssG must be refused pursuant to Section 31 (5) WaStrG. The above principles shall also apply if a duty to approve under the Federal Immission Control Act (BImSchG) exists and an ssG is incorporated by consideration in an approval under the BImSchG.

Reasons to reject the approvals generally exist if the operation and the effect of shipping installations or marks, the use of shipping lanes, shipping itself or the navigable status of the federal waterways would be impaired and this cannot be compensated for by conditions and obligations.

When selecting and developing suitable locations for wind generators and cable routes in the scope of these Guidelines, the above mentioned interests must therefore be considered.

The decision on the approval of wind generators and connection to the grid shall usually be made in individual case examination by the competent WSA .

Purpose

The following Guidelines contain basic requirements with respect to the necessary conditions and obligations for the design, operation and marking of wind generators and for the laying and operation of the grid connections. These Guidelines represent the current update status and supplement to the "Guidelines for the Design, Marking and Operation of Offshore Wind Farms" of the Waterways and Shipping Directorates North and North-West and of the Traffic Technologies Centre (FVT) dated April 2002. Emphasis has been placed in particular on updating the state of the art and the requirements resulting from the knowledge gained.

As a result of a project examination on an individual case basis it may be necessary for additional conditions and obligations to be imposed in a binding manner as part of ancillary provisions of approvals pursuant to SeeAnlV, WaStrG or BImSchG. The satisfaction of conditions and obligations shall be incumbent on the approval holder.

Scope

These Guidelines shall be used for the erection and operation of wind generators and their grid connections on German navigable maritime waterways, the bordering waters seawards of the German coastal sea and in the German EEZ.

Measures may also be necessary for the avoidance of impairments to the safety and efficiency of vessel traffic by marking wind generators as obstructions to aviation if such installations are operated on land but in the direct vicinity of German navigable maritime waterways and effects on the safety and efficiency of vessel traffic are to be expected. The nature and extent of conditions to be expected in such cases shall be examined in the individual case by the WSA competent for the area under consideration. The respective regional authorities shall be responsible for generators erected on land.

Target group

Target group are applicants/operators of offshore wind generators, cable layers or operators and the authorities and agencies competent within the scope of these Guidelines.

Further information

These Guidelines are subject to updating. The requirements set out reflect the actual and development status in the area of wind energy generation at sea at the time of announcement which reflects the current application and approval situation.

2 Planning and design of wind farms

When assessing potential locations for wind generators within the scope of these Guidelines all nautical traffic and maritime policing interests (within territorial waters also: morphological and technical and water policing interests) must be fully considered. The following should be observed:

Principles

1. Effects on the safety and efficiency of vessel traffic (and within the territorial waters effects also on the navigable status of the federal waterways) must be avoided in the erection and operation of wind generators or compensated for by protective measures.
2. It is not permitted to erect wind generators if shipping itself or the use of marked traffic routes and of areas otherwise used by shipping is impaired (see Art. 60 (7) UNCLOS). Wind generators may not have a barricade effect for shipping.
3. The shipping routes may not be impaired by the operation of wind generators.
4. If it is planned to erect wind generators on German navigable maritime waterways, the seaward bordering waters of the German coastal sea or in the German EEZ, it will be necessary to prepare state of the art risk analyses using recognised methods.
5. By default, a safety zone with a radius of 500 m must be set up around the wind generators, measured from the outer limits of the generators (see Section 7 (1) VOKVR). The erection pattern of wind farms must be such that a closed safety zone with a radius of 500 m can be set up around the wind farm, measured from the periphery of the wind farm. Consent of the competent WSA shall be required for any deviations.
6. Pursuant to Art. 89 Basic Law, the Federation is the private-law owner of the federal waterways. In the event of using federal areas (by wind generators and/or current cables) an agreement on use under private law shall therefore be necessary with the WSA competent for the area under consideration before the beginning of use.

Requirements placed on the spatial design of wind farms

7. Individual wind generators which directly border on each other must be summarised into blocks. The requirement of block formation shall also exist under consideration of Paragraph 11 if existing wind farms or wind farms planned in the direct vicinity are extended. Corridors which, under consideration of the peripheral conditions to be encountered at sea, do not permit safe passage should be avoided where possible.
8. The spatial requirements of offshore wind farms should be minimised by optimising the distance between the individual wind generators and using a sensible lay-out within the blocks.
9. The distance between the individual generators within a block may not basically exceed 1,000 metres. Exceptions must be justified and approved by the competent WSA.
10. The size and alignment of the blocks – under consideration of Paragraph 3 – must be restricted by position, extension and course of shipping lanes and other areas used by shipping.
11. Blocks and the internal patterning of the wind generators must be designed such that the probability of a collision is minimised. This can be determined in individual cases by a risk analysis.
12. A corridor of at least 2 nautical miles plus 2 x 500 m safety zone is necessary as passage width between 2 blocks, depending on the vessel traffic frequency and structure.
13. A distance of at least 2 nautical miles plus a 500 m safety zone is necessary between the traffic separation areas and the wind generators.
14. The minimum distance between wind generators and shipping lanes and other routes otherwise used by shipping shall be determined in every individual case taking into account vessel traffic and other peripheral conditions. A guide value of 2 nautical miles plus 500 m safety zone shall apply.
15. The distance between wind generators and designated roadsteads and other anchor areas used by shipping shall be determined in analogous application of Paragraph 14 in every individual case under supplementary consideration of an additionally necessary traffic area for manoeuvring, weathering and drifting.

Basic constructional requirements placed on wind generators to guarantee traffic safety

16. The wind generators should be erected in a so-called "collision-friendly" manner. This will be the case, for example, if the generator falls away from a ship in the case of a collision and if no sharp edges and/or rigid projections are produced which could gouge into the ship's hull or deeply penetrate the ship's structure.

17. The intrinsic safety of the wind generators must be demonstrated and guaranteed during the entire duration of the operating taking into account water depths, wind load, sea swell and tides. Proof must be provided of stability and protection from falling down or individual parts being ripped off (e.g. rotor blades, nacelle etc.). The ice drift must also be considered in the Baltic Sea and surrounding waters.

General requirements placed on the construction phase of wind generators

18. Construction phase within the scope of these Guidelines is defined as the period from the beginning of the erecting of the building site to the final completion of the wind generators. The wind generators are completed once the measures set out in the protection and safety concept (see Part 6) have been implemented and are effective to avert dangers and for the safety and efficiency of vessel traffic including the markings necessary for shipping and aviation.
19. During the entire construction phase traffic safety measures must be taken in coordination with the competent WSA(s). Where necessary, a traffic safety vehicle must be deployed.
20. During the construction phase the building site must be marked in accordance with the requirements of the competent WSA.

3 Grid connection

Grid connections are also subject to approval under SeeAnIV and WaStrG with respect to the construction and operation of wind generators in the scope of these Guidelines. When assessing the potential cable routes, all interests concerning vessel traffic and shipping and waterways policing as well as port aspects must be given full consideration. The following must be considered:

Principles

1. Any effects on the safety and efficiency of vessel traffic and on the navigable status of the federal waterways as a result of laying, operating and repairing sea cables must be avoided or compensated for by protective measures.
2. If an application is filed for the laying of cables within or in the direct vicinity of particularly sensitive traffic areas, it will be necessary to examine alternative routes outside the areas used by shipping in detail.
3. If it is planned to lay cables in traffic-relevant areas, it will be necessary to prepare state of the art risk analysis using recognised methods. In particular, risks for shipping during the construction phase, the probability of a damage to cables and the possible consequential risks for shipping (e.g. in the case of de-anchorage, cable breaks or other special incidents) must be considered. If several cables are laid in a contiguous traffic area, their possible cumulative effects must be assessed.

General requirements placed on the laying and operation of sea cables in traffic areas

4. If several cables or cable systems are necessary, these should, by default, be laid bundled in cable corridors. Exceptions are permissible for technical reasons effectively disallowing bundling, or if the bundling is not expedient. The distance between the cables is to be minimised to the extent which is technically necessary.
5. Cable routes must cross shipping lanes by the shortest path (i.e. usually at right angles to the main direction of traffic).
6. The cables should essentially be laid within the future wind farm blocks. The permeability of wind farm blocks for future “external” cables or other construction measures must be guaranteed. The passage corridors to be set up between individual wind farm blocks in accordance with the provisions of the United Nations Convention on the Law of the Sea (UNCLOS) should be kept free where possible.
7. According to the state of the art, laying methods should be applied which involve the smallest possible impairment to safety and efficiency of vessel traffic and the navigable status of the federal waterways.

8. When laying cables in the vessel traffic areas, a suitable depth must be permanently guaranteed which takes adequate account of the interests of vessel traffic (e.g. protection in the case of emergency anchoring).
9. Suitable vessel traffic safety measures must be taken in the laying phase. These include the permanent provision of one or several suitable traffic safety vessel(s) on site. This shall also apply to any cable repairs which may be necessary.
10. After the cables have been laid, their exact position and depth must be demonstrated to the competent WSA in suitable form. During the operational phase the position and depth must be checked at regular intervals. Any deficiencies of depth determined must be rectified. These regular checks and the rectification of deficiencies must be demonstrated to the competent WSA in suitable form.
11. Shipping may not be exposed to any direct dangers (short-circuits, compass deflection etc.) as a result of operating the cables.
12. Regarding equipping of wind farms with technical systems for observing the maritime environment and/or for vessel traffic monitoring (see Chapter 7), the cables must be designed, by default, such that adequate transmission capacity exists for the transmission of vessel traffic data (e.g. radar images, AIS data and VHF radio communications).

Laying of cables inside or in the direct vicinity of navigational channels within the meaning of the German Traffic Regulations for Navigable Waterways (SeeSchStrO) and the Shipping Regulations for the River Ems Estuary

13. The laying and operation of sea cables in the above mentioned areas must basically be avoided in view of the traffic load on the navigable maritime waterways and their significance for the unimpeded access to the German sea ports.
14. If an application of this kind is nevertheless filed for any such measures, the possible consequences for the safety and efficiency of vessel traffic, the navigable status of the federal waterways and the interests of the ports must be given due consideration when assessing the pros and cons. In particular, alternative routes which circumvent the traffic areas must be considered and checked in an analysis which takes account of shipping and port interests.
15. Laying sea cables parallel to and in the direct vicinity of designated navigational channels or within the morphological channel of a federal waterway will not be approved regularly. The minimum distance to be adhered to will be stipulated in the individual case depending on surrounding vessel traffic conditions and the local dynamic of the course of the morphological channel.
16. In the event of an unavoidable crossing of a designated navigational channel within the meaning of the SeeSchStr/SchOEms, the following pe-

ripheral conditions must be satisfied in addition to the above mentioned general requirements:

- During the laying phase at least a half width of the navigational channel and of the “fairway” (deepest part of the navigational channel kept at a specific depth) must be kept free for the safe and unimpeded passage of passing ships. This shall also apply in the case of any cable repairs which may be necessary.
- For repairs, sufficient cable to lay a bypass in the navigable maritime waterway must be provided to conduct any repairs as quickly as possible and in a “traffic friendly” manner.
- In the case of navigational channel crossings, it must be permanently ensured that the cables are laid in sufficient depth from the point of view of shipping. This shall be calculated as dependent on the following peripheral conditions:
 - Traffic frequency and structure
 - Depth of penetration of the anchor of the design ship of the respective waters under consideration of the so-called high-hold anchor
 - Designated bed depth
 - Area-specific deepest positions of the morphological bed
 - Current and future development objectives (with a clear traffic development) in the area of the morphological channel
 - Dredger tolerances

Laying of cables in other traffic-relevant areas

17. The laying of sea cable in traffic separation schemes, coastal traffic zones, approach areas and other highly frequented shipping routes at sea should be avoided where possible. If the laying of cables cannot be avoided, the general requirements set out in Paragraph 4 et seq. must be observed.
18. The area of an “unrestricted manoeuvring zone” is viewed as a highly frequented “traffic hub” in the estuaries of the rivers Elbe, Weser, Jade and Ems. In view of the local traffic composition and the operational manoeuvring situation (pilot transfers, frequent collision avoidance situations with reductions in speed, conversion from sea to river operation and vice versa etc.), the “unrestricted manoeuvring zone” must basically be kept free of sea cables.
19. Designated roadsteads (as regular anchorage areas) and connected manoeuvring areas to be stipulated in the individual case (safety mark-up) must generally be kept free of sea cables.

Repair and maintenance

20. The prior consent of the competent WSA is required for the conducting of repairs and service work.

4 Visual marking

4.1 Basic requirements

1. With the exception of onshore installations, wind generators in the scope of these Guidelines are generally classified as obstacles to shipping by the WSV and must be marked as such.
2. In an individual case wind generators on German navigable maritime waterways may be classified as presenting no obstacle to shipping if it is determined that the location cannot be approached or reached by vessels even under unfavourable conditions. The decision on the classification shall be made by the competent WSA.
3. Onshore installations in the direct vicinity of the navigable maritime waterways and wind generators which are classified as presenting no obstacle to shipping within the meaning of Paragraph 3, need not be marked as obstacle to shipping. The requirements of the Shipping Police set out in Section 4.4 on marking as an obstacle to aviation must be taken into consideration, however.
4. The marking of the obstacles to shipping covers visual (optical and lighting) und radio (see Chapter 5) aspects.
5. The competent WSA must be presented with a complete documentation on the marking of the wind generators in good time before the beginning of construction. The documentation must contain the following information:
 - Daytime marking as obstacle to shipping or aviation;
 - Night time marking as obstacle to shipping or aviation and short-range marking / illumination.(See Paragraph 4.5 for example of marking plans)
6. In the event of an extension of an existing wind farm or the erection of a directly neighbouring wind farm, the visual marking should be adjusted as required. The formation of blocks (see Chapter 2) must be taken into consideration.
7. The requirements placed on the visual marking of wind generators will depend on the type of generator (individual generator / wind farm), the generator location (EEZ / navigable maritime waterways / onshore) and the classification as obstacle to shipping (which is generally the case; there may be exemptions on an individual basis).

N.B.:

For reasons of simplification the visual marking in the following figures and drawings is shown by way of example. The requirements shown here also

apply in principle to the use of other generator types. If there is a basic difference to the currently known generator types, the specific requirements placed on the visual marking shall be stipulated by the competent WSA on an individual basis.

In addition, simplified erection patterns (with all outer wind generators located on the periphery line) have been assumed in the figures and drawings of the visual marking of wind farm blocks. An example for the stipulation of the peripheral generators in the case of different erection patterns is shown in Annex 1.

4.2 Case distinctions

Different requirements apply with respect to the marking of wind generators regarding the following cases:

- a. Wind farms or individual generators on German navigable maritime waterways or in the German EEZ.
- b. Individual generators on German navigable maritime waterways in which a safety zone pursuant to Section 7 (1) VOKVR cannot be completely erected in an individual case.
- c. Wind farms or individual generators which in individual cases are not classified as an obstacle to shipping and onshore generators in the direct vicinity of the German navigable maritime waterways.

The individual requirements and their application are listed in the following:

No.	Individual requirement	a) Wind farm or individual generator in the EEZ or within territorial waters	b) Individual generator with safety zone which does not satisfy the requirements of Section 7 (1) VOKVR	c) Individual generator, no obstacle to shipping, onshore generators
1	Daytime marking	+	+	-
2	5 nautical miles lantern, yellow (*)	+	+	-
3	Conditions for aviation light (*)	+	+	+
4	Synchronisation and harmonisation of the markings (**)	+	+	-
5	Short-range marking	+	-	-
6	Tower illumination	-	+	-

Table 1: Requirements placed on the marking of wind generators depending on their type, location and classification

Explanations:

+ → Application necessary

- → Application not necessary

(*) → Certificate on a successful prototype test from FVT necessary

(**) → The marking of all wind farms must be synchronised. Pulsing must be harmonised (see specification sheet 4).

4.3 Marking as obstacles to shipping

With the exception of the cases set out in Table 1, column c, the requisite visual marking of wind generators refers to daytime and night time marking.

4.3.1 Daytime marking

1. The daytime marking of offshore wind generators is basically provided by a 15 m high yellow band on every individual wind generator and by an inscription. Within this zone, the mast/tower and all generator parts such as ladders, platforms, cranes, etc. must be painted yellow.

2. For generators in the North Sea, the area to be painted yellow must extend from HAT (Highest Astronomical Tide¹) to HAT plus 15 metres. For generators in the Baltic Sea this applies in an area of 2 to 17 metres above the “average water level” (AWL). Depending on the type and height of the short-range marking, it may be necessary to paint additional areas yellow (see Chapter 4.3.2, Paragraph 20).
3. Specification sheet 1 (Chapter 10) should be heeded with respect to the paint coat.
4. The tower of every individual wind generator in a wind farm block must be inscribed in black by way of identification. The inscription should be provided within the yellow painted area (Paragraph 2) in two rows. If the inscription is clear, the inscription elements required in Paragraph 5 (sequences of letters and numbers) may appear together in one row. The legibility of a single-row inscription must comply with specification sheet 10.1 d). Depending on the short-range marking, it may be necessary to attach the inscription at the height of the short-range marking (see Chapter 4.3.2, Paragraph 20).
5. The top row of the inscription must show an abbreviated designation of the wind farm, consisting of up to three capital letters. The bottom row must show the number of the wind generator of the respective wind farm, consisting of up to 4 numbers.
6. In the case of individual generators, the numbering (bottom row of lettering) need not be provided.
7. Both rows are to be arranged centred above each other.
8. The inscription is to be provided in a circular arrangement three or four times.
9. The wind farm operator is responsible for stipulating the sequence of letters and numbers. The sequence of letters may not lead to any confusion with the inscription of shipping signs or other offshore installations.
10. The inscription can also be supplemented by an arrow with the word “EXIT”.
11. The arrow informs about the shortest possible route to leave the wind farm. It is depicted by a compact triangle in accordance with specification sheet 1 (Chapter 10) below the inscription. For every individual generator it must be attached vertically to the shortest peripheral distance twice (at a 180° horizontal offset) to the tower.

¹ **Highest Astronomical Tide (HAT)** is the height of the maximum high water which can be calculated for a location solely on the basis of the local tides determined for a location (i.e. on an astronomical basis alone).

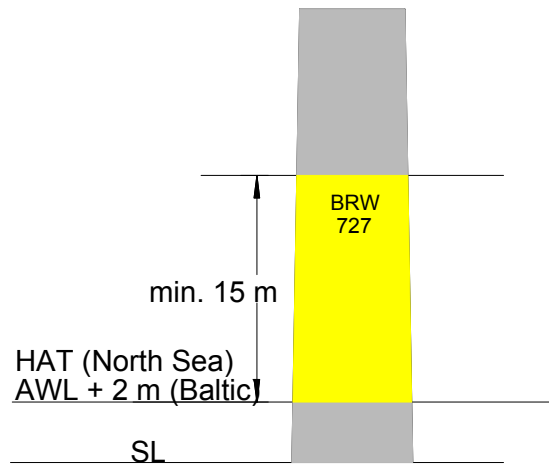


Fig. 1: Example of a daytime marking with painted band and inscription

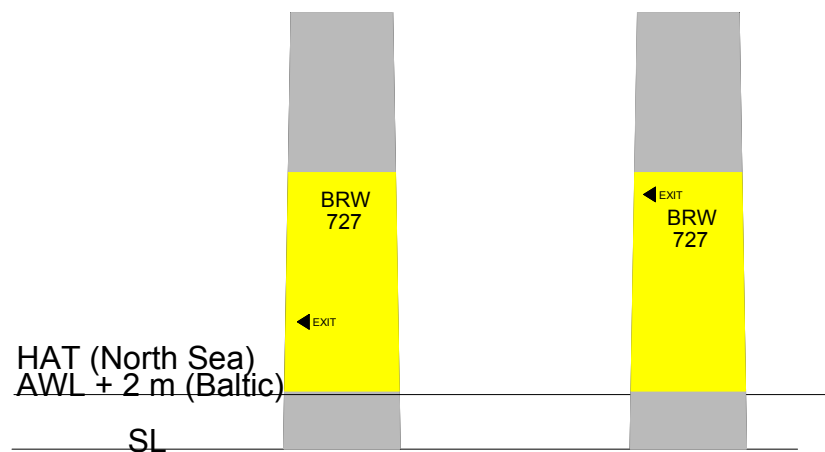


Fig. 2: Examples of a daytime marking with painted band, inscription and additional marking "EXIT arrow"

12. The competent WSA must be notified of the inscription in good time before the start of construction. In cases of doubt, the competent WSA shall decide on the permissibility of the inscription.

4.3.2 Night time marking

1. The night time marking consists of lighting of all peripheral wind generators with yellow 5 nautical miles lanterns and a short-range marking of every individual wind generator. If in individual cases a safety zone pursuant to Section 7 (1) VOKVR cannot be set up (see also Table 1, column b), the short-range marking must be replaced by an indirect tower illumination.
2. The lighting must be switched on one hour before sunset and switched off one hour after sunrise. The reference point for sunrise and sunset is the

Cuxhaven location. The reference times may be derived from the BSH tides calendar.

3. The lights must also be switched on during the day
 - if the horizontal light intensity is below 150 lux;
 - if the practical meteorological visibility is below 1000 m; or
 - at the request of the competent WSA.
4. Specification sheet 4 (Chapter 10) applies to the synchronisation and harmonisation of the markings.
5. Every wind farm block must be marked by means of lighting of all peripheral wind generators with yellow 5 nautical miles lanterns. Sectional lights may need to be used to achieve the requisite horizontal illumination.
6. The 5 nautical miles lanterns are always to be attached at a height of between 10 and 25 m above HAT. To avoid the effects of sea swell, the lights may be attached higher in agreement with the competent WSA under consideration of the 50 year design wave applicable to the sea area.
7. All lights used for night time marking (5 nautical miles lantern, tower illumination, short-range marking) must have automatic monitoring for failure recognition.
8. There must be a 99% availability of the lights in accordance with the IALA Recommendation O-139. The following documents must be taken into consideration.
 - IALA Recommendation O-130 On Categorisation and Availability Objectives for Short Range Aids to Navigation
 - IALA Recommendation V-128 On Operational and Technical Performance Requirements for VTS Equipment
 - IALA Guideline No. 1035 To Availability and Reliability of Aids to Navigation
9. With respect to the horizontal beam characteristics of the 5 nautical miles lanterns, two types of lighting are admissible:
 - a) The 5 nautical miles lanterns of all peripheral wind generators shine the light exclusively in directions outside of the wind farm.
 - b) The 5 nautical miles lanterns of all peripheral wind generators shine the light in all directions (360°).
10. The decision on the horizontal beam characteristic of the 5 nautical miles lantern is made by the competent WSA, possibly on the basis of simulations.

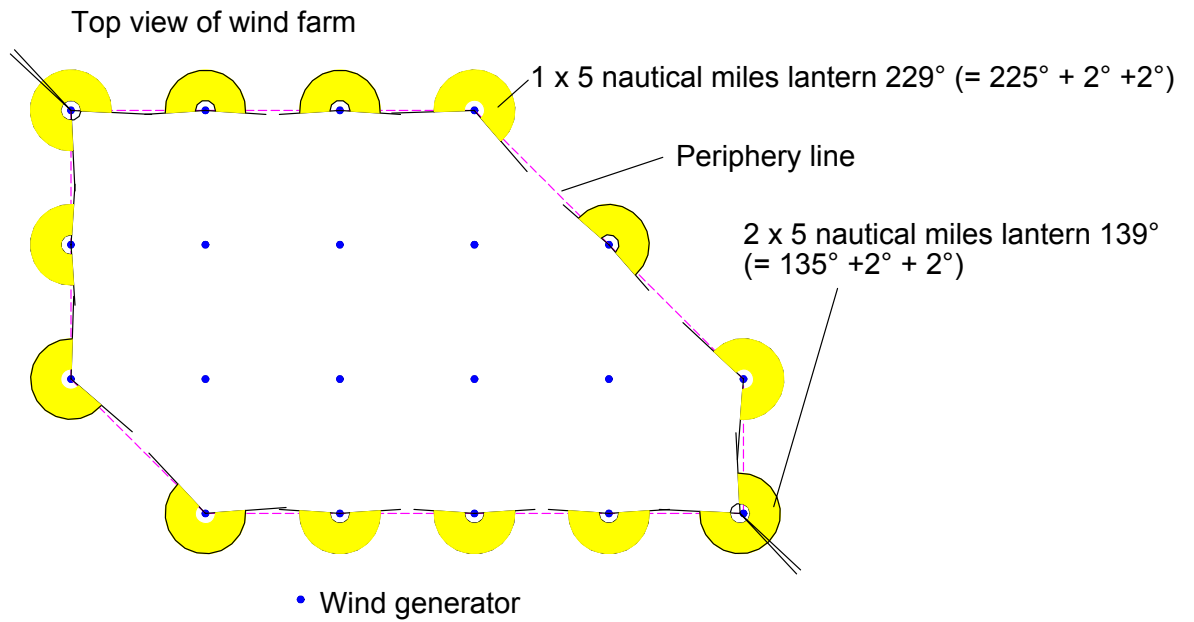


Fig.3: Visualisation of the horizontal beam characteristic according to Paragraph 9 (a) by way of example

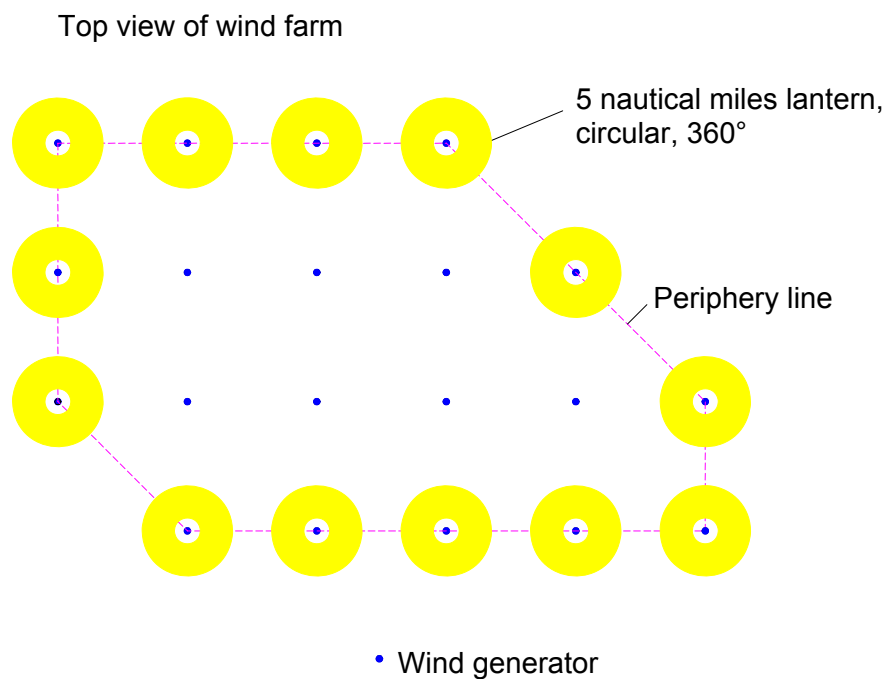


Fig.4: Visualisation of the horizontal beam characteristic according to Paragraph 9 (b) by way of example

11. Individual generators must be lit omnidirectionally with a yellow 5 nautical miles lantern and marking Mo (U) 8s (in accordance with specification sheet 2, Chapter 10). The visibility of the light on the whole horizon must be guaranteed by a sufficient number of sectional lights.

12. A short-range marking must be implemented for all generators of a wind farm.

13. The short-range marking must satisfy the following requirements:
- Horizontal visibility: 360°, visibility distance: 1000 m.
 - A font size of at least 0.65 m must be used.
 - Colour: yellow.
 - Permanent light.
 - Unnecessary light emissions should be avoided.
14. The short-range marking is provided either by illuminating the daytime marking or by a reflective, inverse marking. Combinations of illumination and inverse depiction and the illumination of inscription by internally lit table signs are admissible.
15. If the additional information of “EXIT arrow” (Chapter 4.3.1, Paragraph 11) is necessary, it must also be part of the short-range marking (inverse).
16. The short-range marking can be provided as follows by way of example:

a) Short-range marking by illumination

The inscription must be illuminated. The area to be illuminated is a rectangle around an inscription. The minimum distance between the characters and the outer edges of the area to be illuminated is 0.25 mm. The luminance on the yellow band within the rectangle must be at least 10 cd/m². The colour of the illuminated area must be within the specifications according to specification sheet 5 (Chapter 10).

The lights must be designed such that no direct light is shone from the light horizontally outwards. The light volume not falling on the area to be illuminated (scattered light) must be minimised.

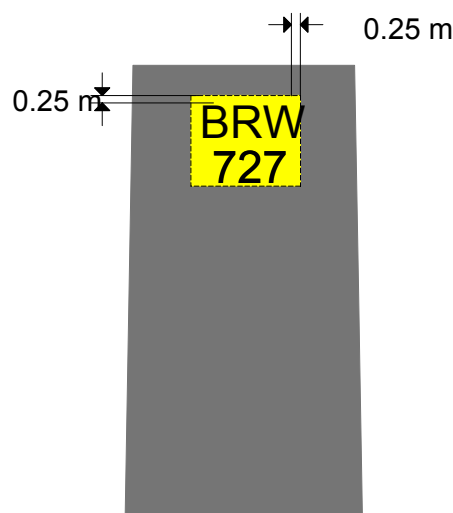


Fig. 5: Area to be illuminated for short-range marking in the form of indirect illumination

b) Short-range marking by inverse depiction

The short-range marking consists of the inscription which reflects yellow by night. If the additional information of "EXIT arrow" is necessary, it must similarly be depicted inversely.

The requisite luminance for inverse marking should be 5 to 10 cd/m². The font size should be at least 65 cm. The same font type as for the daytime marking must be used.



Fig. 6: Short-range marking using inverse depiction

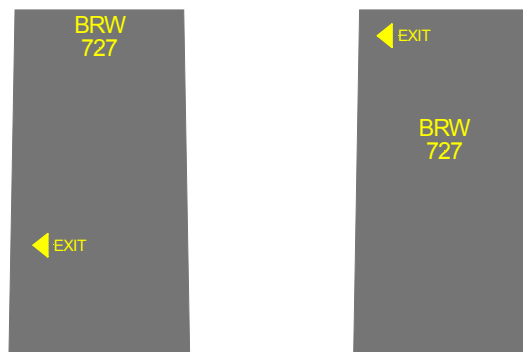


Fig. 7: Inverse depiction with additional information "EXIT arrow"

17. With particularly protrusive foundation structures or similar cases, an additional contour marking may be necessary to mark such. This will be the case in particular if the dimensions of protruding structures cannot be derived from a short-range marking directly attached to or in the direct vicinity of a tower. If individual generators are erected in navigable maritime waterways, and a safety zone of 500 m (see Section 7 (1) VO KVR) cannot be set up in an individual case, the above short-range marking must be replaced by a tower illumination.
18. In the case of tower illumination, the tower must be illuminated from all horizontal angles of observation from the area of the waterway potentially used by shipping (Figure 8).
19. The illumination lights up a vertical area of the tower of 2 metres in height. The lower edge of this area is located 6.5 metres above HAT (North Sea) and AWL + 2 m (Baltic Sea). The single-line inscription is thus completely illuminated. With a two-row inscription, the height of the illumination must be enlarged to 4 metres. Technical details of the tower illumination are contained in specification sheet 6 (Chapter 10).

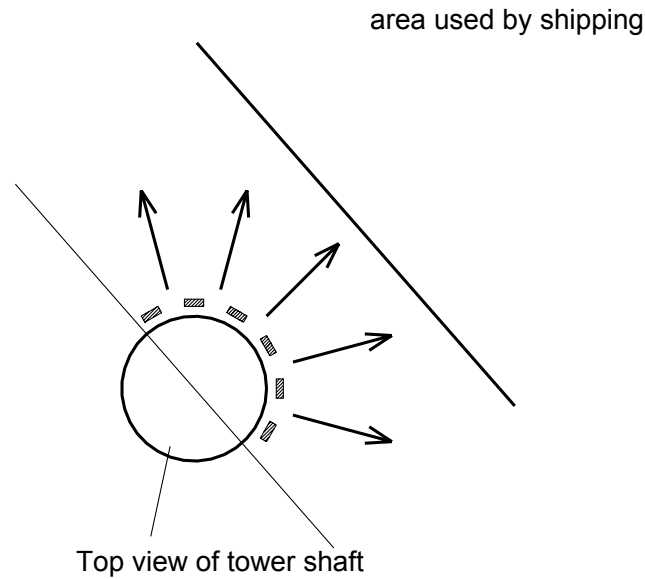


Fig. 8: Horizontal area of tower illumination

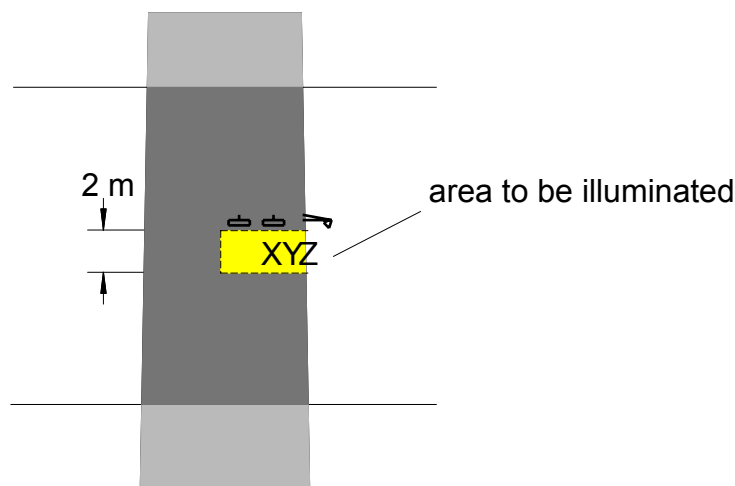


Fig. 9: Vertical area of the tower illumination

20. The short-range marking should basically be attached at the height of the inscription. To avoid the effects of sea swell, the short-range marking should be attached – under consideration of the 50-year design wave for the maritime area – in agreement with the competent WSA also above the area of HAT to HAT + 15 m and of AWL + 2 m to AWL + 17 m. In these cases the inscription should be attached at a corresponding height and the area to be illuminated in accordance with Paragraph 19 painted yellow if the short-range marking is provided by indirect illumination.

4.4 Requirements placed on the marking of obstacles to aviation

In view of the large number of wind farms planned in the direct vicinity of designated navigational waterways and shipping routes and under consideration of the peripheral conditions encountered at sea, an impairment to the safety and efficiency of vessel traffic can also be brought about by the marking of the wind generators as obstacles to aviation. On 8 May 2007, the General Administrative Regulation on the Marking of Obstacles to Aviation (AVV) (NOTAM I 143/07) was issued by the BMVBS (Annex 2).

Excerpt from the General Administrative Regulation:

*Section 1
Marking requirements*

3 General marking requirements

3.3

When marking obstacles to aviation in coastal areas and the connecting inland waterways and in the Exclusive Economic Zone, it must be ensured that the impairment to the safety and efficiency of vessel traffic, in particular disturbances to shipping signs, is avoided.

17.4

With visibility above 5000 m the nominal luminous intensity of the hazard light and W- red light, may be reduced to 30 %, and for visibility above 10 km to 10 %. The visibility shall be measured in accordance with Annex 4 (of the General Administrative Regulation).

*Section 4
Marking of installation in the sea area*

18 Scope

The following provisions for daytime and night time marking shall be applicable to wind generators and other installations in the coastal sea, the connected inland waterways and in the Exclusive Economic Zone.

19 Daytime marking

19.1

Number 13 shall apply mutatis mutandis to the daytime marking of wind generators and other installations insofar as nothing to the contrary is provided for in the following. When using white flashing lights pursuant to Number 6, it must be ensured that an impairment to the safety and efficiency of vessel traffic, particularly confusing with shipping signs, is ruled out.

19.2

The rotor blades of the wind farms and other installations must be marked with three orange/white/orange stripes or with three red/grey/red stripes each with a length of 6 m in accordance with Number 5.2 (of the General Administrative Regulation), starting at the tip of the blade. The mast shall be marked in accordance with the rules and regulations of the Federal Waterways and Shipping Administration for the design, marking and operation of wind farms and other installations to maintain the safety and efficiency of vessel traffic.

20 Night time marking

20.1

The night time marking shall consist of a W-red light (doubled) or a blade tip light. Numbers 15.2, 15.3, 16 and 17.3 (of the General Administrative Regulation) shall apply accordingly.

20.2

The switching times of all obstacles to aviation lights and the flashing sequence (identification) within the wind generator blocks shall be coordinated with the shipping signs (synchronised or at least harmonised). The rules and regulations of the Federal Waterways and Shipping Administration for the design, marking and operation of wind farms in the sea area must be observed.

The following additional requirements arise from the tasks of the WSV. These requirements are guide values on which the approval authority decides in individual cases in agreement with the WSV and the responsible aviation authority.

The WSV will check the marking and lighting of obstacles to aviation under consideration of the requirements set out in the abovementioned AVV and can provide for measures to consider the safety and efficiency of vessel traffic. The following objectives must be considered in particular:

- The effects of glare in the area of shipping and reflections on the water surface must be avoided or minimised.
- An increase in the background brightness must be avoided or minimised.
- The recognisability and usability of shipping signs must be guaranteed. The danger of confusing shipping signs with aviation signs must be minimised.

With respect to the additional requirements for the daytime and night time marking, the provisions of the AVV must be heeded as follows:

1. The daytime marking of wind generators must basically be provided with the assistance of coloured markings. White flashing day lights can only be authorised in justified individual cases.
2. For night time marking, only W-red light or blade tip obstacle light may be used possibly in connection with obstacle lights in accordance with the AVV. The decision on this shall be made in an individual case by the approval authority at its due discretion after the consent authorities (the competent aviation authority or the competent WSA) have achieved agreement. If no agreement is reached, the BMVBS shall decide.
3. The effective operating luminosity of the W-red light must comply with Annex 3 of the AVV and the specification sheet 3 of these Guidelines and may not exceed 150 cd.
4. The nominal luminous intensity of the W-red light, must be reduced in accordance with Number 17.4 of the AVV. If in an individual case a reduction in the nominal luminous intensities going above this is fore-

seen, this must be agreed between the relevant competent authorities. If no agreement is reached, the BMVBS shall decide.

5. The photometric luminous intensity of obstacle lights and rotor tip obstacle lights must be set in accordance with the AVV, but may not exceed 15 cd.
6. On times and cycles of shipping and aviation obstacle markings of wind generators on German navigable waterways, the bordering waters seawards of the German coastal sea or in the German EEZ must be harmonised or synchronised in accordance with the specification sheet 4 (Chapter 10) of these Guidelines.

4.5 Supplements

Examples of marking plans for wind farms:

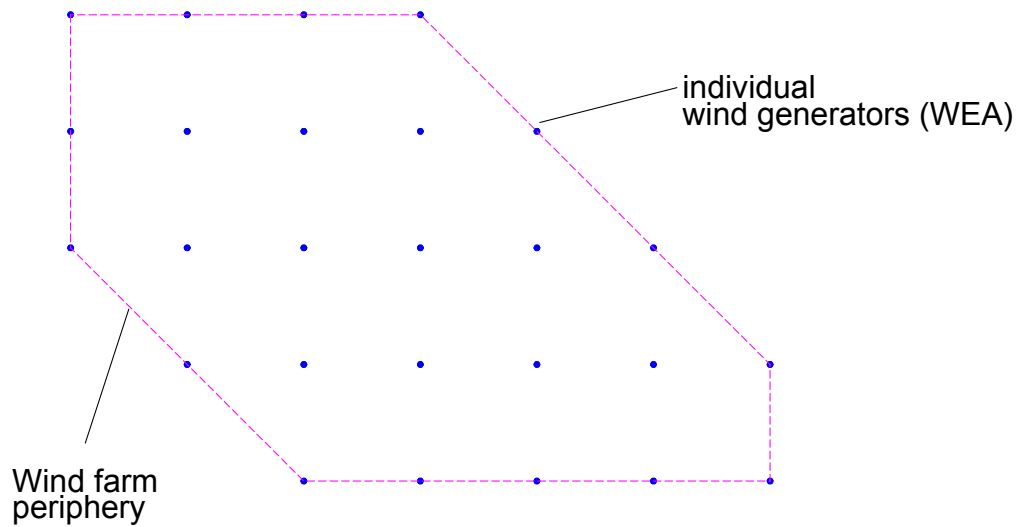
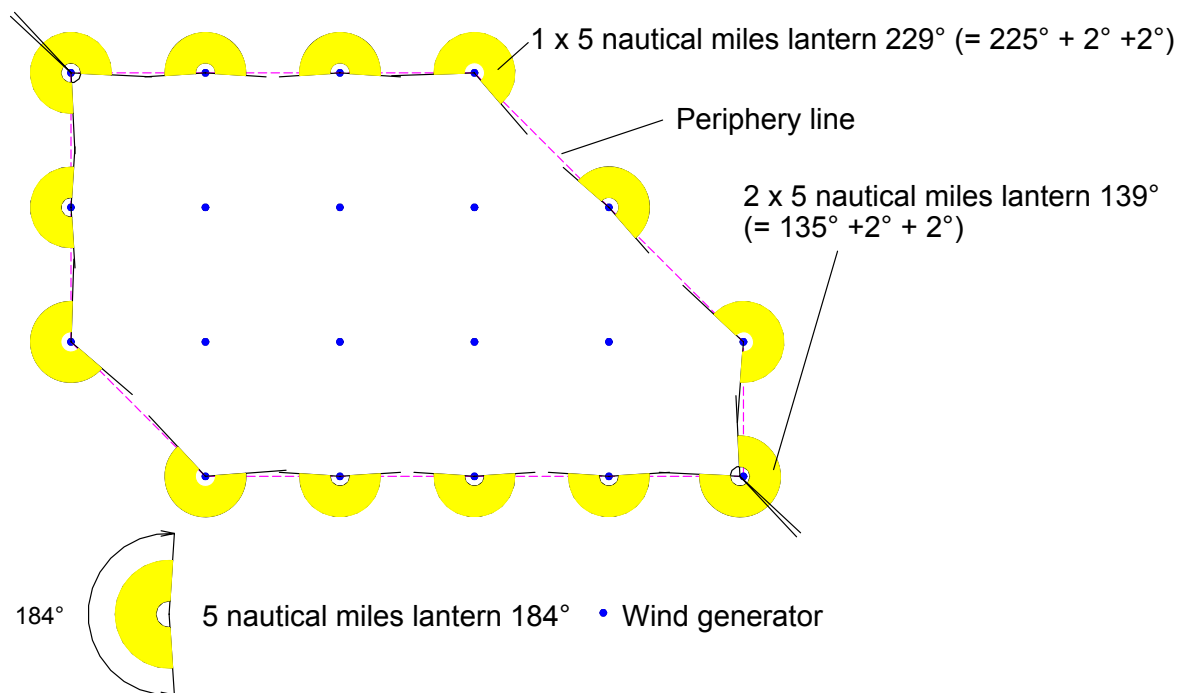
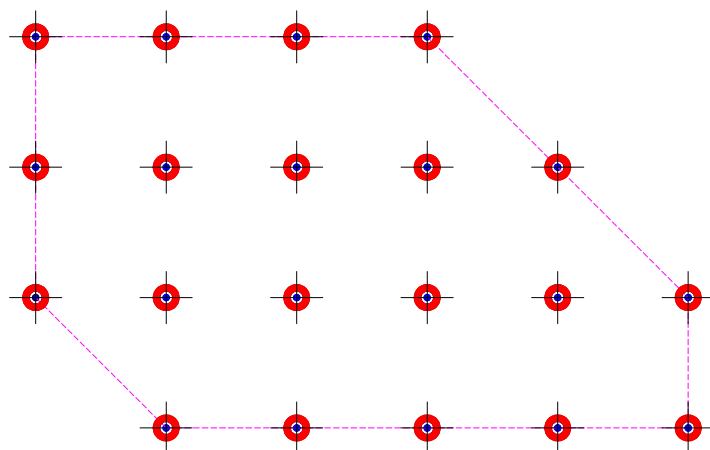



Fig. 10: Top view of wind farm, geometric drawing, by way of example



*Fig. 11: Top view of night time marking for shipping
(by way of example: version from Chapter 4.3.2, Paragraph 6a,
horizontal beam only outwards)*



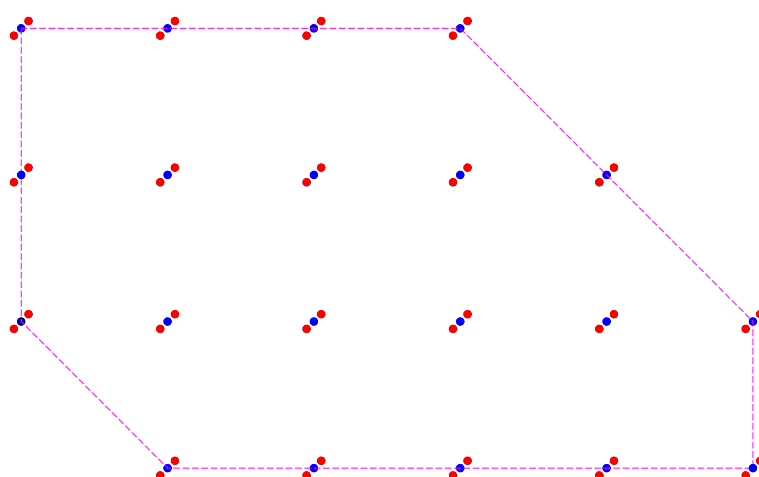

 Obstacle lighting for aviation 10 cd on mast
 omnidirectional, 360° (multiple arrangement of lights)

*Fig. 12: Top view of night time marking for aviation
(plane of the obstacle lights)*

Remark on obstacle lighting

The number and position of the levels for obstacle lights is stipulated by the competent aviation authority.

It should be remembered that when using the obstacle lights in accordance with the abovementioned AVV two lights must be visible for slim obstacles from every horizontal position and every level.




 W-red light, dual

*Fig. 13: Top view of night time marking for aviation
(plane of the W-red light, nacelle)*

Examples of marking a wind generator by section light (yellow 5 nautical miles lantern):

To light a structure omnidirectionally (360°) and horizontally, several lights will usually be necessary which can each illuminate a horizontal sector (section lights).

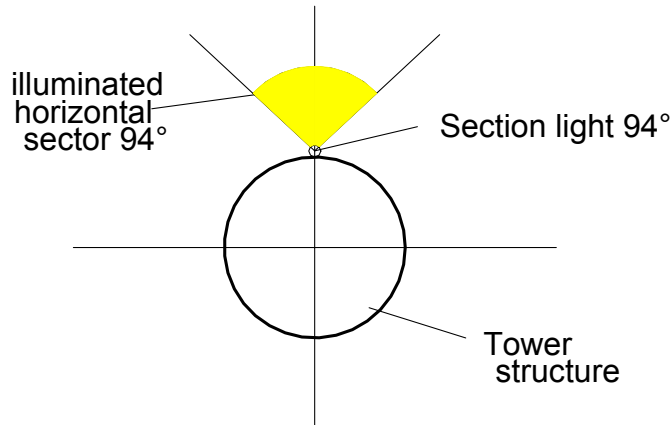


Fig. 14: Section light on the structure (top view)

The entire horizon 360° can, for example, be illuminated by the use of 4 section lights 90° , 3 section lights 120° or 2 section lights 180° . To reliably illuminate the transition between the sectors of the section lights, the sectors of the section lights must be selected 2° larger on each side.

Sector sizes of 94° , 124° and 184° arise for the above mentioned cases.

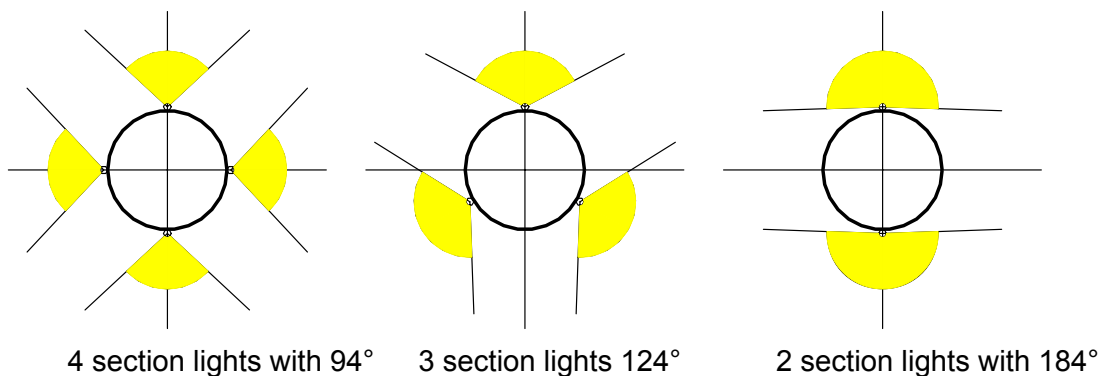


Fig. 15: Omnidirectional lighting using section lights, top view

An arrangement of section lights may also be a good idea if the sector to be illuminated on the horizon is smaller than 360° .

5 Radiocommunication marking

The WSV is in the process to establish coverage of the Exclusive Economic Zone (EEZ) of the Federal Republic of Germany regarding AIS and VHF radio telephony via the VHF maritime radio channels 70 and 16. This will be implemented by so-called SMV Remote Stations (VTA). It is planned to locate these stations partly on wind farms or their supply platforms.

Every wind farm operator is generally required to secure his wind farm against collisions with vessels by using AIS AtoN.

In exceptional cases, an AIS AtoN need not be used after coordination with the WSV. For example, if a VTA is set up in the respective wind farm, it may also be used to mark the offshore,

The marking of offshore wind farms by AIS AtoN is described in the IALA Recommendation A-126. The nature of the AIS marking must be coordinated with the WSV individually for every wind farm before starting construction work.

The AIS AtoN must have an availability of 99.75 %.

The following must be observed in particular:

1. The AIS AtoN are divided into three categories in the above mentioned Recommendation A-126. Type 3 (Type 3 AIS AtoN Station) is basically used to mark wind farms. The AIS AtoN station must comply with the IEC Standard 62320-2 "Maritime navigation and radiocommunication equipment and systems - Automatic identification system (AIS) - Part 2: AIS AtoN Stations - Minimum operational and performance requirements, methods of testing and required test results". The conformity with this standard must be certified by a laboratory accredited for AIS tests.
2. The range of the AIS AtoN to mark a wind farm may not exceed 20 nautical miles omnidirectionally. For this reason, antenna heights of the AIS AtoN of at least 36 m above the highest tide must be observed. Deviations from this requirement must be coordinated with the WSV on an individual case basis. Consent from the competent WSD is required.
3. At least two AIS AtoN must be used.
4. Corner points are used to mark the wind farm and some peripheral generators marked in the case of longer side lengths (no area marking). The marking of the wind farm must be coordinated with the WSV.
5. "Synthetic" AIS AtoN messages may be used to mark a wind generator in part. These are transmitted by the AIS AtoN of the wind generator.
6. Operating mode of the AIS AtoN

- Reporting mode of the AIS AtoN: Mode A according to IALA Recommendation A-126 dated June 2007.
 - The AIS AtoN message (AIS-VDL message 21) must be transmitted using RATDMA (Random Access Time Division Multiple Access). A future conversion to the FATDMA procedure must be facilitated.
 - The AIS AtoN transmits the AIS VDL message 21 cyclically every 10 minutes.
 - The message intervals can be reduced temporarily via the AIS service (VHF) and via a remote control unit. For this purpose the AIS AtoN must have a remote configuration facility via the AIS-VHF radio channel.
 - The AIS radio channels can be altered regionally temporarily using the so-called radio channel management. The transmit-receive channels of the AIS AtoN must therefore be switchable within the entire VHF maritime mobile service band and must have a remote configuration facility via the AIS-VHF radio channel.
7. The AIS AtoN message (AIS VDL message 21) must be configured as follows:
 - Name of the wind farm which may not exceed 20 characters, however.
 - Position information = centre point of the wind generator
 - Type of EPFD: measured
 - Position accuracy = 1 (high)
 - Dimensions: radius (A=B=C=D), circumference of the wind farm.
 - Type of AtoN
 - AtoN status: the AtoN status bits must be set accordingly
 - Off-position indicator = 0
 - Virtual AtoN flag = 0
 8. The AIS AtoN must be equipped such that in future the functionality "Relay of AIS-SART messages" can be facilitated (device upgrade).
 9. On instruction of the WSV a remote configuration of the AIS AtoN on the wind farm must be possible from the shore.
 10. Additional AIS VDL messages sent from the AIS AtoN must be handled restrictively and must be coordinated with the WSV.

6 Impairments of technical systems

6.1 Radio communication installations of the Maritime Traffic Technology System (SMV) of the WSV

The WSV conducts “Maritime Traffic Safety” (MVS) as an integral part of the “German Coast Safety Concept”. The MVS is to be understood as the traffic information and traffic support provided by the VTS centres of the WSV to prevent collisions and running aground and for traffic control as well as orders issued for traffic regulation and steering. Essential for the MVS is the detection and identification of vessels and the communication with them.

To that end, the WSV uses the “Maritime Traffic Technology System” (SMV) with its radio communication installations.

Therefore the following must be observed in the erection and operation of wind generators within the meaning of these Guidelines:

1. The functionality of the radio communication installations of the SMV may not be impaired by the erection and/or operation of wind generators. Any impairment must be balanced out by compensatory measures.
2. Regarding radio propagation, the coverage area of VTS radar systems and directional radio systems of the WSV may potentially be impaired in particular by the erection of wind generators. The degree of impairment will depend on the nature and the dimensions of the planned individual structures (design, material) and the number and geometric arrangement of the wind generators in relationship to each other and in relationship to the installations of the WSV.
3. Any such impairments must be assumed in particular if wind generators are erected and operated
 - in the path of directional radio installations, i.e. within the spatial sector (three dimensional) which is defined by the antenna position, the beam direction and the antenna properties;
 - within the coverage areas of VTS radar installations, i.e. within the traffic areas monitored by radar as part of the MVS.
4. An assessment of individual generators or of wind farms in this respect is made by the WSV where necessary for an initial recording and evaluation of possible impairments to the radio communication installations of the SMV. The competent WSA must be provided with the following documents on request:

- Site plan of the individual generators / of the wind farms and of the wind generators in the wind farm (incl. coordinates of the individual generators) and
 - Design drawings or detailed description of the wind generator type expected to be used.
5. If it is determined by the WSV during the primary assessment taking into account all radio communication installations that the final clarification of the circumstances requires a supplementary, individual-case-related and independent expert opinion, this must be provided by the applicant. The expert opinion must describe and assess any effects on the radio communication installations of the SMV and present any compensation measures. Specific requirements placed on an expert opinion of this nature shall be set out by the competent WSA.
 6. The transmission of electromagnetic interference of every individual wind generator, of the separate infrastructure systems and of the wind farm in total must be restricted. It must be ensured that the requirements set out in the current version of the IEC 60945 standard (Maritime Navigation and Radiocommunication Equipment and Systems. General Requirements. Methods of testing and required test results) are observed.

6.2 Ship radar systems

1. Ship radar systems are an indispensable navigational aid for safe shipping. They are used for terrestrial navigation, locating obstacles to shipping and in particular to prevent collisions. With reduced visibility, ship radar systems are the only non-cooperative means of navigation to recognise and assess the danger of collision with other vessels early on and to take defensive measures (avoidance of short-range positions, ban on avoidance (see Rule 19 COLREG)).
2. The correct use of ship radar systems must therefore be guaranteed. The following requirements must be taken into consideration:
 - The permanent, complete and clear radar image representation of other traffic participants in the surrounding area of individual generators/wind farms must be guaranteed.
 - Impairments to track initialisation and tracking as well as to the ARPA function must be avoided.
 - Inadequate radar information must be avoided where possible.
3. In view of their influence on the spread and reflection of electromagnetic radiation, wind generators may have effects on radar systems, such as:
 - Shading, saturation zones
 - Multiple reflections
 - Side lobe echoes
 - Impairment to the radial and azimuth resolution capacity.
4. The effects on shipping using radar navigation possibly caused by wind generators/wind farms may not lead to mentionable impairments to the correct use of ship radar systems. In particular, it must be possible at all times to determine the danger of collision with other vessels.

5. Arrangement and reflection capacity of individual generators/wind farms as well as the geometry of wind generators in the blocks must be such that
- any effects on radar communication in the surrounding traffic area is avoided where possible or minimised; and
 - the recognisability of the periphery of a wind farm facing a vehicle required to carry equipment (SOLAS) is ensured from a distance of 6 nautical miles or less.

It may be necessary to adjust the reflective capacity by suitable measures.

6. For the purpose of initial recording and assessment of possible impairments to ship radar systems, an evaluation of individual generators or wind farms shall be made by the WSV in agreement with the technical authorities concerned. The following documents are to be provided to the competent WSA on request for this purpose:
- Site plan of the individual generators / of the wind farms and of the wind generators in the wind farm (incl. coordinates of the individual generators) and
 - Design drawings or detailed description of the wind generators type expected to be used.
7. If it is determined by the WSV during the primary assessment as part of Paragraph 6 under consideration of all radio communication installations that the final clarification of the circumstances requires a supplementary, individual-case-related and independent expert opinion, this must be provided by the applicant. The expert opinion must describe and assess any effects under consideration of the local traffic circumstances and present any compensation measures. Specific requirements placed on an expert opinion of this nature shall be set out by the competent WSA.
8. The use of RACONs to mark wind generators or wind farms is not admissible due to the fact that they may be triggered (trigger of response signals) by multiple reflections.
9. If it is necessary to provide an independent radar expert opinion in accordance with Paragraph 7, this shall finally be checked by the FVT.

7 Operation

Protection and safety concept

1. A protection and safety concept must be submitted by the applicant/operator. The submission must be made in good time and at least six months before starting construction of a wind farm or individual wind generators.
2. Measures of prevention and of damage minimisation in connection with the operation of the wind farm must be presented in the protection and safety concept. This also covers the type and extent of the sea area observation to be performed by the operator in the surrounding area of the wind farm.
3. The protection and safety concept must be approved by the competent WSA.
4. The project organisation must draw up a certified safety management system and a safety manual with procedural instructions and emergency plans.
5. The preventive measures (on protection of the project and/or securing the surrounding vessel traffic) to be presented in the protection and safety concept may make the installation and operation of technical systems and service rooms on wind generators necessary on the part of the operator. The technical requirements placed on service rooms of this type and their equipment with radio communication components are comparable with those of the VTAs (see below). Synergy effects between measures for own protection by the operator and Maritime Traffic Safety can be used.

Equipping of wind farms with traffic technology of the WSV

6. On request by the WSV, the erection and operation of VTA(s) in wind farms must be tolerated and supported where necessary.
7. The VTAs accommodate the technical equipment of the WSV and must be connected to the onshore data centres of the WSV. The SMV Network is used for that purpose. The operator must tolerate the co-use of the wind farm's internal data network and the connection to an onshore gateway point on request and explain this to third parties.
8. The detailed technical requirements for the planning of the VTA along with aspects related to connecting to the SMV Network taking into account the wind farm's internal data networks must be coordinated with the competent WSA.

9. Within the margin of which is actually and legally possible, the operator must provide free of charge the VTAs, the network connection to the gateway point of the SMV Network onshore, capacities in the wind farm's internal data networks and any technical components of the SMV services or provide resources for such. Quality parameters such as availability, integrity and security must be observed for these data transmissions.

Decommissioning

10. After the approvals have expired without replacements (i.e. by termination, expiry, revocation etc.), individual generators and wind farms and their grid connections must be decommissioned.
11. During and after the decommissioning phase, the safety and efficiency of vessel traffic and the navigable status of the federal waterways must be guaranteed on an ongoing basis.
12. The decommissioning should return the federal areas used under private law to the original condition or – if the WSV has consented – to a correct status adjusted to the altered circumstances. Private law aspects of decommissioning shall be set out in the agreement on use under private law.
13. The costs for the decommissioning must be secured in a suitable form. Evidence of this must be provided before the start of construction. The calculation of the amount of the expected decommissioning costs must be shown to be logical.

8 Definitions

Abbreviation	Definition	Description
Beam angle		Horizontal and vertical angle areas in which, for example, primary light sources shine their light.
AIS	Automatic Identification System	Automatic ship identification system. Ships identify themselves using AIS and give their position, course and speed and other data to others. AIS serves to avoid collisions at sea, the automatic exchange of information between ships and with land stations.
Approach area		Access and exit area bordering a navigational channel seawards.
AVV	AVV Kennzeichnung Luftfahrt	General Administrative Regulation for Marking Obstacles to Aviation dated 24 April 2007.
EEZ	Exclusive Economic Zone	Sea area located outside (i.e. seawards) of the coastal sea and sea area adjoining this at a maximum of 200 nautical miles to the base line (see Art. 55 et seq. UNCLOS).
BImSchG	Federal Immission Control Act	Act on the Prevention of Harmful Effects on the Environment caused by Air Pollution, Noise, Vibration and Similar Phenomena
Rotor blade tip obstacle light		Obstacle light to mark obstacles to aviation. The lights are mounted on or in the rotor blade tips of wind generators. The specifications of the light are defined in the General Administrative Regulation for Marking Obstacles to Aviation.
Glare		Glare is described as a visual discomfort which is caused by particularly bright light sources.
BMVBS	“Bundesministerium für Verkehr, Bau und Stadtentwicklung”	Federal Ministry of Transport, Building and Urban Development
Pulsing		Temporal course of a light phenomenon (light and dark time) of a lantern.
BSH	“Bundesamt für Seeschifffahrt und Hydrographie”	Federal Maritime and Hydrographic Agency: Higher federal authority in the area of competence of the BMVBS, competent authorising authority in the EEZ.
Federal waterways		Areas stipulated in § 1 WaStrG.
Bypass		Bypass describes the circumvention of an existing connection in the majority of contexts.
DCF77	D = Germany C = Long wave transmitter F = Frankfurt (transmitter location) 77 = Frequency 77.5 kHz	Long wave transmitter which supplies the majority of radio-controlled clocks in Central and Western Europe with the precise time signal.
DFS	Deutsche Flugsicherung GmbH	The DFS Deutsche Flugsicherung GmbH is the competent body for Air Traffic Control (ATC) in Germany. The DFS also develops ATC tracking and navigation systems.
Direct light		Direct light from a light source in the direction of the observer; glare occurs if specific border values are undercut.

Abbreviation	Definition	Description
DWD	“Deutscher Wetterdienst”	German Meteorological Service: Official weather service of the Federal Republic of Germany, headquarters in Offenbach.
effective operational luminous intensity		Results from the photometric luminous intensity (as time characteristic) under consideration of the perception of the human eye and a loss factor (definitions in VV-WSV 2405, IALA Recommendations as well as DIN V/ENV 50234).
EmsSchEV	Ordinance on the Introduction of the Shipping Regulations for the River Ems Estuary	Ordinance places the Shipping Regulation for the River Ems Estuary into force.
Fairway		Deepest part of a navigational channel kept at a specific depth.
Navigational channel		Water areas which within the meaning of § 2 (1) No. 1 SeeSchStrO and Art. 1 (1) No. 2 SchOEmsmündung are restricted or marked by visible signs or are intended for passing shipping.
Continuous light		Operation without pulsing. There is no interruption of the light period.
W-red light		A light to mark obstacles to aviation which is used exclusively on wind generators. The specifications of the light are defined in the General Administrative Regulation for the Marking of Obstacles to Aviation.
W-red ES light		A light W-red which satisfies the specifications of the General Administrative Regulation for the Marking of Obstacles to Aviation and the extended specifications of these WSV Guidelines.
Five nautical miles lantern		Sea lantern whose luminous intensity is defined such that it can be recognised at a distance of five nautical miles with permanently defined ambient conditions (reference is made to nominal range by the IALA).
FVT	“Fachstelle für Verkehrstechniken der WSV”	Traffic Technologies Centre of the Federal Waterways and Shipping Administration; situated in Koblenz
GG	“Grundgesetz”	Constitution of the Federal Republic of Germany
HAT	Highest Astronomical Tide	Height of the highest tide which can be calculated in advance for a location solely on the basis of the prevalent local tidal conditions (i.e. solely on astronomical basis).
HHP anchor , high-hold anchor	Anchor with high holding power	Modern anchor which, compared to conventional anchors, has equivalent holding power with low weight but penetrates more deeply into the anchor bed due to its design.
Obstacle light		Type of light to mark obstacles to aviation. The specifications of the light are defined in the General Administrative Regulation on the Marking of Obstacles to Aviation.

Abbreviation	Definition	Description
Indirect light		Light which reaches the lit area not from the light source directly but by reflection.
Inverse depiction		In the case of inverse depiction (from the Latin "inverso": reverse) all colours shown are reversed.
Collision friendly construction		Type of design, foundation or construction of wind generators which guarantees that the ship's hull is damaged as little as possible in the case of a collision.
Coastal sea		Territorial waters of a coastal country up to a maximum distance of 12 nautical miles from the base line (i.e. up to a maximum of 12 nautical miles from the coastal line at low water, see Art. 3 et seq. UNCLOS).
KVR	Collision prevention rules	International regulations of 1972 to prevent collisions at sea. International maritime law, applicable on the high seas and adjoining navigable waters, i.e. also in the German EEZ and subsidiary to this on German navigable maritime waterways.
KVZ	Coastal traffic zone	Area between the coastal line of a state and a traffic separation scheme bordering seawards.
Luminance		Luminance is the photometric measurement for the impression of brightness which the eye has of a shining or illuminated area.
Light emission, inadmissible		An undesirable brightening of the horizon results from a scattered beam from light sources. So-called light bells can form.
Pilot transfer		The bringing on or off board of a pilot by means of a ship (pilot transfer ships) or helicopter.
Obstacle to aviation		An obstacle which rises so far above the ground that it constitutes a hazard to aviation. The limits are defined nationally in the General Administrative Regulation for Marking Obstacles to Aviation.
Average water level		Stipulated average level of the water level fluctuations = chart datum. Only applies to the Baltic! Reference in Schleswig-Holstein: sea level in Mecklenburg-Vorpommern: average water level over many years.
Morphological channel		Use-related: area within navigable waters which is formed by the outermost cover of all fairways required for shipping.
Morphological bed		Use-related: Vertical extension of natural deepest positions of the natural water base within the morphological channel.
MVS	"Maritime Verkehrssicherung"	Maritime Traffic Safety: Traffic information and traffic support as well as traffic regulations and steering provided by the Vessel Traffic Services (VTS) centres of the WSV to prevent collisions and running aground or to control traffic processes.
MW		Medium wave is a frequency band and serves communication through the transmission of electromagnetic waves. It includes the range of 300 kHz (1000 m) to 3000 kHz

Abbreviation	Definition	Description
		(100 m).
Night time marking		Visual (usually light) marking which marks a structure or obstacles at night.
Short-range marking		Marking of wind generators which is defined for a maximum visibility distance of 1000 m.
Periphery line		Line which forms the outer border of a wind farm (see example in Annex 1).
Photometric luminous intensity		The luminous intensity of a light source determined using measurement techniques.
Practical meteorological visibility		A measurement of the haze in the atmosphere (fog, mist). is recorded by weather observations of the DWD, for example.
Roadsteads		Designated anchor areas for shipping.
River operation		Operating state of the drive and manoeuvring system of a ship within territorial waters (e.g. whilst travelling along the River Elbe).
Barricade effect		Disadvantageous influencing of shipping by, for example, the forced necessity to take diversions and/or loss of time as a result of circumventing obstacles.
Switching times		Times at which the lighting of wind generators are switched on and off synchronously.
Shipping police		Defence against hazards to the safety and efficiency of vessel traffic and defence against hazards emanating from shipping for the maritime environment (see § 1 (2) SeeAufgG).
SchOEmsmündung	Shipping Regulations for the River Ems Estuary	Bilateral German-Dutch maritime law, applicable in the area of the River Ems estuary.
SeeAnIV	Offshore Installations Ordinance	Ordinance on offshore installations seaward of the limit of the German territorial sea; applicable to the erection and operation of installations in the German EEZ.
SeeAufgG	Maritime Navigation (Federal Competences) Act	German Act on the tasks of the federation in the area of shipping.
SeeSchStr	Navigable maritime waterways	Water areas, the extent to which is stipulated in § 1 SeeSchStrO and § 1
SeeSchStrO	German Traffic Regulations for Navigable Maritime Waterways	EmsSchEV National maritime transport law of the Federal Republic of Germany, applicable on all German navigable maritime waterways with the exception of the River Ems estuary.
Safety zone		Water areas which extend at a distance of 500 m measured from every point of the outer edge around installations or similar (§ 7 (1) VOKVR).
nm	Nautical mile	Arc minute of a great circle (e.g. of a meridian), length: 1,852 m.
SMV	“System Maritime Verkehrstechnik”; Maritime Traffic Technology System	Coherent service-oriented, coastal-wide technical system operated by the WSV for maritime traffic safety and efficiency. The SMV is composed of different technical services. The responsibility for planning, development, operation, maintenance and

Abbreviation	Definition	Description
		decommissioning to original state rests with the WSV.
SMV Network		The SMV Network provides the coastal-wide shore-base data transportation within the SMV and inter-connects, amongst others, the VTAs, the SMV data centres and the VTS centres of the WSV.
SOLAS	Safety of Life at Sea	International Convention for the Safety of Life at Sea. Regulations to implement international safety standards for the construction and equipping of sea ships.
UNCLOS	UN Code for the Law of the Sea	International maritime law
ssG	“Strom- und Schifffahrtspolizeiliche Genehmigung”	Water and shipping police permit: Approval necessary under § 31 WaStrG to erect, operate and change installations in, above, below or on the shore of federal waterways if as a result of the intended measures an impairment to the safety and efficiency of vessel traffic or to the navigable state of the federal waterway is to be expected.
Water police		Maintenance of the navigable state of the federal waterways (see § 24 (1) WaStrG).
Synchronisation		(from the Greek <i>sýn</i> , “together” and <i>chrónos</i> , “time”, literally “creation of synchronisation”), describes the harmonisation of processes.
Daytime marking		Visual (usually light or coloured) marking which marks a structure or obstacle by day.
VHF		Very high frequency (VHF) describes electromagnetic waves in the frequency range from 30 MHz to 300 MHz, corresponding to wave lengths of between 10 and 1 metre.
UM	Unrestricted manoeuvring zone	Water areas identified by the Waterways and Shipping Directorates North and North-West in the Inner German Bight and in the estuary areas of Ems, Jade, Weser and Elbe. The UM muss must be fully available to shipping where possible in view of the traffic situation prevailing here (traffic frequency and structure, line and area traffic, encounter, overtaking and crossing situations), the ship-side operational and manoeuvring states and the nautical and meteorological and hydrological peripheral conditions. It must therefore basically be kept free of artificial obstacles and structures (also: sea cables).
VTS	Vessel Traffic Services	
VO KVR	Ordinance on the Introduction of the KVR	Ordinance to put the KVR into force
VTA	“Verkehrstechnik-Außenstation”	Remote Station of the SMV: VTA designates the housing environment of the technical components of one or several services of the SMV, but the term does not, by definition include these technical components

Abbreviation	Definition	Description
		themselves. The housing can be created by one or several rooms or cabinets. An important property of a VTA is that only WSV-authorized staff may have access to the technical components housed. A VTA also comprises the infrastructure for technical components of the service(s) in the outdoor area (e.g. antenna). The dimensioning of the VTA must satisfy the requirements of all necessary components. The term also covers the cable routes to and from the outdoor components, the overvoltage protection, the provision of the necessary environmental working conditions for the components, the energy supply and the data transfer point to the SMV Network.
TSS	Traffic Separation Scheme	Shipping lanes determined by the International Maritime Organisation (IMO) which are subdivided by separating lanes or separating zones into one-way lanes. They may only be navigated in the main direction to the right of the separating zone or separating line (see Rule 10 International Regulations for Preventing Collisions at Sea).
WaStrG	Federal Waterways Act	National waterways law
White flashing day-time light, daytime light		A category of light types in accordance with the General Administrative Regulations for the Marking of Obstacles to Aviation (AVV Luffahrt). White flashing daytime lights have an effective luminous intensity of 20,000 cd in the light colour of white
Wind farm		Arrangement of several wind generators which are spatially connected.
WSA	“Wasser- und Schifffahrts- amt”	District or local office of the Federal Waterways and Shipping Administration (WSV).
WSD	“Wasser- und Schifffahrts- Direktion”	Waterways and Shipping Administration Directorates (WSD) are intermediate authorities reporting to the Federal Ministry of Transport, Building and Urban Development
WSD Nord		Waterways and Shipping Directorate North, situated in Kiel
WSD Nordwest		Waterways and Shipping Directorate North-West, situated in Aurich
WSV	“Wasser- und Schifffahrts- Verwaltung des Bundes”	Federal Waterways and Shipping Administration

9 Reference documents

- SeeAufgG, WaStrG, SRÜ, KVR, VOKVR, SeeSchStrO, SchOEmsmündung
- IALA Maritime Buoyage System
- DIN 5031 Strahlungsphysik im optischen Bereich und Lichttechnik, Teil 3, March 1982
- DIN 5032 Lichtmessung, Teil 1, April 1999
- DIN 5033 Farbmessung, Teile 1(03/1979), 2 (05/1992), 3 (07/1992) and 8 (04/1982)
- DIN 5036-1 Strahlungsphysikalische und lichttechnische Eigenschaften von Materialien, July 1978
- IALA Recommendation O-139 On The Marking of Man-Made Offshore Structures, December 2008
- IALA Recommendations for the rhythmic characters of lights on aids to navigation E-110, December 2005
- IALA Recommendation O-130 On Categorisation and Availability Objectives for Short Range Aids to Navigation, December 2004
- IALA Recommendation V-128 On Operational and Technical Performance Requirements for VTS Equipment, June 2005
- IALA Guideline No. 1035 To Availability and Reliability of Aids to Navigation, December 2004
- IALA Recommendation E-200 On Marine Signal Lights Part 1 Colour, December 2008
- IALA Recommendation E-200 On Marine Signal Lights Part 3 Measurement, December 2008
- DIN EN 12899-1: Ortsfeste, vertikale Straßenverkehrszeichen (Teil 1: Ortsfeste Verkehrszeichen); Tabelle 10 Klasse L1 und Tabelle 12 Klasse U2, February 2008
- Allgemeine Verwaltungsvorschrift zur Kennzeichnung von Luftfahrthindernissen of 8 May 2007 (NfL I 143/07)

10 Specification sheets

10.1 Specification sheet 1

Daytime marking of the tower

a) Yellow band on the tower

Geometry:

The daytime marking is provided by a yellow band on the structure (see Figure S10).

The vertical height of the band is basically as follows:

- for the North Sea 0 to 15 metres above HAT (Highest Astronomical Tide),
- for the Baltic Sea 2 to 17 metres above the average water level (AWL).

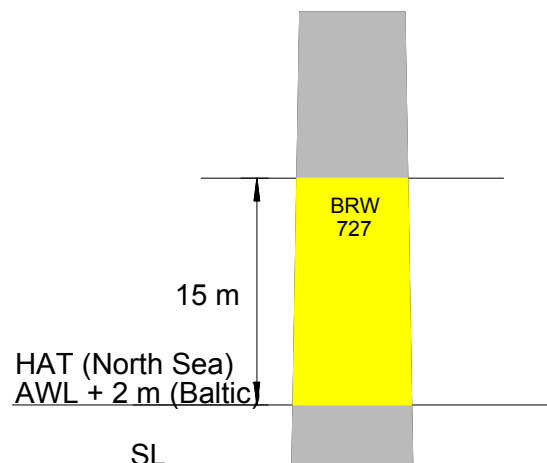


Figure S10

Colour:

The yellow colour in new state must comply with the colour range and luminance factor set out in specification sheet 5. If the colour no longer complies with the requirements of specification sheet 5, the operator must arrange for a new coating.

b) Inscription

The inscription on the tower is provided by black lettering on the yellow daytime marking. The size of the type is 1 metre. The type to DIN 1451 Sans-serif Linear Antiqua Part 2: Medium-spaced Traffic Typeface is used.

The black colour in new state must comply with the colour range and luminance factor set out in specification sheet 5. If the colour no longer complies with the requirements of specification sheet 5, the operator must arrange for a new coating.

The inscription is to be provided on the structure horizontally either three times around 120° or 4 times around 90° on the circumference of the structure.

c) Additional information “directional arrow and EXIT”

Optionally the structure may be marked with a black arrow and the inscription “EXIT” on the yellow daytime marking. The arrow provides information about the shortest path to leave the wind farm

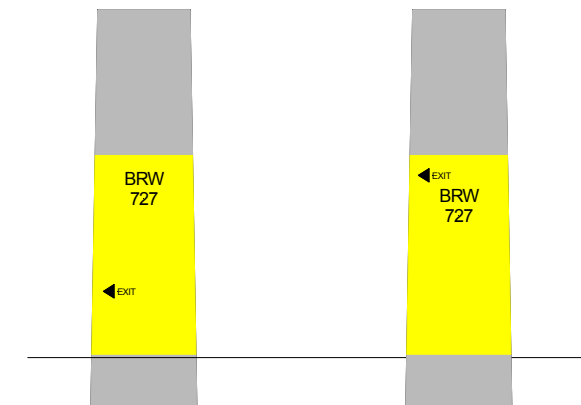


Figure S11

The same colormetric requirements apply to the black colour as to the inscription (b). The arrow is attached vertically to the shortest distance to the periphery on both sides (180° offset) (Fig. S12).

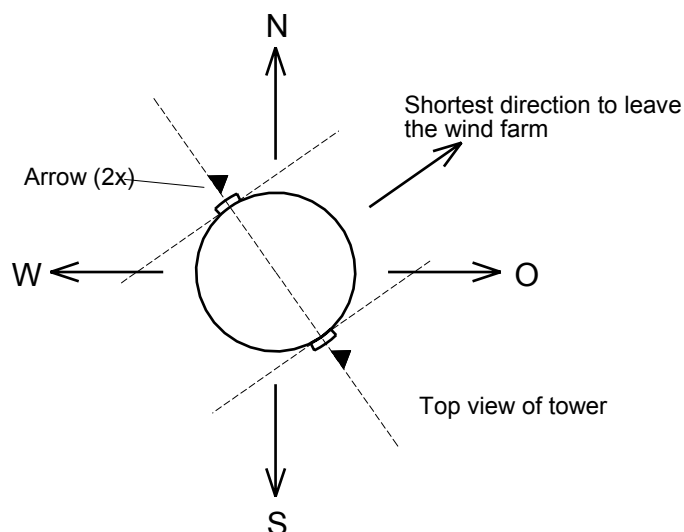


Figure S12

d) Geometry of the inscription for simple daytime marking

Fig. S13 shows the geometrical arrangement of the inscription. Upper and lower rows must be centred horizontally to each other.



Figure S13

e) Geometry of the marking for additional information

Fig. S14 shows the geometrical arrangement of the arrow and the EXIT inscription. The inscription is always on the blunt side of the arrow.

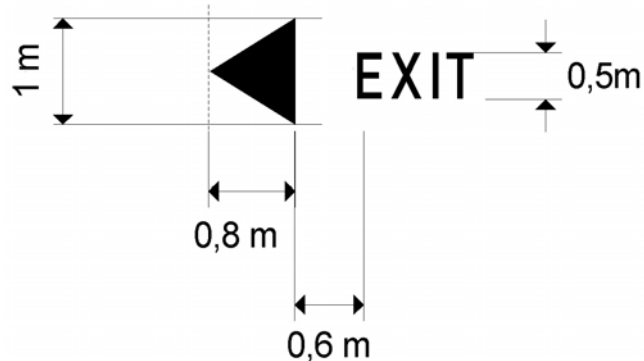


Figure S14

N.B.: For technical reasons, the representation of the typeface in this document may deviate from the actually required typeface. The data on the requisite typeface in DIN 1451 should therefore be used to implement the inscription.

10.2 Specification sheet 2

5 nautical miles lantern, yellow

Part A Application

Vertical position of the lights on the tower:

10 to 25 metres above reference height (HAT or AWL + 2 m)

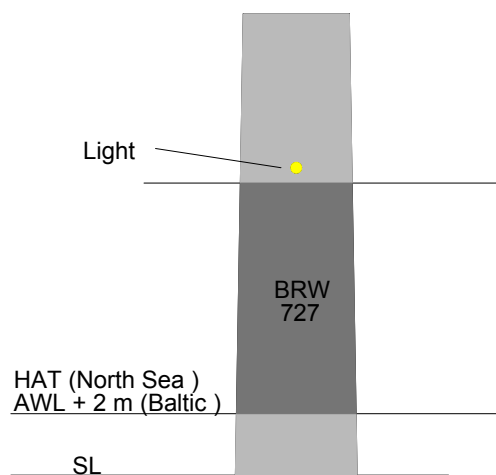


Figure S20

Horizontal beam angle:

Every light shines horizontally only in a specific sector. The illumination of the horizon must be ensured by selecting suitable lights and arranging them on the wind generators. The sector illuminated by the light must be 2° larger on the sector boundaries to balance out tolerances.

Examples:

a) Straight periphery for version in 4.3.2 (9) letter a

With a straight course of the periphery, the requisite horizontal beam angle is 180° . For the tolerance compensation a beam angle of 184° ($= 180^\circ + 2^\circ + 2^\circ$) for one light therefore results.

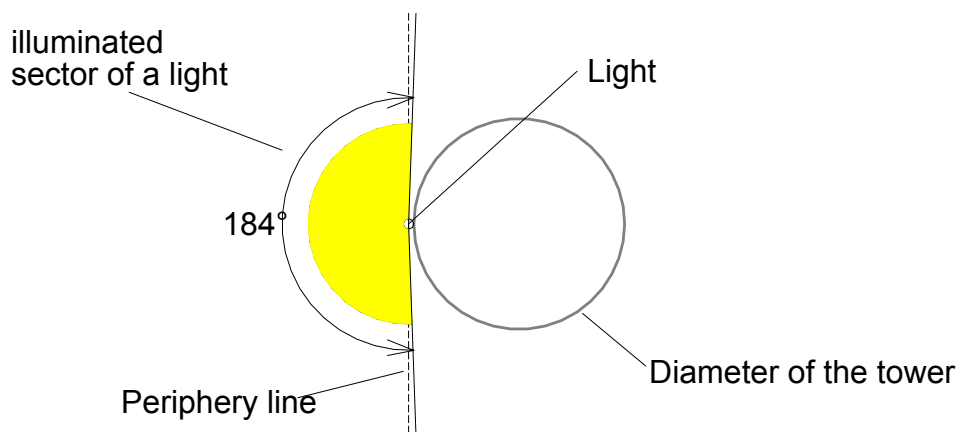


Figure S21

b) Rectangular course of the periphery for version in 4.3.2 (9) letter a

The marking can be provided by two lights. The entire area to be illuminated is 270° and is divided over two lights ($2 \times 135^\circ$). For the tolerance compensation lanterns with a beam angle of 139° are necessary ($135^\circ + 2^\circ + 2^\circ$).

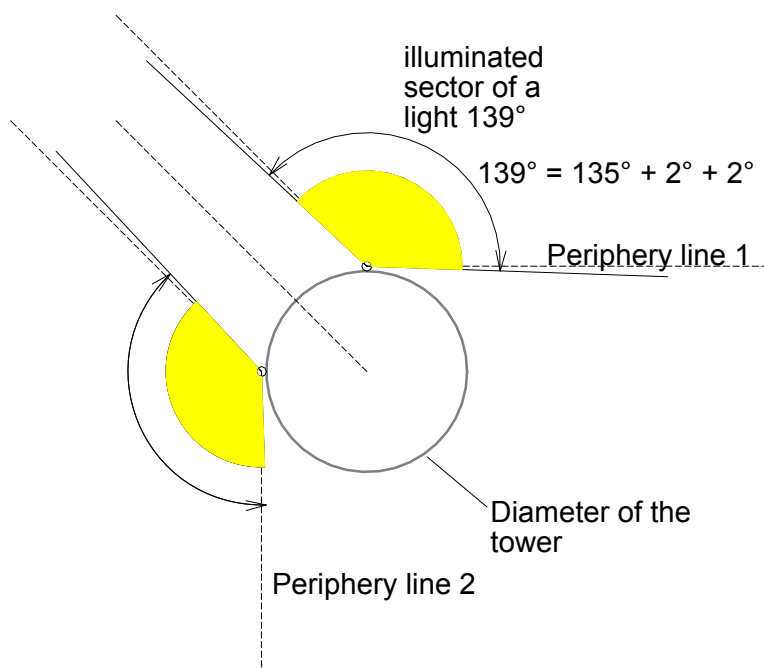


Figure S22

c) General change in direction of the periphery for version (a) in 4.3.2

In the case of changes in direction of the periphery line around the angle α , the beam angle of the lantern is $184^\circ (= 180^\circ + \alpha + 2^\circ + 2^\circ)$.

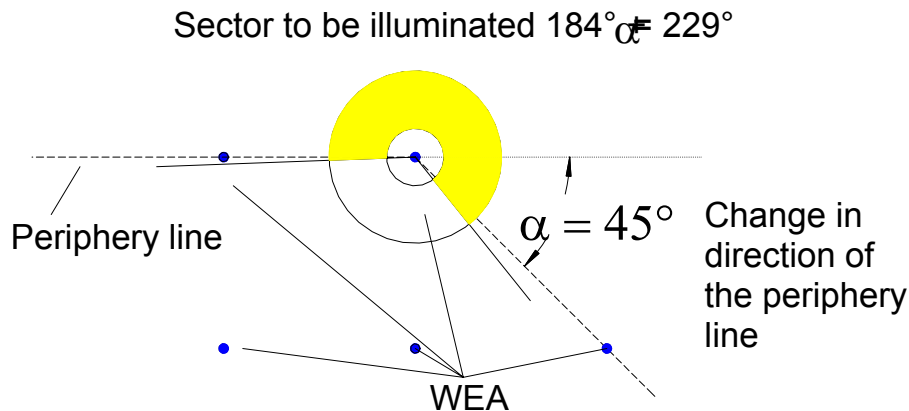


Figure S23 (example: $\alpha = 45^\circ$)

N.B.: The sector of 229° is preferably covered by two lights.

Part B Technical standard of the lights

1. Preliminary remarks

Wind generators within an offshore wind farm are marked in accordance with the IALA Recommendation O-139 "On the Marking of Man-Made Offshore Structures" including the use of 5 nautical miles lanterns. This document implements the recommendation of the IALA to produce a technical light description.

5 nautical miles lanterns to mark wind generators in the area of responsibility of the Federal Waterways and Shipping Directorates North and North-West must basically be implemented in accordance with the existing technical standards. The approval of the competent WSA is required for any exceptions.

This standard describes both minimum and maximum values for the luminous intensity of the lanterns within the framework of the IALA Recommendations. It is necessary to restrict the value range to guarantee the safety and efficiency of vessel traffic, rule out disturbances to shipping signs and avoid unnecessary light emissions.

The WSV standard exclusively describes the quality of the visual marking by the lanterns. Irrespective of this, the lanterns must comply with additional technical standards (e.g. CE conformity, class of protection) which are set out in other sets of rules and regulations or in approval procedures.

2. Inscription and marking of the lanterns

A lantern usually only illuminates a specific sector in the horizon. The size of the illuminated sector (horizontal beam angle Φ_L) together with the luminous intensity are the main features of the lantern.

The lights must therefore be visibly marked with the inscription: "5 nautical miles lantern" and with the numerical value for the horizontal beam angle. The beam angle range must be marked on the housing in yellow. The direction to the tower axis must be marked by a black line (Fig. S24).

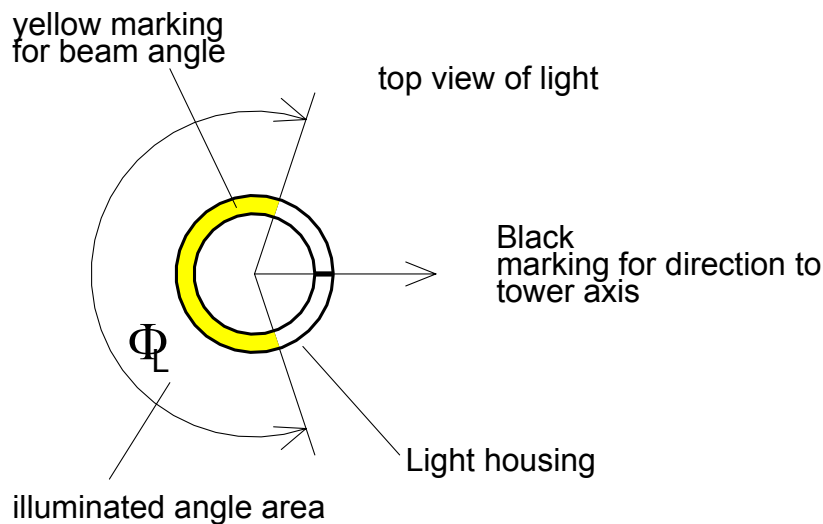


Fig. S24: Inscription and marking of the lanterns

3. Luminous intensities

3.1 Geometry

The reference planes shown in Figures S25 and S26 are used to specify the distribution of luminous intensity (see also [4]). The up beam in the vertical plane system is described by a positive angle and the down beam by a negative angle.

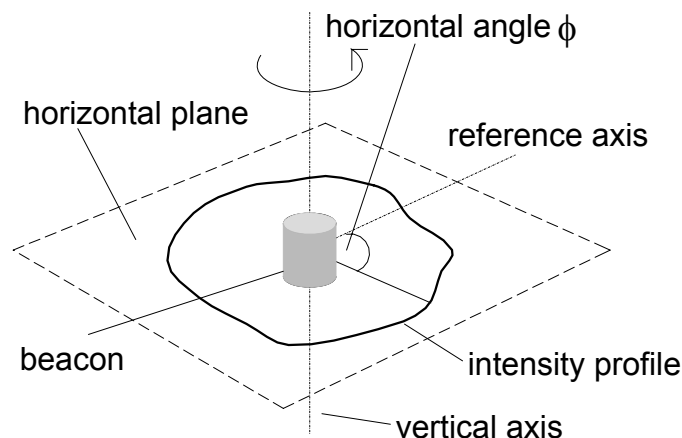


Fig. S25: Horizontal plane (IALA Rec E-200-3)

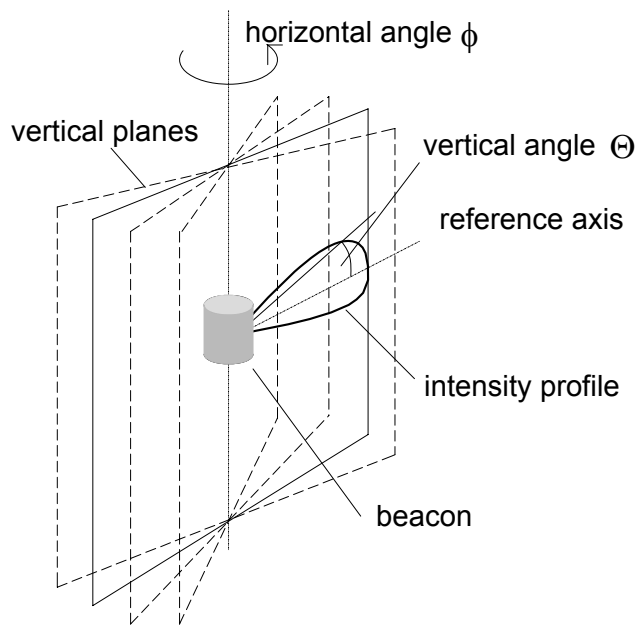


Fig. S26: Vertical plane system (IALA. Rec. E-200-3)

3.2 Requirements placed on pulsing

It is only possible to specify a photometric luminous intensity if the time characteristic of the luminous intensity is virtually rectangular. Figure S27 shows a measured time characteristic. The time characteristic is viewed to be sufficiently rectangular if the times t_{on} and t_{off} are smaller than 0.1s (both times are defined by the reaching of the thresholds 10% and 90%). Times over 0.1 s are inadmissible.

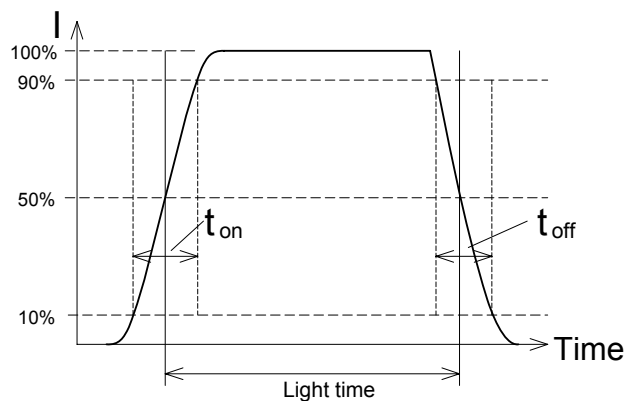


Fig. S27: Time characteristic of the luminous intensity

3.3. Distribution of luminous intensity

The vertical distribution of luminous intensity (measurable photometric luminous intensity) of the lights must be within the following tolerance band for continuous lighting and for all horizontal beam angles in the illuminated sector.

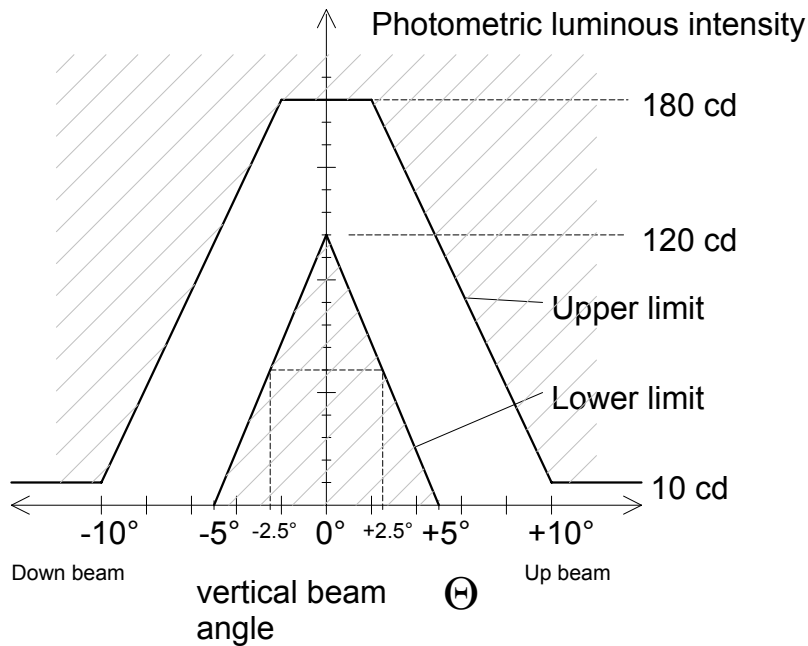


Fig. S28: Requirements for the distribution of luminous intensity

Mathematical description of the lower limit:

$$I_{\min} = \begin{cases} 120 \text{ cd} - 24 \text{ cd} * |\Theta| / 1^\circ & \text{für } |\Theta| \leq 5^\circ \\ 0 & \text{für } |\Theta| > 5^\circ \end{cases}$$

Mathematical description of the upper limit:

$$I_{\max} = \begin{cases} 180 \text{ cd} & \text{für } |\Theta| \leq 2^\circ \\ 180 \text{ cd} - 21,25 \text{ cd} * (|\Theta| / 1^\circ - 2^\circ) & \text{für } 2^\circ < |\Theta| \leq 10^\circ \\ 10 \text{ cd} & \text{für } |\Theta| > 10^\circ \end{cases}$$

4. Colorimetry

The luminous colour must be within the optimum range of the "IALA-Recommendation E-200 on Marine Signal Lights, Part 1: Colours" [2]. See Figure S29: The optimum range is highlighted in yellow in the standard colour table.

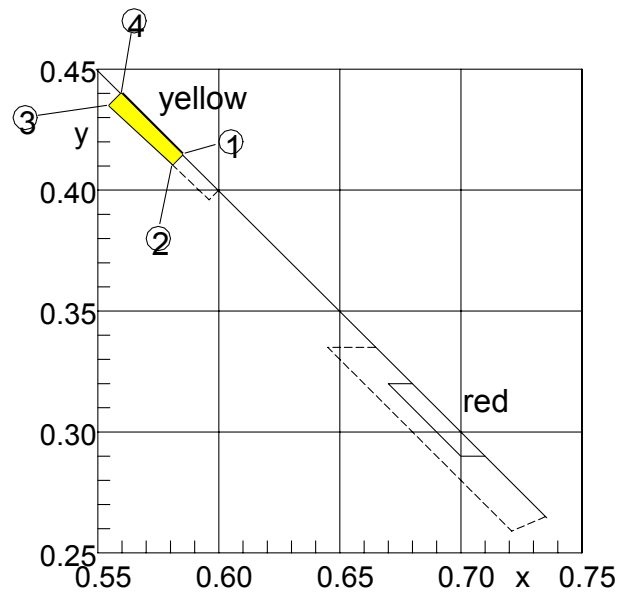


Fig. S29: Admissible range for the luminous colour

Coordinates of the corner points:

1		2		3		4	
x	y	x	y	x	y	x	y
0.5865	0.413	0.581	0.411	0.555	0.435	0.560	0.440

5. Supplements

5.1 Derivation of light-related data

The IALA Recommendation O-139 On The Marking of Man-Made Offshore Structures requires a lantern with a range of no less than 5 nautical miles to mark wind generators. The implementation of the IALA Recommendation into light-related values is not clear. For the area of the WSV this implementation is hereby stipulated in a uniform manner.

For offshore wind farms, the 5 nautical mile lantern is to be used with the following pulses:

Designation	Sequence
Ubr (3) yellow 16s	6.5 + (1.5) + 2.5 + (1.5) + 2.5 + (1.5)
Blz yellow 4 s	1 + (3)

Numerical values are time values in seconds. Values in brackets describe dark phases, and values without brackets describe light phases.

The conversion of the ranges into light-related values is made on the assumption that these are nominal ranges in accordance with "IALA-Recommendation E-200 on Marine Signal Lights, Part 2: Calculation, Defini-

tion and Notation of Luminous Range“ [3]. The nominal range refers to a practical meteorological visibility of 10 nautical miles and a threshold luminance of $2 \cdot 10^{-7}$ lx.

A nominal range of 5 nautical miles corresponds to an effective luminous intensity of 76.7 cd. Operational losses and the pulsing must be taken into consideration for conversion to a photometric luminous intensity.

According to IALA Recommendation [1] and [3] the operational losses are to be taken into consideration with a service condition factor of $b = 0.75$. The measurable photometric luminous intensity must therefore be higher than the service condition value by a factor of $1/b = 1.33 \approx 1/0.75$.

The pulsing of the light in the calculation of the effective luminous intensity is considered in accordance with IALA Recommendation “Determination and Calculation of Effective Intensity“ [4].

To standardise the technical specification of the light for both pulses, the short light time (1 s) is used.

On the condition that the pulsing is approximately rectangular (see 3.2), the following applies to the effective luminous intensity: $I_e = \frac{I_0 * \tau}{a + \tau}$, with $a = 0,2$ s and I_0 luminous intensity in rectangular pulse.

For the shortest light time of 1 s, a transfer ratio of

$$k := \frac{I_e}{I_0} = 0,833.$$

results.

If the service factor and the transfer ratio are considered together, this results in a measurable photometric luminous intensity as lower limit for the 5 nautical miles lantern of

$$I_{\min} = \frac{76,7 \text{ cd}}{0,75 \times 0,833} = 122,8 \text{ cd} \approx 120 \text{ cd}.$$

6. Reference documents

- [1] IALA Recommendation E-200 on Marine Signal Lights, Part 0: Overview, December 2008
- [2] IALA Recommendation E-200 on Marine Signal Lights, Part 1: Colours, December 2008
- [3] IALA Recommendation E-200 on Marine Signal Lights, Part 2; Calculation, Definition and Notation of Luminous Range, December 2008
- [4] IALA-Recommendation E-200 on Marine Signal Lights, Part 4: Determination and Calculation of Effective Intensity, December 2008
- [5] DIN 5031 Strahlungsphysik im optischen Bereich und Lichttechnik, Part 3
- [6] DIN 5032 Lichtmessung, Part 1
- [7] DIN 5033 Farbmessung, Parts 1, 2, 3 and 8

10.3 Specification sheet 3

Extended specification for the "W - red light"

Explanation:

The W-red light must be executed in accordance with the "General Administrative Regulation on the Marking of Obstacles to Aviation".

The extended specification of the W-red light set out here contains the requirements of the General Administrative Regulation and an angle-dependent upper limit for luminous intensity.

This is necessary to facilitate a harmonisation with lighting for shipping and to avoid unnecessary light emission as part of environmental protection.

Geometry:

The reference planes used in Figures S30 and S31 are used to specify the distribution of luminous intensity. The up beam in the vertical plane system is described by a positive angle and the down beam by a negative angle.

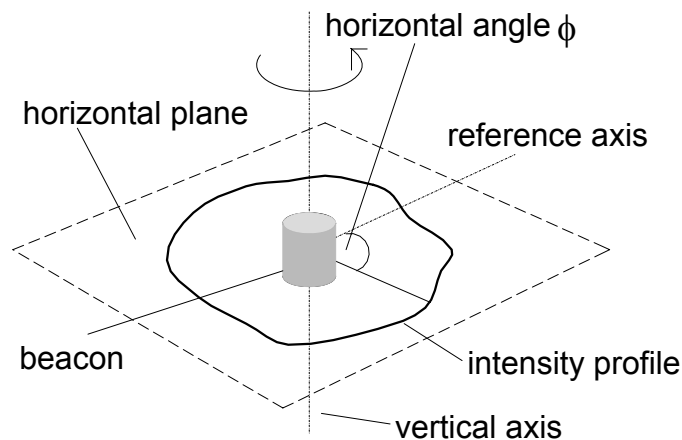


Fig. S30: Horizontal plane (IALA Rec E-200-3)

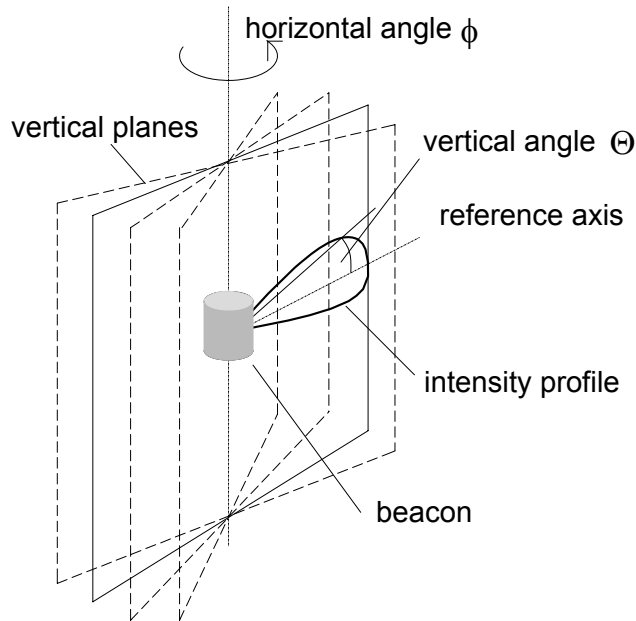


Fig. S31: Vertical plane system (IALA. Rec. E-200-3)

Requirements placed on pulsing:

It is only possible to specify a photometric luminous intensity if the time characteristics of the luminous intensity is virtually rectangular. Figure S32 shows a measured time characteristic. The time characteristic is viewed to be sufficiently rectangular if the times t_{an} and t_{ab} are smaller than 0.1s (both times are defined by the reaching of the thresholds 10% and 90%). Times over 0.1 s are inadmissible.

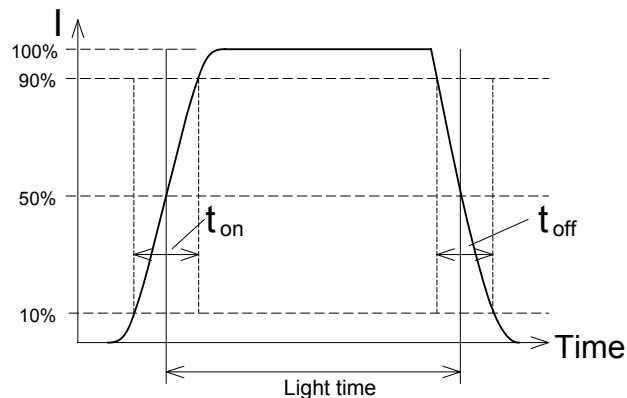


Fig. S32: Time characteristic of luminous intensity

Luminous intensity distribution:

The vertical distribution of luminous intensity (measurable photometric luminous intensity) of the lights must be within the following tolerance band (Fig. S33) for continuous lighting and for all horizontal beam angles.

The minimum values (lower limit) are prescribed by the General Administrative Regulation for the Marking of Obstacles to Aviation.

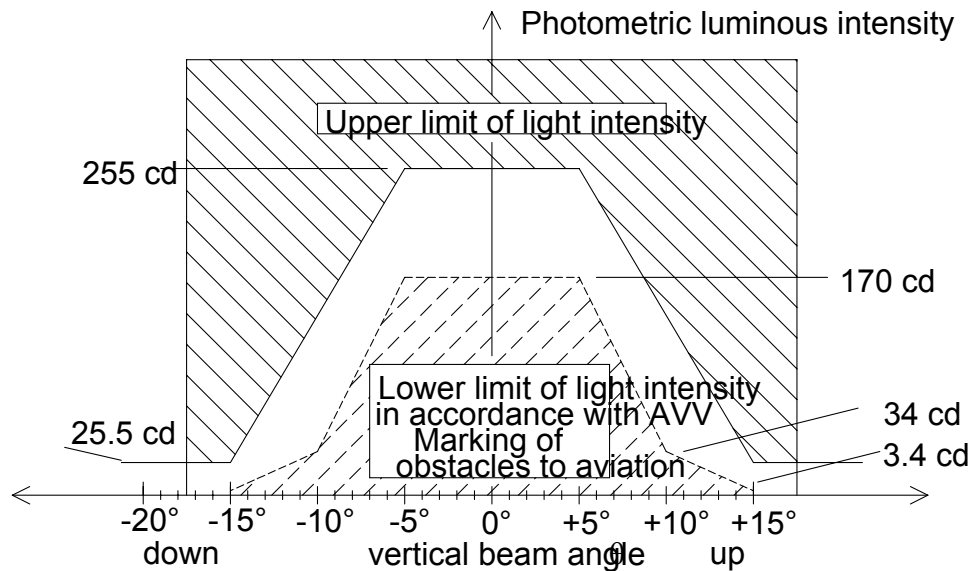


Fig. S33: Maximum values for vertical distribution of light intensity

The following maximum values (upper limit) may not be exceeded:

$$I_{\max} = \left\{ \begin{array}{ll} 25,5 \text{ cd} & \text{für } \Theta \leq -15^\circ \\ 369,75 \text{ cd} + 22,95 \text{ cd} * \Theta / 1^\circ & \text{für } -15^\circ < \Theta \leq -5^\circ \\ 255 \text{ cd} & \text{für } -5^\circ < \Theta \leq +5^\circ \\ 369,75 \text{ cd} - 22,95 \text{ cd} * \Theta / 1^\circ & \text{für } +5^\circ < \Theta \leq +15^\circ \\ 25,5 \text{ cd} & \text{für } \Theta > +15^\circ \end{array} \right\}$$

N.B.:

In the case of lights with an adequate rate of change of pulsing / identification, the factor of 1.7 is set for the ratio between the photometric and effective operational luminous intensity.

A light which satisfies both the specifications of the General Administrative Regulation for the Marking of Obstacles to Aviation and the extended specifications of these WSV Guidelines is referred to as

“W-red ES light”.

10.4 Specification sheet 4

Synchronisation and harmonisation

Four different night time markings of wind generators are used.

Light	Designation	Sequence
Yellow light (periphery)	Blz 4 s	1 + (3)
Yellow light (corner points)	Ubr (3) 16 s	6.5 + (1.5) + 2.5 + (1.5) + 2.5 + (1.5)
Yellow light (individual structure)	Mo (U)	0.5 + (0.5) + 0.5 + (0.5) + 1.5 + (4.5)
Light W-red	-	1 + (0.5) + 1 + (1.5)

Explanations on sequence: numerical values without brackets describe the light time in seconds; values in brackets describe the dark times.

Harmonisation, wind farms:

All lights in a wind farm must be harmonised according to the following diagram.

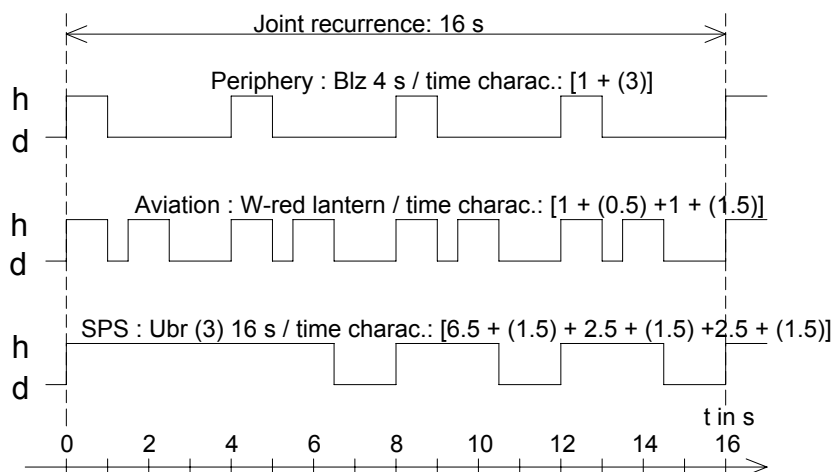


Figure S40

Harmonisation, individual wind generators:

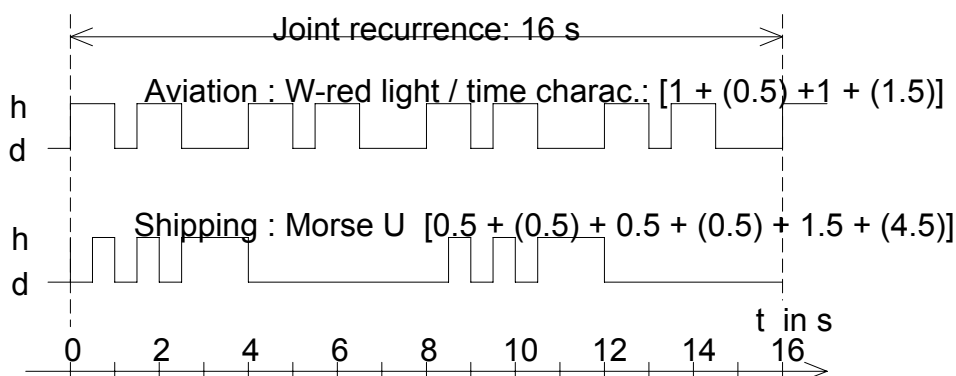


Figure S41

Synchronisation

All lights must be synchronised in accordance with the universal time coordinated UTC. The lights have a repetition of sequence of 16 s. The sequence is started from the time 00:00:00 UTC, as shown in the following diagram. The sequences repeat every 16 seconds ($16 \cdot n$, n whole number).

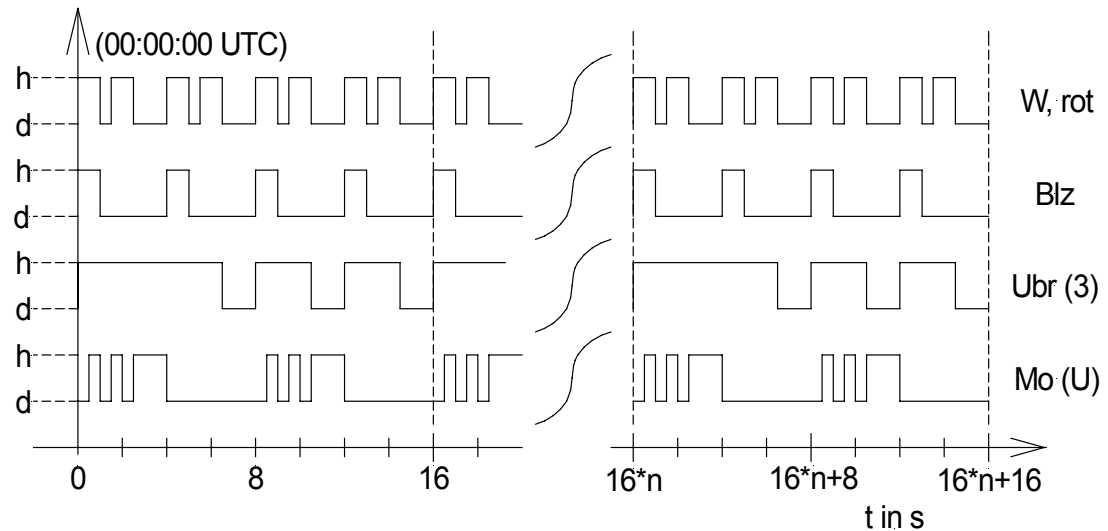


Figure S42

The deviations in the switching times from UTC requirements must be smaller than 0.01 s.

Explanations of Fig. S43:

UTC	Universal Time Coordinated
W-red	W-red light
Blz	Flash signalling
Ubr (3)	Interrupted signalling
Mo (U)	Morse signalling U
h	light
d	dark
t	time
s	seconds
n	whole number

The universal time coordinated UTC is, for example, available via

- the long wave transmitter DCF 77 of the Physikalisch-Technische Bundesanstalt (PTB). The time signal sends either the Central European Time (CET) or the Central European Summertime (CEST). A conversion to UTC must be made.
- the time information of the satellite navigation system GPS (Global Positioning System)

N.B.:

On issuing the UTC via the corresponding data records (NMEA), the time difference between UTC time and GPS time (leap seconds) must be taken into consideration. This time difference is contained in the navigation message of the GPS L1 CA-Code.

10.5 Specification sheet 5

Surface colours

- The surface colours are described in accordance with DIN 5033 Colorimetry with the standard chromacity coordinates x and y ; the definition in DIN 5036-1 Radiometric and photometric properties of materials applies to the luminance factor

The following measurement conditions are taken as basis here:

2°-normal observer, illuminant D65, measurement geometry 45/0 or 0/45

The colours yellow, white and black must be within the ranges shown below. Ranges for new state and used state are defined.

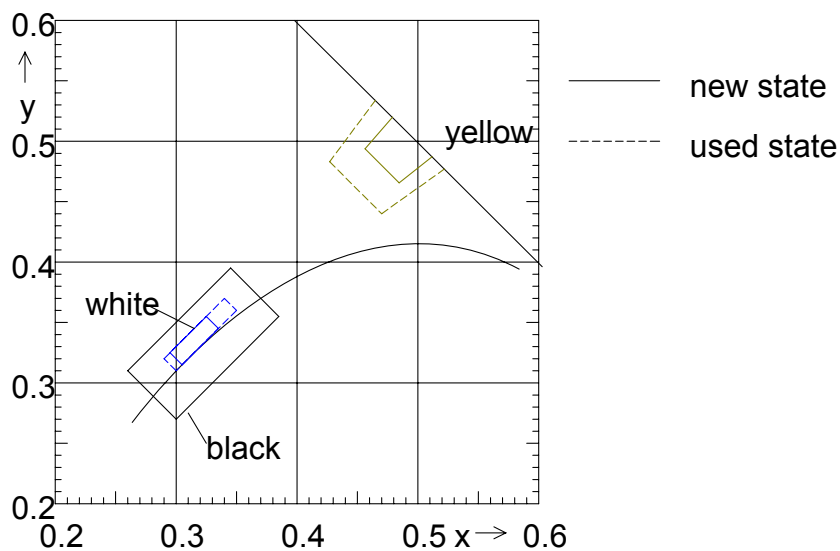


Figure S50

The vertices of the ranges are provided in the following tables.

Colour		Vertex coordinates of the colour ranges				Luminance factor β
		1	2	3	4	
yellow, new state	x	0.479	0.456	0.484	0.512	≥ 0.50
	y	0.520	0.494	0.466	0.487	
yellow, used state	x	0.465	0.427	0.470	0.522	≥ 0.50
	y	0.534	0.483	0.440	0.477	
black	x	0.260	0.300	0.385	0.345	≤ 0.02
	y	0.310	0.270	0.355	0.395	

N.B.:

Yellow is restricted additionally by the spectrum locus. The new and used states are virtually identical for black.

10.6 Specification sheet 6

Tower illumination

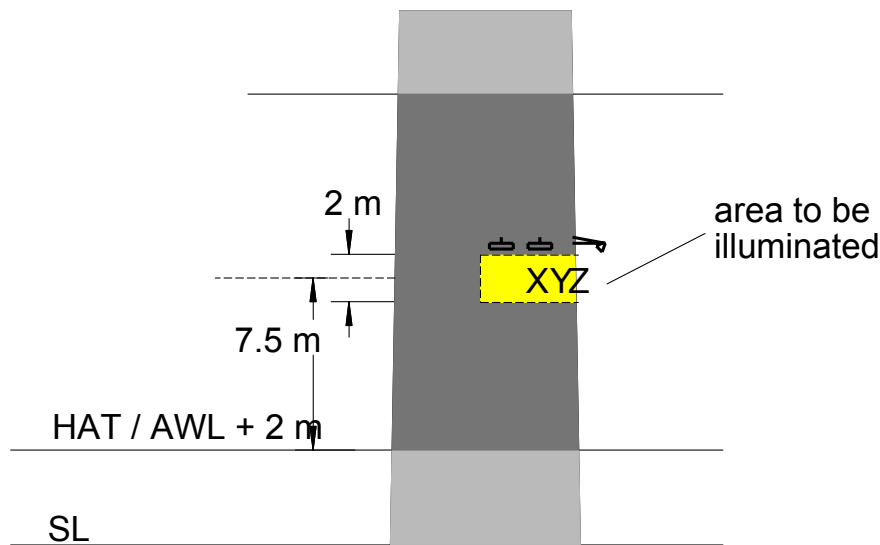


Figure S60

The tower is only illuminated if individual generators are erected in shipping lanes and a safety zone of 500 m in an individual case cannot be designated (Chapter 4.3.2 Section 16).

In this case it replaces the short-range marking and is clearly brighter than this.

The luminance of the illumination follows DIN EN 12899-1: Fixed, vertical road traffic signs (Part 1: Fixed signs).

The average luminance must be within the range of 30 and 100 cd/m² (DIN EN 12899-1, Table 10, Class L1). The evenness of the illumination in the specified field is 1:6 (DIN EN 12899-1, Table 12, Class U2).

The lights must be designed such that no direct light shines horizontally outwards from the wind generator. The light volume which falls on the area which is not to be illuminated (diffused light) should be minimised.

The yellow colour of the illuminated area must satisfy the requirements of specification sheet 5 in new state. If the colour leaves the range of used state set out in specification sheet 5, the operator must arrange for repainting.

Alternatively, the area can also be illuminated by internally lit panels. The same requirements apply with respect to luminance and colour as for the illuminated areas. The individual panels must be at least 1 m high and wide. The unlit gap between two neighbouring panels may be a maximum of 0.15 m.

11 Annex

Annex 1 Example of periphery lighting:

A.) Determination of the periphery line

1. The periphery line is basically stipulated after having widely determined all convex and concave wind generators at the corners of a wind farm block (so-called “Significant Peripheral Structures” (SPS), shown here in green). “Widely” in the sense used here means that the periphery line for all rowed and similar arrangements of the wind generators need not bend at the end point of individual rows if the parallel or vertical offset at the end point of a row is no more than 1,000 m. This SPS are widely arranged such to keep their number as small as possible, i.e. the “corners” of the wind farm of relevance to shipping are designated as SPS. This serves to optimise marking.

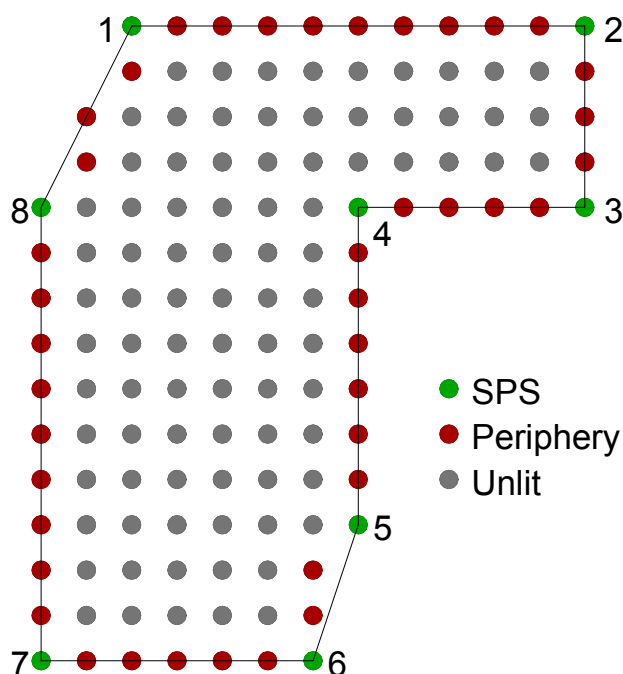


Fig. A1: Example of a wind farm with periphery line and lit wind generators

2. The periphery line is determined by applying a secant between the neighbouring SPS.
3. Outer wind generators between the SPS lying on the periphery line are generally viewed to be wind generators in the straight course of the periphery (red) and must be marked in accordance with paragraph 6.

4. Outer wind generators between the SPS which are inside the periphery course as a result of the irregular arrangement and have a straight-line distance of less than 1,000 m to the periphery line (Fig. 2), must be basically marked in accordance with paragraphs 6 and 7 as for wind generators with a straight course of the periphery line. The number of the outer wind generators to be lit between the SPS in this case must be selected such that their distance projected perpendicular to the periphery line (Fig. A3, $y_{1,2,3}$ and 4) is below 1,000 m. If one of the above requirements cannot be satisfied, the periphery line is to be “bent inwards” and one or several SPS inserted. It may be necessary to adjust the erection pattern.

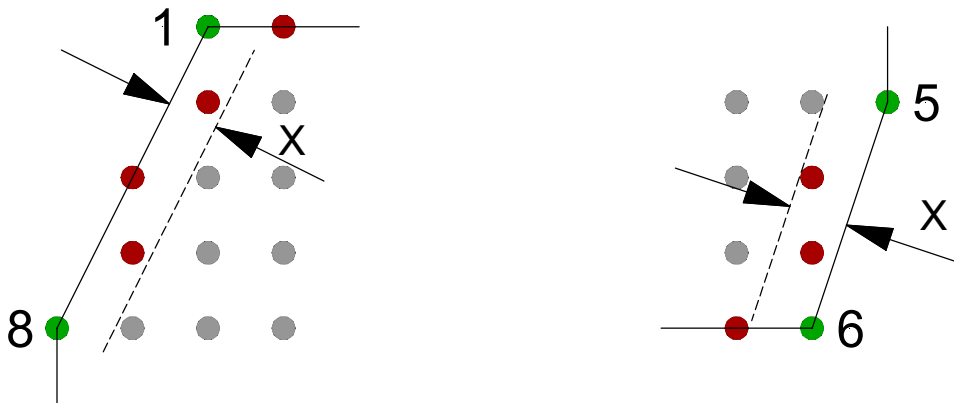


Fig. A2: Determination of the wind generators in the straight periphery line ($x < 1000$ m)

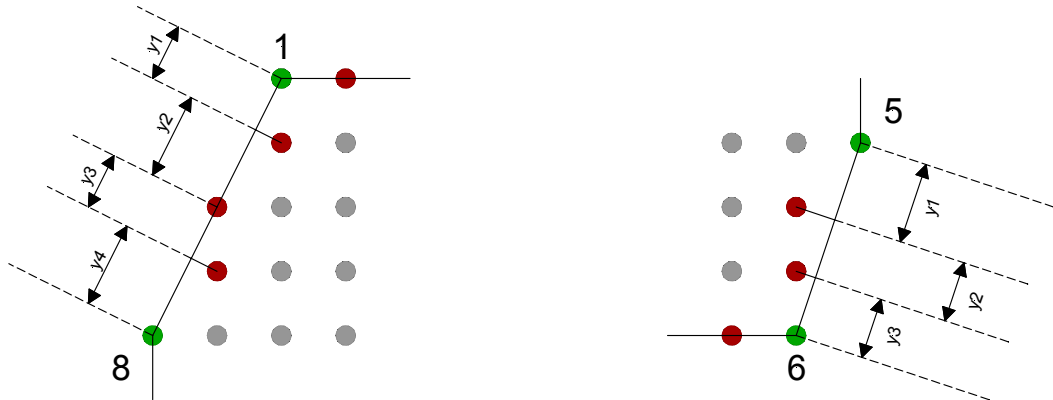


Fig. A3: Stipulation of wind generators to be lit in the straight periphery line (y_{1-n} each $< 1,000$ m)

5. Wind generators identified as SPS must be lit with the marking Ubr (3) yellow 16s.
6. Wind generators in the straight periphery line must be lit with the marking Blz. yellow 4s.

7. If when stipulating the horizontal beam angle of the wind generators in the straight course of the periphery line a beam exclusively outside the wind farm (see Part 3.3, version a.) is determined, the mid axis of the lit sector is to be aligned vertically to the periphery line.
8. If the SPS and the periphery lines cannot be determined in agreement with the above example due to differently arranged wind generators, the competent WSA shall examine the erection pattern and marking plan to determine which wind generators are to be lit with 5 nautical mile lanterns and their identification.