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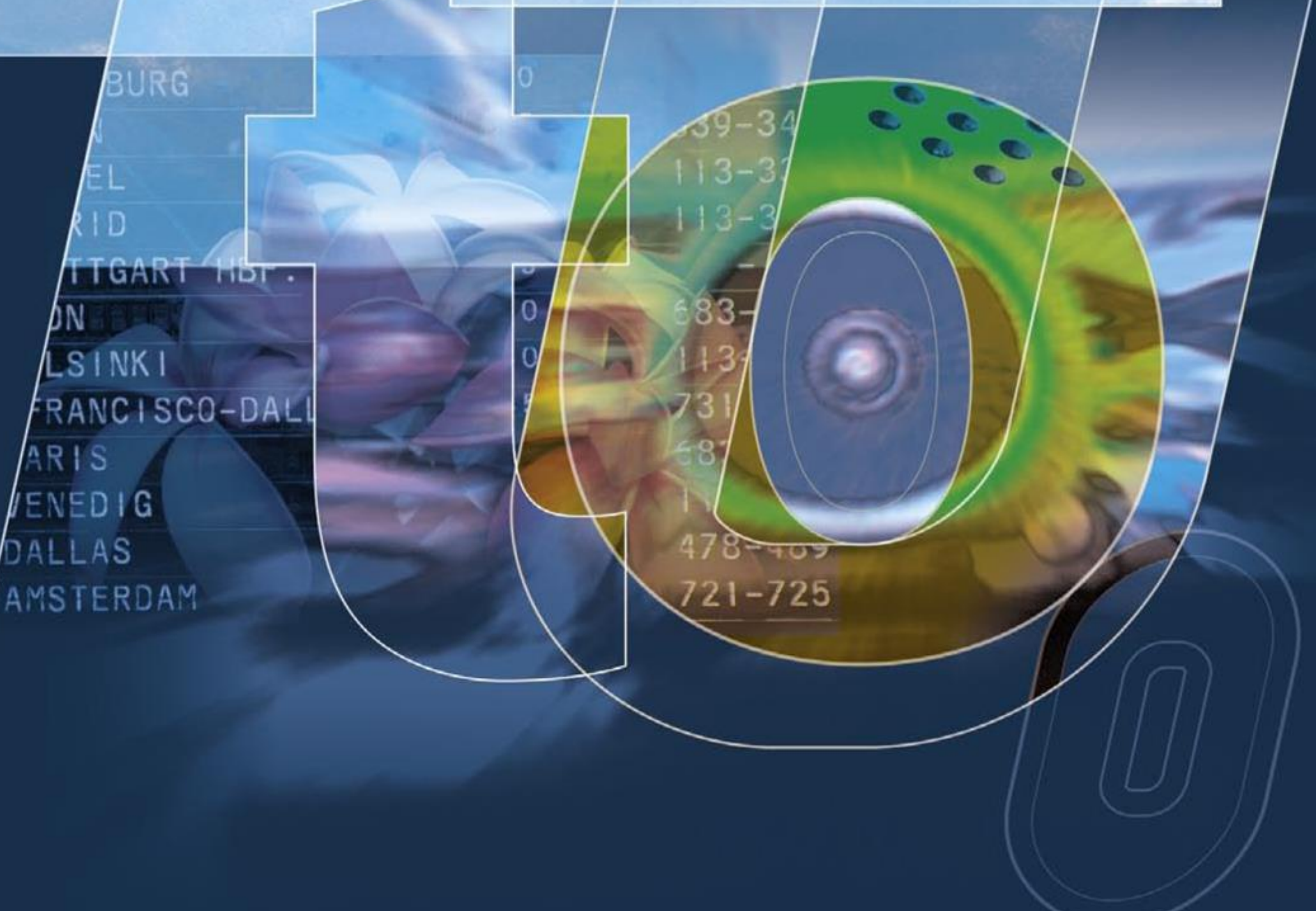
Desk study report



Helicopter accessibility of oil & gas platforms near the offshore wind farm sites Hollandse Kust (zuid and noord)

Desk study report

Prepared for:

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Contents

1 Introduction

The designated wind farm zones Hollandse Kust (zuid and noord)are located close to, and around, a number of operational oil & gas platforms and their associated helicopter 'safety' zones (Helicopter Protected Zones and Helicopter Traffic Zones).

The Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO.nl) has contracted aviation consultancy company To70 to perform a desktop study to the accessibility of oil & gas platforms near the offshore wind farm zones Hollandse Kust (zuid and noord) by helicopter, once these wind farms are realized in these sites.

This study analyses the impact on the accessibility of oil & gas platforms near the planned offshore wind farm zones Hollandse Kust (zuid and noord) once these plans are realized. Suggestions for follow-up research are provided in a number of areas.

To70 teamed up for this project with experts from helicopter operator NHV, flight procedure design company gCAP, and Air Traffic Control the Netherlands. These experts contributed in the workshops that To70 organized to gather data and discuss bottlenecks and measures with specific expertise on helicopter operations, flight procedure design and aeronautical information.

The RVO.nl steering board comprised of experts and representatives of the Ministry of Economic Affairs, Dutch Ministry of Infrastructure and the Environment (IenM), Netherlands Oil and Gas Exploration and Production Association (NOGEPA), The Netherlands Wind Energy Association (NWEA), Department of Waterways and Public Works (Rijkswaterstaat), helicopter operator CHC, , the Human Environment and Transport Inspectorate (ILT) and the electricity transmission system operator TenneT. Wind Asset specialist Outsmart supported RVO.nl in the execution of the project. The RVO.nl steering board was involved in the discussions on study scope and (preliminary) outcomes of the study.

This document captures the final scope of the study and its outcomes. Chapter 2 provides background information on the offshore helicopter operations. Chapter 3 describes the framework of the study. Chapter 4 describes the methodology and parameters used for the calculation of the accessibility. Chapter 5 shows the impact of wind farms on the available flight directions and calculated accessibility. Chapter 6 provides general considerations related to the implementation. Chapter 7 contains conclusions and recommendations.

2 Offshore helicopter flight operations

2.1 Navigation

Offshore helicopter operations above the North Sea can be conducted in normal and low visibility conditions. In normal visibility conditions, "Visual Meteorological Conditions (VMC)", the crew often operates under the visual approach rules for offshore flights from EASA (European Aviation Safety Agency).

In low visibility conditions ("below VMC"), the operation of the helicopter will primarily be through the use of flight instruments (Instrument Flight Rules (IFR)) rather than visual reference. Such weather conditions are known as Instrument Meteorological Conditions (IMC).

2.2 Visual navigation

Under VMC, the pilot must be able to operate the aircraft with visual reference to the ground, and by visually avoiding obstructions and other aircraft ("see and avoid").

> *Night VFR*
>
> In some countries VFR flight is permitted at night, and is known as Night VFR. This is generally permitted only under more restrictive conditions, such as maintaining minimum safe altitudes, and may require additional training.

2.3 Instrument navigation

Here, two types of instrument navigation are addressed:

- Airborne Radar Approach (ARA)
- Point-in-Space (PinS) approach

Airborne Radar Approach

ARA procedures have been used by helicopter pilots flying to oil rigs and platforms since the early seventies of the twentieth century. The use of ARA procedures is regulated by EASA in (document) EASA AIR OPS (Annex I to VIII). They are based on the use of the helicopter's onboard weather radar. This weather radar can also be used to detect the presence of obstacles, herein oil rigs and platforms. Although this weather radar assists the crew in obtaining an image of the obstacle situation, the radar view does not provide information on the height of the detected obstacles. Therefore, with ARA, the by radar detected obstacles should always be flown along (with lateral separation), rather than be overflown (with vertical separation).

In summary, the ARA is flown as follows:

- Firstly, the final approach track must be determined, and it must be set against the wind direction and clear of obstacles;
- The approach is flown straight towards to the oil rig or platform, and
- From the missed approach point (called MAP, located at least 0.75 NM (~1400 meter) from the point of landing on the oil rig or platform), the crew must have visual contact with the destination (rig or platform) to proceed with the landing. If the crew cannot see the oil rig or platform, a missed approach must be conducted. This missed approach procedure is a 'turning missed approach' (a turn away from the rig or platform), and the turn should be at least 30° and should not, normally, be greater than 45°.

Different types of ARA exist[1]:

- Straight-in ARA. With a straight-in ARA procedure the helicopter performs the full length of the final approach into to the wind.
- "Circling ARA". With a circling ARA, the helicopter commences the final approach not into the wind. As final approach and touchdown must be performed, for as far as is possible, into the wind, a short, curved, path is flown in visual conditions around the helipad to maneuver the helicopter into the position that allows this landing.

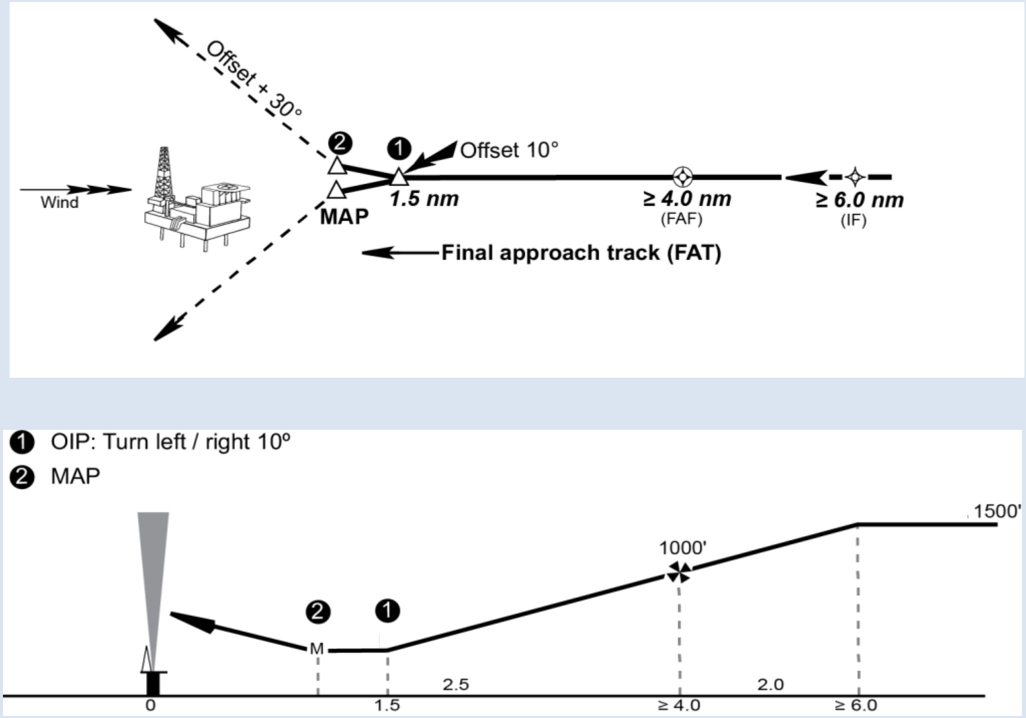


Illustration of a straight-in ARA (final approach track into the wind) and missed approach (with a 30 degree turn to both the left and to the right). (source EASA AIR OPS)

Point-in-Space (PinS)

A point-in-space approach (PinS) is a precision satellite-based navigation that allows GPS approach procedures (or more general GNNS - Global Navigation Satellite System). These procedures can be custom based for fixed wing ('airplanes') and/or helicopters, and can also be designed for specific destinations like hospitals and offshore platforms.

The approach is comprised of a reference point located at a geographic location / altitude (i.e. a point in space) that then permits flight maneuvering onto an approach & landing using visual maneuvering in

[1] Another type of ARA procedure is the Nearby target ARA. With a nearby ARA, the helicopter performs the approach not to the platform of destination, but to a nearby located object (e.g. another platform or a ship), and once visual with this object, the helicopter maneuvers at low altitude in visual conditions to the actual destination oil rig or platform. As this procedure depends on the availability and accessibility of other nearby objects, the nearby target ARA procedure is not further discussed here.

visual conditions such that it is possible to see and avoid obstacles. The reference point mentioned above could be a single point or a series of waypoints. In any case, the last defined point for a helicopter PinS approach procedure will be the missed approach point. From here a PinS visual segment links the missed approach point with the landing location. The transition from precision navigation to the final, visually-flown approach is known as a PinS "proceed visually" procedure.

The PinS approach offers a number of advantages over the current airborne radar approach (ARA) that is primarily used. The two main advantages of this system is the greater accuracy of the GPS system and that the PinS approach offers precision vertical guidance in a way that the ARA does not. A PinS approach procedure will be designed and published prior to its use. As an approved instrument approach, the procedure must take account of all possible obstacles, fixed and mobile, within its dimensions. In case of PinS approach to an offshore platform, the design of the PinS procedure and the conditions to fly it, could therefore depend on the highest possible ship that could possibly be present (within the lateral limits of the procedure). This could be a disadvantage compared to an ARA procedure, as it does not provide a flexibility when in daily practice the presence of such high ships is rare. Next to that, the number of approach directions is normally limited to avoid mistakes by the crew in selection the right procedure.

On the other hand, ARA approaches have the advantage over the PinS approach in that ARA procedures can be used to approach the platform from many directions whilst a PinS procedure is normally developed and approved for an approach from a single direction.

PinS offers safety and efficiency advantages to operators with suitably equipped helicopters and trained crews in States that permit such operations. However, not all EASA States have yet implemented PiNS approaches in their States. Trials in a number of European States, including Norway, UK and Switzerland, have demonstrated the viability of the method. From July 2018, EASA requirements for helicopter offshore operations (Part OPS.HOFO) will permit PinS approaches to be developed and flown. There are a number of elements requiring certification / approval, including:

- Helicopter type approval (not all helicopters are currently certified for PinS);
- Helicopter equipment modifications (there are particular equipment fits required);
- Data integrity for the route / navigation databases;
- Approach charts, and
- Flight crew training.

2.4 Obstacle clearance

While navigating a helicopter, sufficient separation between the aircraft and the surface (ground or water level) and obstacles must be respected to conduct a safe flight. Due to the difference in navigation accuracy and capabilities to observe an obstacle in the flight path, the procedures described above (ARA, the PinS and visual flight) each have different obstacle clearance criteria. These criteria are included in general operational regulations and the procedures for flight procedure design criteria. In summary, the following are examples of these differences:

- ARA procedures: At least 1 NM horizontal separation (left and right) is required from any obstacles, independent of its height, along the non-visual part of the final approach path (and the missed approach path) [2];
- PinS procedures: The procedure consists of a complex shape (called the protection area, which provides the horizontal separation[3]), where for the most critical parts of the approach, the design assumes that the helicopter flies at least 75 meter (~250 feet) above the highest possible object.
- Visual procedures: Using the "see and avoid" principle, an aircraft shall be at least 500 ft (~150 meter) horizontally and vertically above the ground or any obstacle during flight other than take-off and landing. A complex slope that varies with the type and size of the helicopter defines the obstacle free path required for take-off and landing.

2.5 Weather conditions

The weather conditions, and especially visibility, determine whether visual navigation or instrument navigation procedures are to be followed for a particular flight. Below the general minima used offshore by the helicopter operators are described for both day and night conditions:

Visiblity

- Visual navigation:
  - VMC-day:
    - Cloudbase: 600 ft (~180 meter) cloud-base (no clouds below)
    - Horizontal visibility: 4000 meter or more
- Instrument navigation:
  - Straight-in ARA procedures:
    - During daylight period:
      - Cloudbase ("lowest clouds"): 200 ft (~60 meter) or more
      - Horizontal visibility: 0.75 NM (~1400 meter) or more
    - Outside daylight period:

---

[2] Some quotes from EASA AIR OPS on obstacle clearance for the final approach and missed approach segments:

- *Before commencing the final approach, the pilot-in-command/commander should ensure that* ***a clear path exists on the radar screen*** *for the final and missed approach segments. During the intermediate segment, the helicopter should be lined up with the final approach track, the speed should be stabilised, the destination should be identified on the radar, and the final approach and missed approach areas should be identified and verified to be clear of radar returns.*
- *The final approach area, which should be identified on radar, takes the form of a corridor (…). This corridor should not be less than 2 nm wide so that the projected track of the helicopter does not pass closer than 1 nm to the obstacles lying outside the area.*
- *(…) the ARA is located in an overwater area that has a flat surface at sea level. However, due to the passage of large vessels which are not required to notify their presence, the exact obstacle environment cannot be determined. As the largest vessels and structures are known to reach elevations exceeding 500 ft above mean sea level (AMSL), the uncontrolled offshore obstacle environment (…) can reasonably be assumed to be capable of reaching to at least 500 ft AMSL. Nevertheless,* ***in the case of the final approach and missed approach*** *segments, specific areas are involved* ***within which no radar returns are allowed****.*

[3] The protection zone of a PinS procedure consists of several parts, each having its own lateral dimensions (which depend on design considerations) and with varying obstacle clearance altitudes.

- Cloudbase ("lowest clouds"): 300 ft (90 meter) or more
- Horizontal visibility: 1,5 NM (~2800 meter) or more

- Circling ARA procedures:
  - During daylight period:
    - Cloudbase ("lowest clouds"): 300 ft (~90 meter) or more
    - Horizontal visibility: 1 NM (~1850 meter) or more
  - Outside daylight period:
    - Cloudbase ("lowest clouds"): 500 ft (~150 meter) or more
    - Horizontal visibility: 1,5 NM (~2800 meter) or more
- PinS procedures: The minima for PinS procedures depends on the designed procedure, which in turn depends (among others) on the obstacle environment. As such, no general minima can be provided.

Wind

- Offshore Helicopter flights are not allowed when the wind speed exceeds 60 kts.

2.6 Helidecks

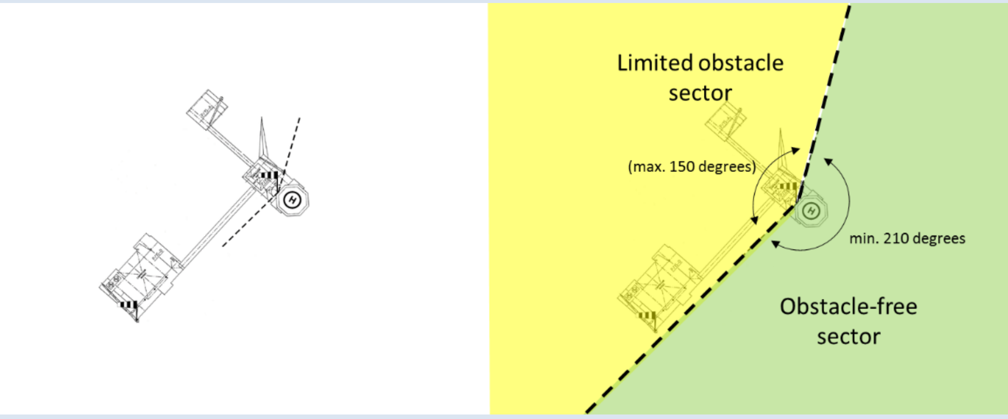
The location of a helideck on an oil rig or platform is the result of a compromise between the different, conflicting, requirements of both the aviation and the energy sectors. There is limited space on such a facility to locate the helideck and vertical obstacles are a necessity (e.g. cranes, flares stacks, etc.) of the oil and gas industry. This results in a limited vertical and horizontal space that remains free of obstacles.

Obstacle free sectors and limited obstacle sectors

ICAO Annex 14, Volume II requires that a helideck shall have an obstacle-free sector and may have a limited obstacle sector. The necessary obstacles will be located in the limited obstacle sector.

For each facility, a chart, known as a rig plate, will be prepared so as to provide the pilot with information on the orientation and layout of the platform, its obstacles and the orientation of the obstacle-free sector and limited obstacle sector. The boundaries between the obstacle-free sector and the limited obstacle sector are visible on these rig plates as dashed lines.

Obstacle free sectors are relevant to the final stages of landing.



Rig plate with obstacle free sector and limited obstacle free sector

Enchanced Class 2 procedures

In offshore helicopter operations, normal[4] operations to and from a helideck for particular directions will not always be feasible without severely restricting the helicopter's payload / range due to deck size and/or obstacles on the helideck environment.

As an alternative, the concept of so-called Enhanced Class 2 take-off and landing profiles has been developed as a compromise to permit efficient and safe offshore helicopter operations. Such operations are accepted by aviation authorities under EASA AIR OPS. The enhanced Class 2 procedures include:

- Deck-edge avoidance maneuvers, and/or
- Drop-down profiles that ensure continued flight clear of the sea.

Such operations may increase the accessibility of the helidecks analyzed in this study, although they will usually result in some loss of payload / range.

Whilst a generalized gain in accessibility that enhanced Class 2 procedures offer has been included in this report, the economic penalty (i.e. restrictions in payload / range) is not analyzed in this report. These procedures, if included in the operator's Operations Manual, are specific to the operator, the helicopter type used, the prevailing weather and design of each helideck being operated to / from.

2.7 Helicopter operators and offshore helicopters

Current helicopter operators to the platforms in scope of this study are:

- CHC
- Heli Holland
- NHV

All offshore helicopter of these operators are capable of flying ARA (and visual) procedures.
Of these helicopter operators, only CHC and NHV currently possess helicopters capable of performing PinS procedures.

[4] In this case normal refers to Performance Class 1 helicopter operations.

3 Accessibility

3.1 Introduction to the study

A Helicopter Traffic Zone (HTZ) is an area established around a platform or rig with a helideck to safeguard helicopter approaches and departures. An HTZ is horizontally defined as a circle of 5 NM radius. It is an area defined to increase safety awareness among pilots that helicopter approaches and take-offs take place (ref. Dutch AIP and Luchtruim Catalogus), and as such does not guarantee that the zone is free of obstacles. A Helicopter Protected Zone (HPZ) is an area that includes multiple HTZ.

The HTZ's 5 NM radius is derived from the lateral distance required by the helicopter to perform a straight-in landing (assuming an approach altitude of 1.500 ft) and to perform a take-off and a departure in which an engine can fail at the most critical part. As the take-off and landing direction is related to the wind direction, the circle shape of the HTZ assumes that take-offs and landings can take place in all directions.

Objects within the 5 NM circle are potential obstacles, and can restrict the available approach and departure directions. If wind conditions are as such that no other directions can be used, the accessibility of the platform will be affected. Some objects may temporarily affect accessibility to the platform (e.g. ships), whilst others permanently affect accessibility (e.g. wind turbines).

This study addresses the impact of the offshore wind farms sites Hollandse Kust (zuid) and Hollandse Kust (noord) on the accessibility of oil & gas platforms by helicopter.

Accessibility

Accessibility in this study is defined as the percentage in time the helicopter can perform a safe landing on and take-off from the platform helipad within the time window used for helicopter operations.

- Safe landing and take-off is defined as: a landing and take-off in accordance with current international standards, guidelines and/or best practices on helicopter flight operations.
- The helicopter time window is defined as the time window in which the helicopters can operate to the platform.

Factors that could influence the accessibility (percentage) are:

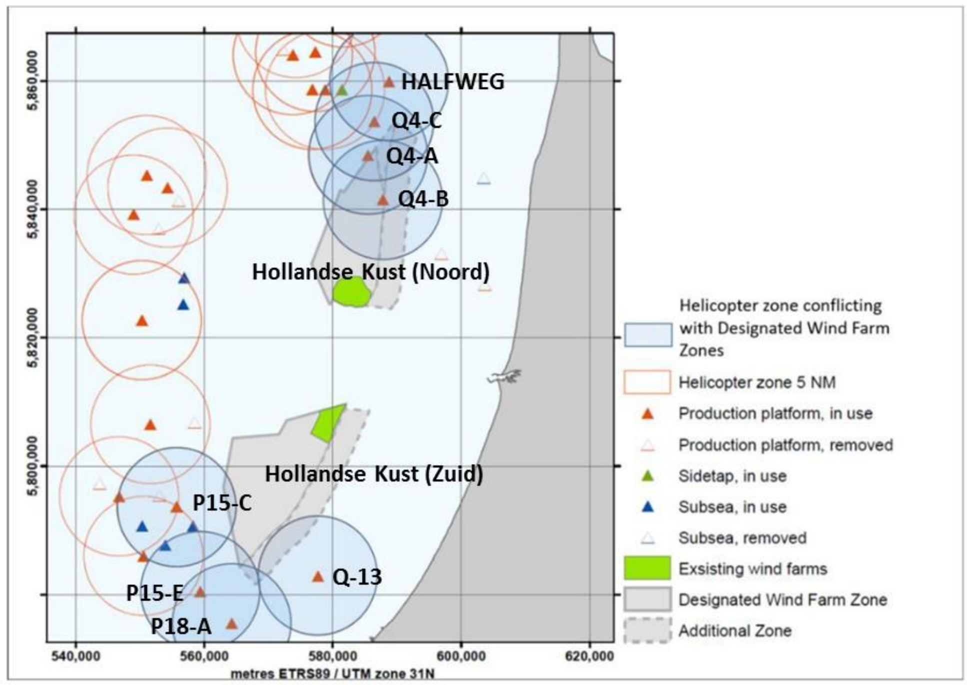
1) Weather conditions
   - Wind (wind direction and strength):
   - Visibility (cloud base and horizontal visibility)
2) Objects in the helicopter 5 NM area of the helipad:
   - Permanent objects (for example: wind turbines/wind farm, other rigs)
   - Temporary objects (for example: ships)
3) The layout of the platform:
   - The orientation of the helipad obstacle free sector
   - Criticality of objects in the limited obstacle free sector platform (for example: cranes, flare stack)
4) Wind farm / wind turbine generated turbulence:
   - the distance within which wind farm/turbine generated turbulence is acceptable for helicopter flight operations

3.2 Scope

Within the scope of this study are:

- Regular helicopter take-off and landing operations to and from oil- and gas platforms for which the 5 NM zone overlaps the boundaries of the two respective wind farm zones Hollandse Kust (zuid) and Hollandse Kust (noord). See map below.

Oil & gas platforms in study scope



Near windfarm site Hollandse Kust (zuid)

ID	Company*	Normally manned	Main heli operator*/**	Flights/year*
P15-C[5]	TAQA	Manned	CHC	~250
Q13-A	ENGIE	Unmanned	CHC	~100
P15-E	TAQA	Unmanned	CHC	~30
P18-A	TAQA	Unmanned	CHC	~50

Near windfarm site Hollandse Kust (noord)

ID	Company*	Normally manned	Main heli operator*	Flights/year*
HALFWEG	Petrogas	Unmanned	CHC	< 10
Q4-C	Wintershall	Unmanned	NHV	~100
Q4-A	Wintershall	Unmanned	NHV	~100
Q4-B	Wintershall	Unmanned	NHV	~50

** 2016 data: various sources*

*** The main contractor can subcontract other helicopter operators to execute flights*

See appendix A for more information about these oil & gas platforms.

[5] Including the temporary subsea completion platforms: results in appendix B

Out of scope of this study are:

- The impact of other existing wind farms;
- The accessibility of other platforms;
- The impact by shipping (both in transit in or outside shipping lanes, and moored in anchorage areas), and
- Other flight operations at the North Sea that might be impacted by wind farms, including:
  - normal aircraft flights;
  - special aircraft and helicopter flights, e.g. coast guard;
  - other helicopter operations (e.g. pilotage operations), and
  - other helicopter operations near wind farms (e.g. maintenance flights to wind turbines).

3.3 Focus

This study focusses on platform accessibility under low visibility conditions using either circling ARA procedures or enhanced class 2 procedures. The three terms, 'low visibility', 'circling ARA procedures' and 'enhanced class 2 procedures' are clarified below.

Motivation for the chosen focus

Low visibility

Under normal visibility conditions, visual separation from obstacles must be achieved. This is considered relatively simple compared to separation under low visibility conditions[6].

Circling ARA procedures

Whereas a straight-in ARA approach commences into the wind, a circling ARA does not. A circling ARA is therefore more flexible in those circumstances where the availability of approach directions is restricted by obstacles (for example by a wind farm).

In addition, it is noted that ARA approaches have the advantage over the PinS approach in that ARA procedures can be used to approach the platform from many directions; a PinS procedure is normally developed and approved for an approach from a single direction.

Enhanced class 2 procedures

The enhanced class 2 procedures, as described above, allow operations to and from a helideck in directions that the limited obstacle free sector would normally not permit.

3.4 Assumptions

The following assumptions apply for this study:

- The positions, boundaries and dimensions of the wind farm zones Hollandse Kust (zuid) and Hollandse Kust (noord) are fixed and cannot be adjusted;
- Wind farm generated turbulence is not critical for safe helicopter flight operations beyond a distance equal to eight times the wind turbine rotor diameter (worst case conditions). Applying a turbulence-

[6] Notitie vliegveiligheid 2008: "*Indien de windparkexploitant onder normale visuele zichtomstandigheden zijn vluchten van en naar het helikopterplatform zal uitvoeren, gelden bovengenoemde eisen van obstakelvrije zones niet. De helikopter dient zich dan visueel te separeren van de obstakels. Dat is redelijk eenvoudig.*"

buffer of 1 NM, the maximum wind turbine rotor diameter is assumed to be 230 meter. (ref. NLR report), and

- The time window during which offshore helicopter flights normally take place is 07:30 – 20:30 LT (local time) at the offshore location[7].

[7] Helicopters to the platforms in scope are based at Den Helder airport. The opening hours of Den Helder Airport are 06:00 – 21:00 LT (local time).

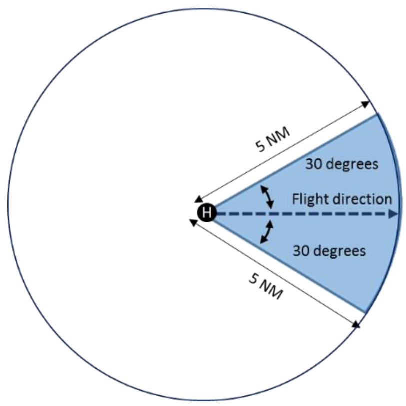
4 Methodology to determine accessibility

The methodology to calculate the platform accessibility has the following steps:

1. With current international standards and/or best practices as on helicopter flight operations as guidelines, shapes of assumed obstacle free sectors are modeled.
2. For all platforms, the available approach and available departure directions are derived by aligning the shapes of assumed obstacle free sectors in between the geographical constraints of the windfarms, other platforms within the 5 NM zone, and where relevant the platform structure itself.
3. Based on the derived approach and departure directions, and the meteorological conditions at the North Sea, the accessibility of each platform has been calculated.

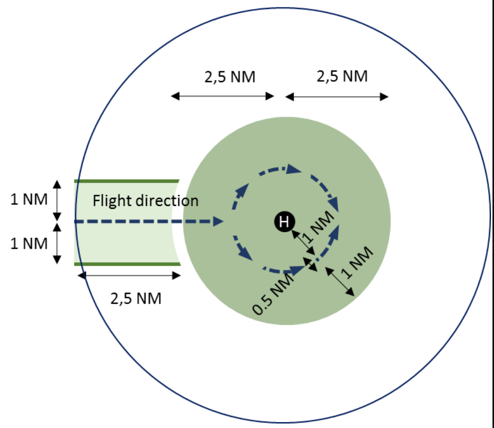
4.1 Shapes of the assumed obstacle free sectors

The shapes of the assumed obstacle free sectors are modelled as follows:

Shape type	Schematic representation
<u>Departure sector</u> Modelled shape: • ARA based departure sector – Length: 5 NM – 60 degrees (2x 30) sector[8]	
EASA AIR OPS does not specify shapes and dimensions for departure sectors. **Motivation:** It is assumed that a 60 degree sector provides sufficient buffer to pass obstacles at 1 NM or more and to compensate for navigation inaccuracies associated with departures from the platform (compass deviation due to the metal of the platform and drifting from the assumed flight path as no target to aim at exists. A straight path of 5 NM length should allow to reach sufficient altitude (EASA AIR OPS: 500 ft obstacle clearance above the offshore obstacle environment of 500 ft AMSL ('ships') that prevails outside the area) in a 1 engine out situation.	

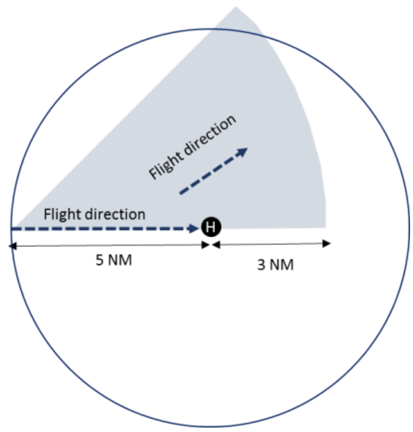
[8] The 60 degree sector is also used in a previous study conducted by NLR for the Helmveld platform (*FOSA voor ARA en departure Q01-HELM-A na realisatie Helmveld windmolenpark*)

<table>
<tr><th>Shape type</th><th>Schematic representation</th></tr>
<tr><td><u>Approach sector</u>

Modelled area:
• ARA based final approach corridor
– Length: 2,5 NM
• Visual “maneuvering” circle
– R = 2,5 NM</td><td>
</td></tr>
<tr><td colspan="2">EASA AIR OPS does not specify shapes and dimensions for circling ARA’s.

Motivation:
The final approach corridor is based on the following quote from EASA AIR OPS ‘The final approach area, which should be identified on radar, takes the form of a corridor (…). This corridor should not be less than 2 nm wide so that the projected track of the helicopter does not pass closer than 1 nm to the obstacles lying outside the area.’
The visual maneuvering circle is based on the concept that a short, curved, path should be flown in visual conditions around the helipad to maneuver the helicopter into the position that a landing into the wind. The 2,5 NM radius provides 1 NM separation from both the platform and the wind farm and some extra buffer (0,5 NM) to compensate for wind drift during the circling maneuvering.</td></tr>
</table>

<table>
<tr><th>Shape type</th><th>Schematic representation</th></tr>
<tr><td><u>Missed approach sector</u>

Modeled area:
• 45° sector, orientated left or right of the final approach track, originating from a point 5 NM short of the destination, and terminating on an arc 3 NM beyond the destination</td><td>
</td></tr>
<tr><td colspan="2">Motivation:
This area is suggested by EASA AIR OPS ‘A missed approach area, taking the form of a 45° sector orientated left or right of the final approach track, originating from a point 5 nm short of the destination, and terminating on an arc 3 nm beyond the destination, should normally satisfy the specifications of a 30° turning missed approach.’</td></tr>
</table>

4.2 Aligning the shapes

By aligning the shapes (departure and approach & missed approach) of the obstacle free sectors in between the geographical constraints of the windfarms, the presence of other platforms within the 5 NM circle, and where applicable the obstacle free sector of the platform itself, available approach and available departure directions are derived.

The shapes (departure and approach & missed approach) should:

- not overlap other platforms within the 5 NM zone
- not overlap the defined buffer area for wind park generated turbulence
- not overlap the limited obstacle sector if this sector contains critical objects preventing enhanced class 2 procedures in this direction

And the assumed path of the missed approach (which ends before the 5 NM circle) should not be aimed at the windfarm.[9]

4.3 Accessibility calculations

The platform accessibility has been calculated by analyzing historical weather data against the derived approach and departure directions, assuming low visibility operations, during the time period reported below and with the following data and parameters for both visibility and wind:

Weather data

- Source: KNMI METAR data
- 30-minute recordings between 2011-2016 from offshore stations:
  - Hoorn (EHQE)*
  - P11-B (EHPG)*

  *) Data coverage of these station: 70%-100%

Time window:

- 7:30 – 20:30 LT (corresponds to the time window for regular offshore helicopter flights)

Visibility

- During daylight period (UDP):
  - Cloud base ("lowest clouds") >= 300 ft
  - Horizontal visibility: 1 NM (~1850 meter) or more
- Outside daylight period (non-UDP):
  - Cloud base ("lowest clouds") >= 500 ft
  - Horizontal visibility: 1,5 NM (~2800 meter) or more

[9] The definition of this shape by EASA AIR OPS is based the assumption that vertical separation of more than 130 ft (~40 meter) is achieved between the base of the area and the offshore obstacle environment of 500 ft (~150 meter) that prevails outside the area. The wind turbines (including the tip of the rotor) will be higher than the assumed maximum obstacle height of 500 ft (~150 meter).

Wind

- Maximum wind: 60 kts;
- Wind speed under 5 kts are assumed as no wind;
- On departure:
  - No tailwind;
  - Maximum cross-wind 20 kts;
  - For cross-winds between 10-20 kts, minimum head wind 5 kts;
- On final approach:
  - No tailwind;
  - Maximum steering angle[10]: 15 degrees (assuming a groundspeed of 60 kts);

<u>Some general derived figures on wind, visibility and accessibility</u>

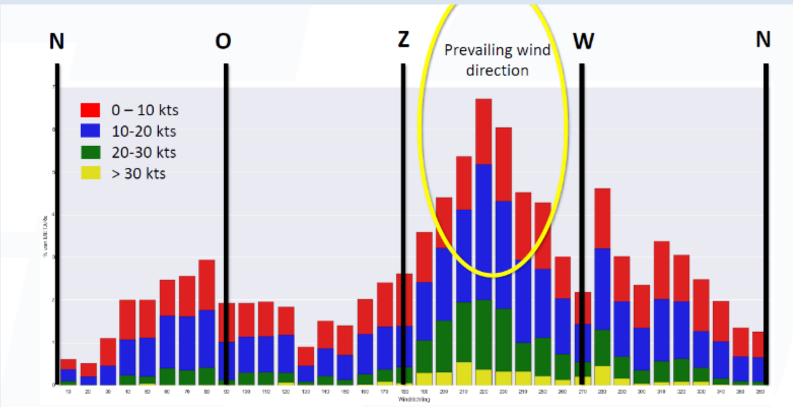
Visibility:

- Normal visibility conditions during daytime (VMC-day): approx. 75% within helicopter time window
- Low visibility conditions (during and outside daytime): approx. 25% within helicopter time window

Wind:

- Platform inaccessible because of winds of more than 60 kts: <1% within helicopter time window
- Wind speed:
  - 80% of the time: wind < 20 kts *
  - 20% of the time: wind > 20 kts *

  (* 20 kts is the maximum cross-wind on departure)
- Wind direction (see diagram below)
  - Prevailing wind direction: South-west
  - Least wind direction: North and East
  - Wind from north and east are generally low in magnitude
  - High magnitude winds in general from ZW – W directions



[10] As the final approach of a circling ARA does not necessarily commence into the wind, compensation for cross-wind (which would result in drifting away from the final approach path) is necessary by steering the helicopter more towards the wind.

5 Platform accessibility

The charts in the next sections show, for each platform:

- the available departure directions (ARA based) and the available approach directions (final approach segment of the ARA and visual path for circling and landing)
- the resulting calculated average accessibility

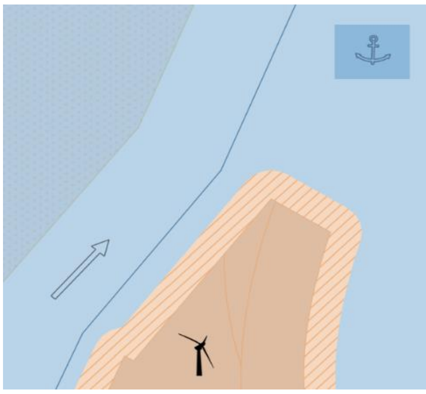
(for sake of clarity the modelled shapes of the obstacle free sectors itself are not shown)

For each platform two situations are considered:

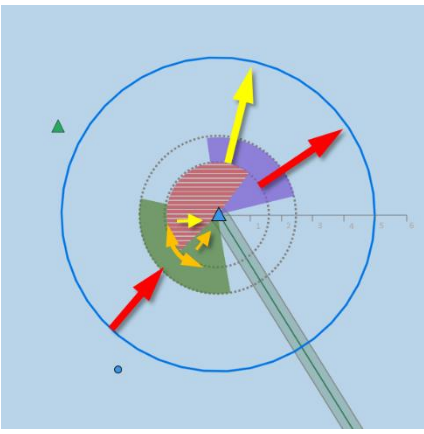
- Baseline: the current situation without a wind park, and
- Wind farm: the foreseen situation when the wind park is present.

Explanation of symbols and colors

Maritime and wind farm related

		Water
		Shipping routes
		Shipping separation zone
		Anchorage area
		Wind park
		1 NM buffer-zone (for wind park generated turbulence)

Platform and accessibility related

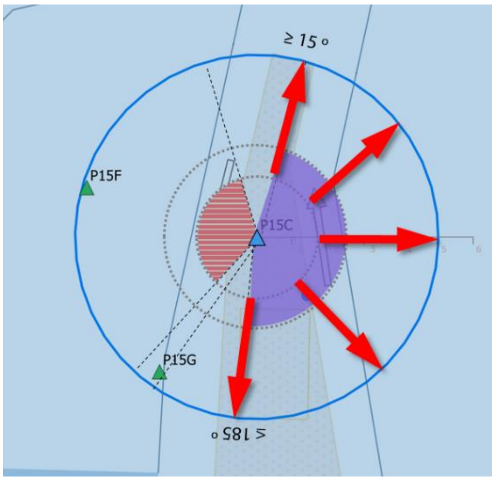
		Platform HTZ outside wind farm zone
		Platform HTZ inside wind farm zone
		Rig Limited obstacle sector (drawn up to 1,5NM)
		Sub-sea completion position (P15-C only)
		Cable or pipeline and maintenance area
		5 NM zone / HTZ boundary
		ARA based approach or departure directions
Scales: – Inner dotted circle: R = 1,5 NM (used to visualize the rig limited sector) – Outer dotted circle: R = 2,5 NM (used to visualize the maneuvering area) – Blue circle: R = 5 NM (the HTZ circle)		Approach or departure directions based on enhanced class 2 procedure
		Visual circling direction possible
		Possible visual approach directions

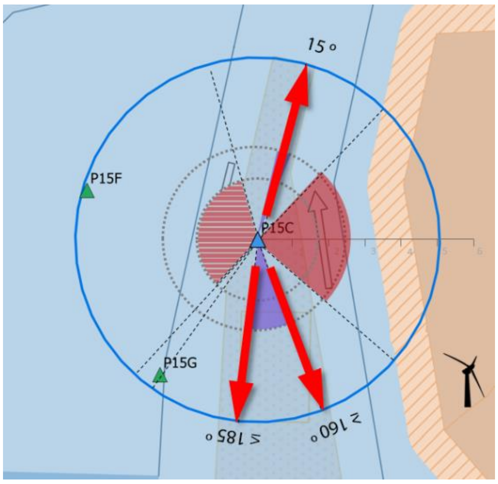
5.1 P15-C

Critical objects in the limited obstacle sector preventing enhanced class 2 procedures in this direction: YES

Other rigs within the 5 NM circle: P15-F, P15-G

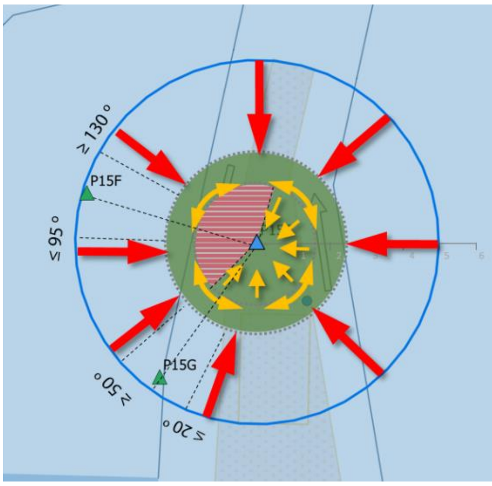
Departures

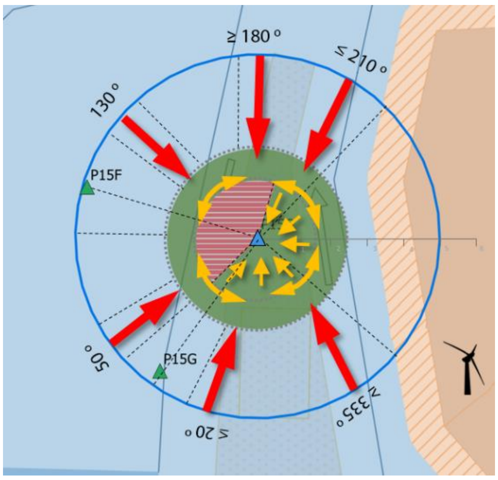
<table>
<tr><th>Baseline</th><th>With wind farm (HKZ)</th></tr>
<tr><td>


</td><td>


</td></tr>
<tr><td>Possible departure directions:
• between 15º – 185º (170 º sector)</td><td>Possible departure directions:
• 15º
• between 160º – 185º (25º sector)</td></tr>
</table>

Approaches

<table>
<tr><th>Baseline</th><th>With wind farm (HKZ)</th></tr>
<tr><td>


</td><td>


</td></tr>
<tr><td>Possible approach directions:
• between 130º – 20º (150 º sector)</td><td>Possible approach directions:
• between 180º – 210º (30 º sector)
• between 335º – 20º (45 º sector)
• 50º, 130º</td></tr>
</table>

Calculated accessibility

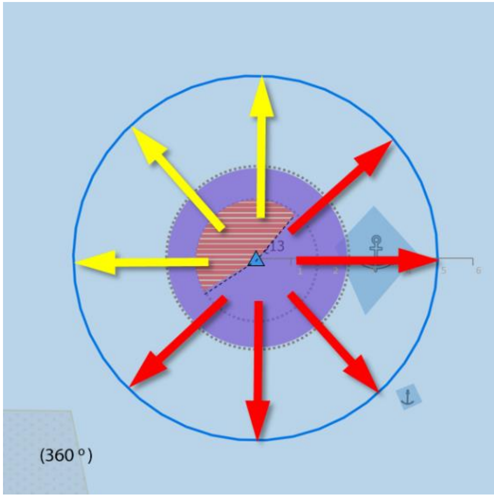
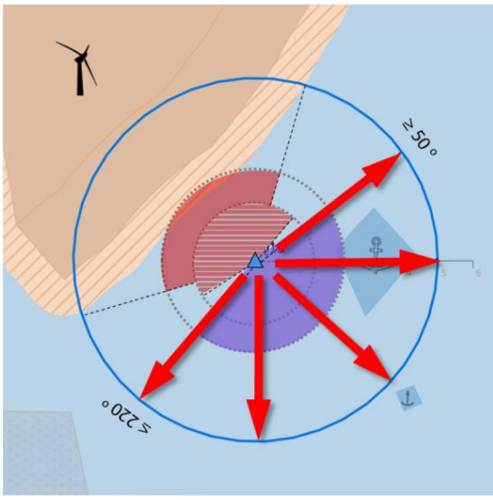
Baseline	With wind farm (HKZ)
Average: 82 %	Average: 81 %

5.2 Q13

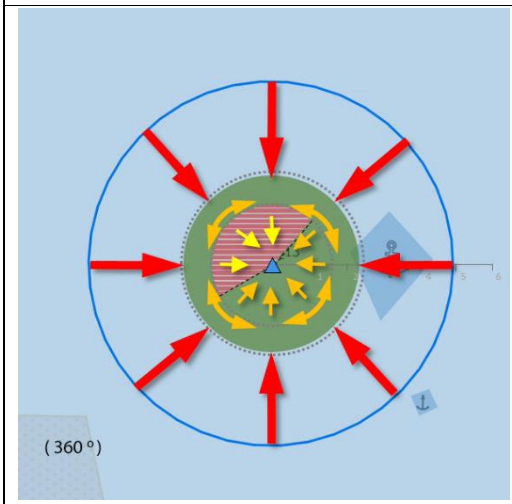
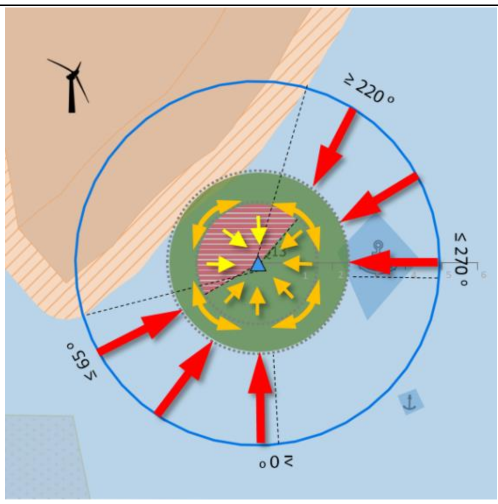
Critical objects in the limited obstacle sector preventing enhanced class 2 procedures in this direction: NO

Other rigs within the 5 NM circle: NO

Departures

Baseline	With wind farm (HKZ)
	
Possible departure directions: • All (360 ° sector)	Possible departure directions: • between 50° – 220° (170 ° sector)

Approaches

Baseline	With wind farm (HKZ)
	
Possible approach directions: • All (360 ° sector)	Possible approach directions: • between 220° – 270° (50 ° sector) • between 0° – 65° (65 ° sector)

Calculated accessibility

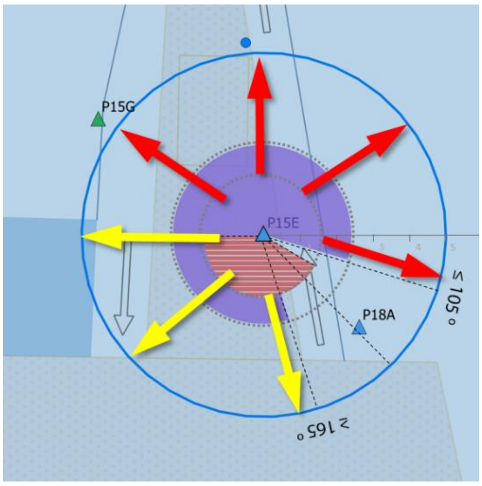
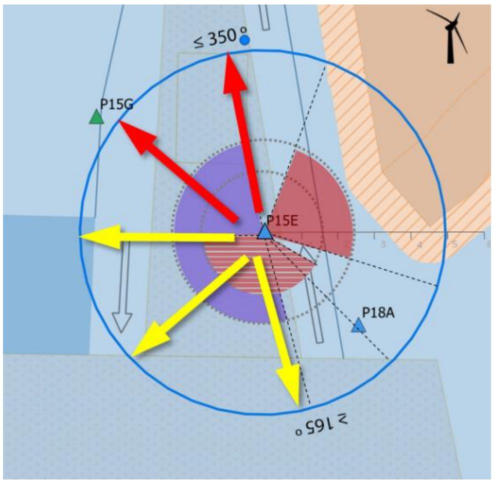
Baseline	With wind farm (HKZ)
Average: 95 %	Average: 87 %

5.3 P15-E

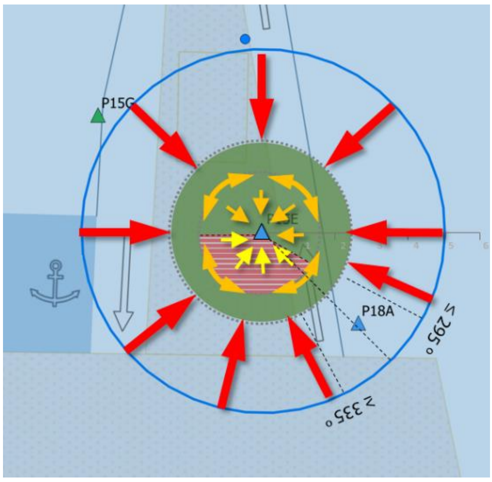
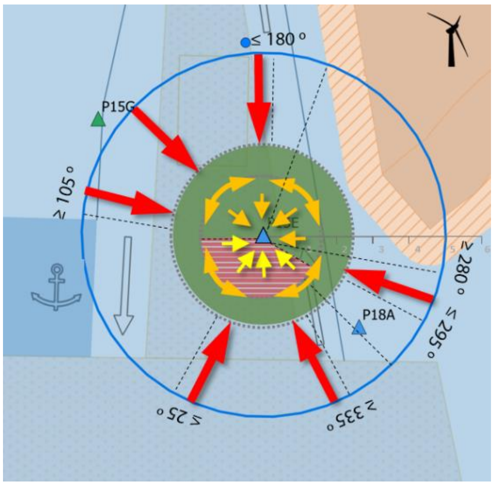
Critical objects in the limited obstacle sector preventing enhanced class 2 procedure in this direction: NO

Other rigs within the 5 NM circle: P18-A

Departures

Baseline	With wind farm (HKZ)
	
Possible departure directions: • between 165º – 105º (300º sector)	Possible departure directions: • between 165º – 350º (185º sector)

Approaches

Baseline	With wind farm (HKZ)
	
Possible approach directions: • between 335º – 295º (320º sector)	Possible approach directions: • between 335º – 25º (50º sector) • between 105º – 180º (75º sector) • between 280º – 290º (10º sector)

Calculated accessibility

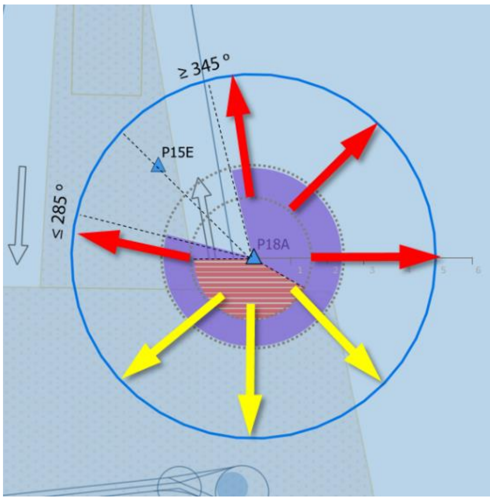
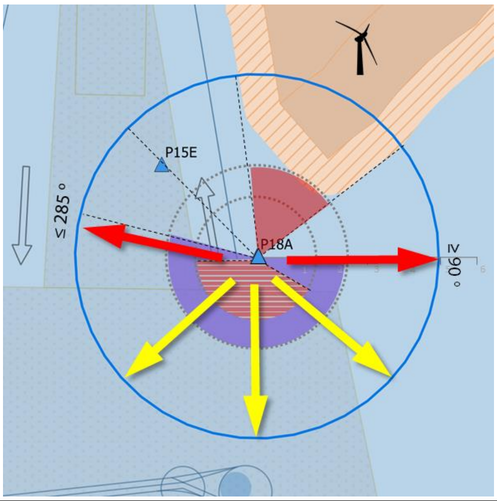
Baseline	With wind farm (HKZ)
Average: 95 %	Average: 90 %

5.4 P18-A

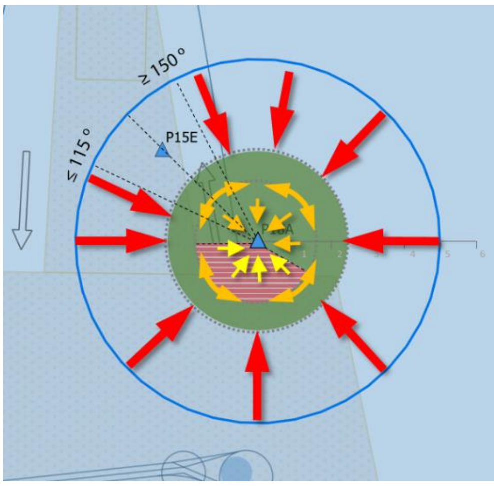
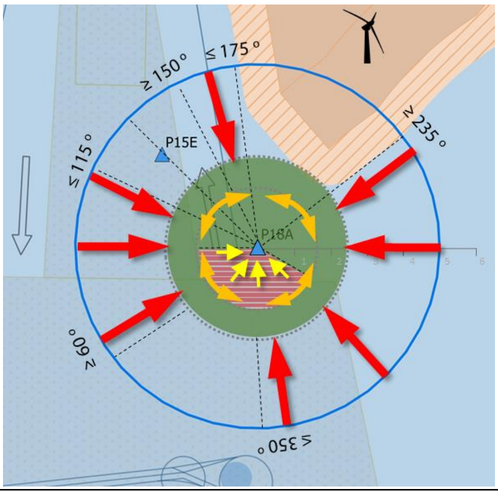
Critical objects in the limited obstacle sector preventing enhanced class 2 procedures in this direction: NO

Other rigs within the 5 NM circle: P15-E

Departures

Baseline	With wind farm (HKZ)
	
Possible departure directions: • between 345º – 285º (300 º sector)	Possible departure directions: • between 90º – 285º (195 º sector)

Approaches

Baseline	With wind farm (HKZ)
	
Possible approach directions: • between 150º – 115º (325 º sector)	Possible approach directions: • between 235º – 350º (115 º sector) • between 60º – 115º (55 º sector) • between 150º – 175º (25 º sector)

Calculated accessibility

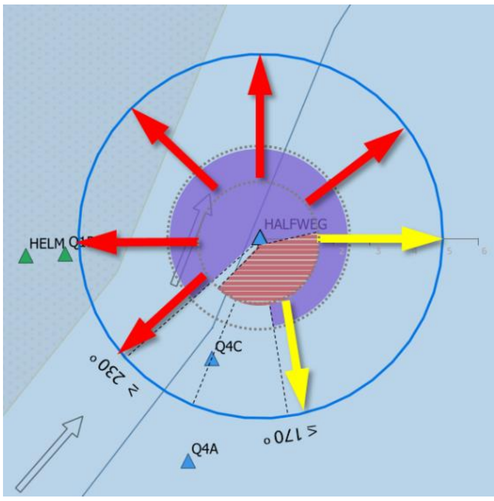
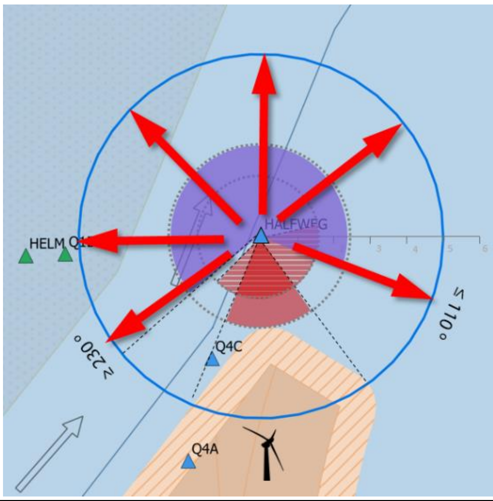
Baseline	With wind farm (HKZ)
Average: 95 %	Average: 94 %

5.5 HALFWEG

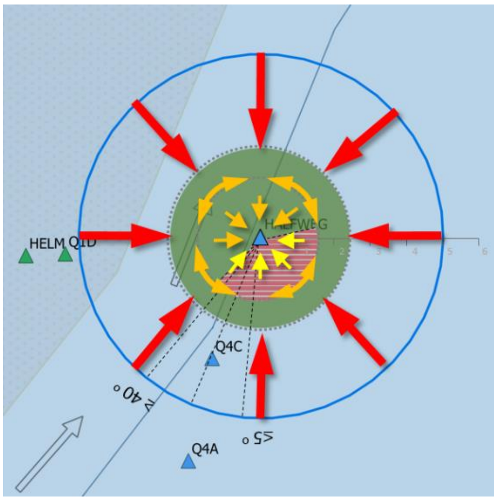
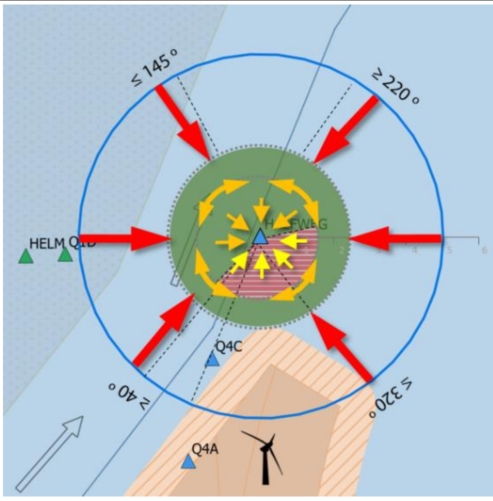
Critical objects in the limited obstacle sector preventing enhanced class 2 procedure in this direction: NO

Other rigs within the 5 NM circle: Q4-C

Departures

Baseline	With wind farm (HKN)
	
Possible departure directions: • between 230° – 170° (300 ° sector)	Possible departure directions: • between 230° – 110° (240 ° sector)

Approaches

Baseline	With wind farm (HKN)
	
Possible approach directions: • between 40° – 5° (325° sector)	Possible aproach directions: • between 40° – 145° (105° sector) • between 220° – 320° (100° sector)

Calculated accessibility

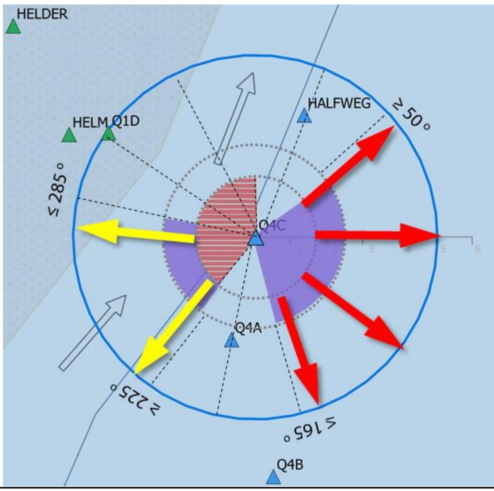
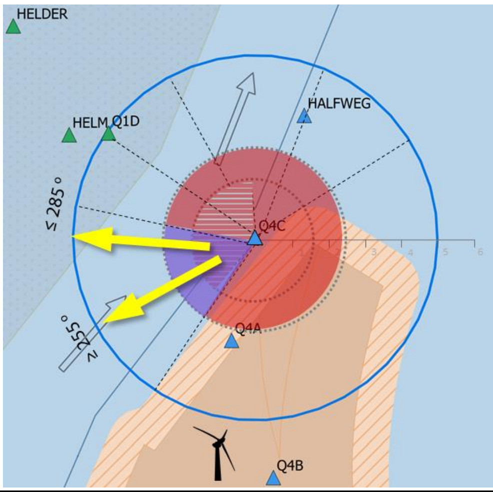
Baseline	With wind farm (HKN)
Average: 95%	Average: 94 %

5.6 Q4-C

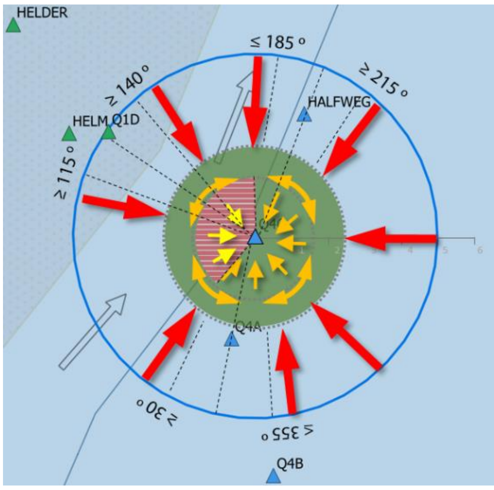
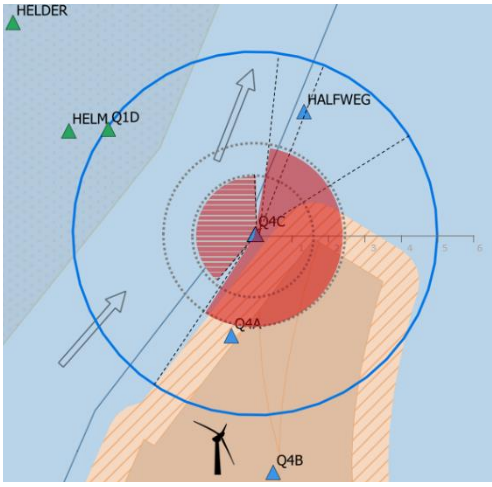
Critical objects in the limited obstacle sector preventing enhanced class 2 procedures in this direction: YES

Other rigs within the 5 NM circle: Q4-A, HALFWEG, Q1-D

Departures

<table>
<tr><td>Baseline</td><td>With wind farm (HKN)</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Possible departure directions:
• between 50° – 165° (115° sector)
• between 225° – 285° (60° sector)</td><td>Possible departure directions:
• between 255° – 285° (30° sector)</td></tr>
</table>

Approaches

<table>
<tr><td>Baseline</td><td>With wind farm (HKN)</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Possible approach directions:
• between 140° – 185° (145° sector)
• between 215° – 355° (140° sector)
• between 30° – 115° (85° sector)</td><td>Possible approach directions:
• NOT (wind park to close)</td></tr>
</table>

Calculated accessibility

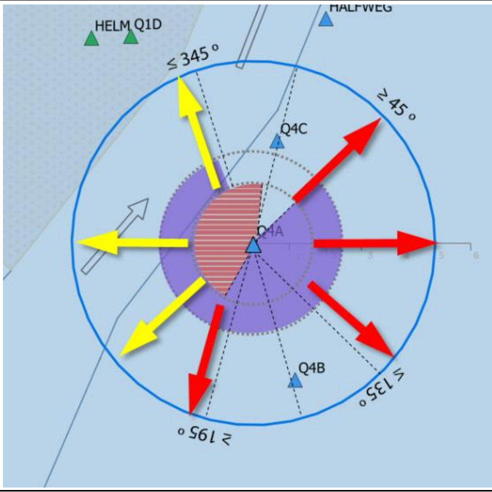
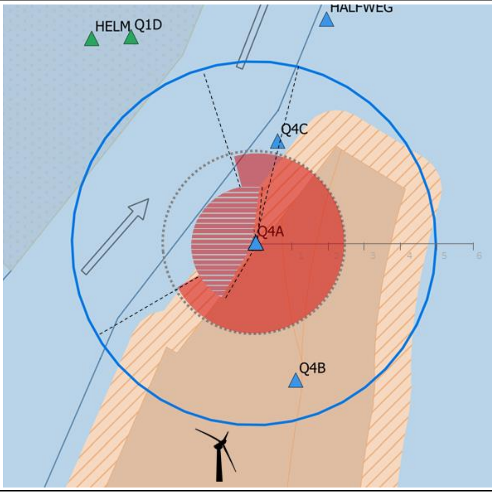
Baseline	With wind farm (HKN)
Average: 96%	Average: n/a

5.7 Q4-A

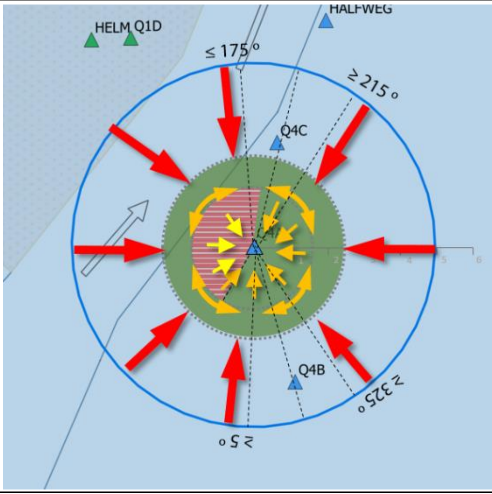
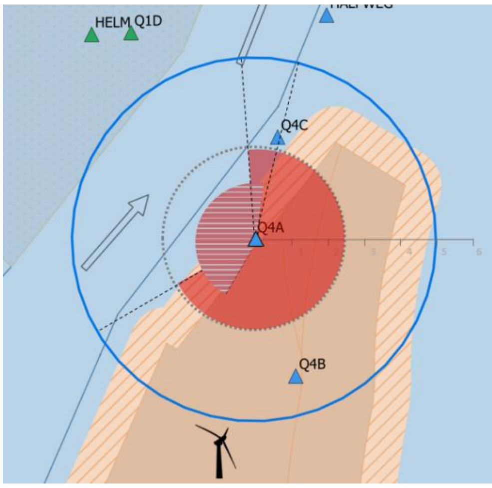
Critical objects in the limited obstacle sector preventing enhanced class 2 procedures in this direction: NO

Other rigs within the 5 NM circle: Q4-C, Q4-B

Departures

Baseline	With wind farm (HKN)
	
Possible departure directions: • between 45º – 135º (90º sector) • between 195º – 345º (155º sector)	Possible departure directions: • NOT (wind park to close)

Approaches

Baseline	With wind farm (HKN)
	
Possible approach directions: • between 215º – 325º (110º sector) • between 5º – 175º (170º sector)	Possible approach directions: • NOT (wind park to close)

Calculated accessibility

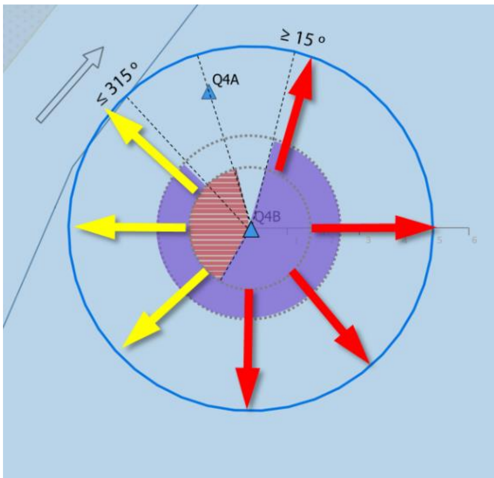
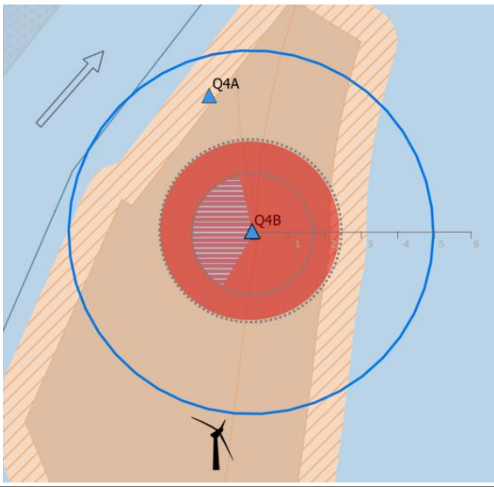
Baseline	With wind farm (HKN)
Average: 96%	Average: n/a

5.8 Q4-B

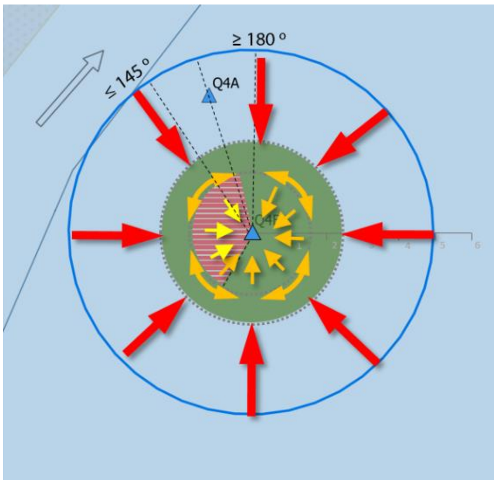
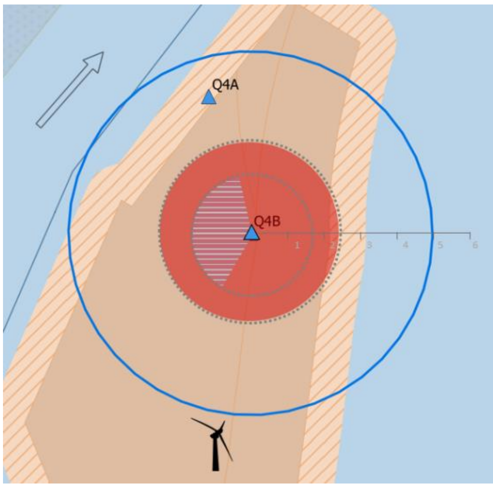
Critical objects in the limited obstacle sector preventing enhanced class 2 procedures in this direction: NO

Other rigs within the 5 NM circle: Q4-A

Departures

Baseline	With wind farm (HKN)
	
Possible departure directions: • between 15º – 315º (300º sector)	Possible departure directions: • NOT

Approaches

Baseline	With wind farm (HKN)
	
Possible approach directions: • between 180º – 145º (325º sector)	Possible approach directions: • NOT

Calculated accessibility

Baseline	With wind farm (HKN)
Average: 96%	Average: n/a

5.9 Summary accessibility

Below the impact on the accessibility is summarized.

Platform	Average accessibility		Decrease in accessibility due to wind farm
	Baseline	With wind farm	
P15-C [11]	82 %	81 %	-1 % points
Q-13	95 %	87 %	-8 % points
P15-E	95 %	90 %	-5 % points
P18-A	95 %	94 %	-1 % points
HALFWEG	95 %	94 %	-1 % points
Q4-C	95 %	0 %	-95 % points
Q4-A	95 %	0 %	-95 % points
Q4-B	95 %	0 %	-95 % points

Brief considerations on the calculated impact

Whilst the accessibility information is generally applicable to both approaches and departures, it is the departure that is the more limiting element of the two (for most of the platforms within scope). Specifically, the following is of note:

- P15-C: The platform itself and the nearby presence of platform P15-G already prevents departures in a 180-degree sector towards the west. This explains the 82% accessibility for the baseline situation.
  The planned wind park prevents departures in a large sector (< 180-degree) towards the east. Easterly winds however do not occur often and do not exceed the 20 kts crosswind limit for departures most of the time. Therefore, with easterly winds, departures can still be performed in north or south directions, explaining the 1% point decrease in accessibility.
- Q13: The wind park prevents departures in a large sector (> 180-degree) towards the northwest. Strong westerly winds do occur, explaining the 8 % points decrease in accessibility.
- P15-E: The wind park prevents departures in a large sector (180-degree) towards the east. This prevents some departures with winds from the east exceeding 20 kts, explaining the 5% points decrease in accessibility.
- P18-A: The wind park prevents departures in a large sector (180-degree) towards the north. Northerly winds are uncommon and are usually light, explaining the 1% point decrease in accessibility.
- HALFWEG: The wind park and the nearby platform Q4-C prevent departures in a small sector (~90-degrees) towards the south. The loss of this sector for departures can however be compensated by a departure flown towards the south-east or south west.
- Q4-C, Q4-A and Q4-B: No accessibility with the wind farm in low visibility conditions is possible due to the current planned location, shape and dimensions of the wind farm site Hollandse Kust (noord).

In summary, the impact in accessibility depends primarily on the:

- relative position of the wind park from the platform;
- the size of the non-accessible sector for departures;
- the crosswind limits for departures;

The accessibility impact is very sensitive when the non-accessible sector is approximately half a circle. A non-accessible sector of 'a bit more than half a circle' compared to a non-accessible sector of 'a bit less than half a circle' can decrease the accessibility with several %points, and vice versa.

[11] For the accessibility of the P15-C subsea completion platforms, see Appendix B.

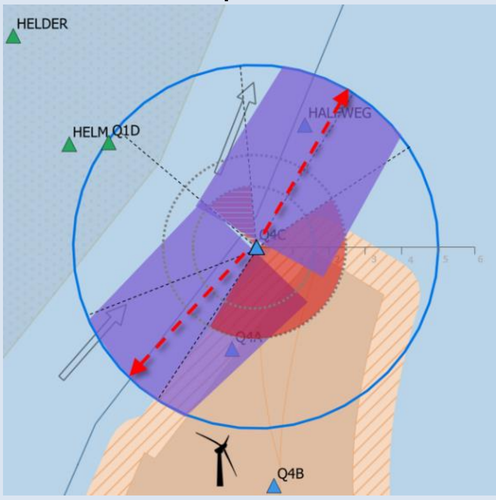
Regain accessibility for Q4-C, Q4-A and Q4-B

To regain accessibility for Q4-C, Q4-A and Q4-B, adjustments to the wind park must be made; a few suggestions are provided below for operations in both low and normal visibility conditions. It should be noted that low visibility operations to Q4-A and Q4-B are not possible without major adjustments to the wind farm. Therefore, only Q4-C is discussed below for possible regaining accessibility in low visibility operations without major adjustments to the wind farm.

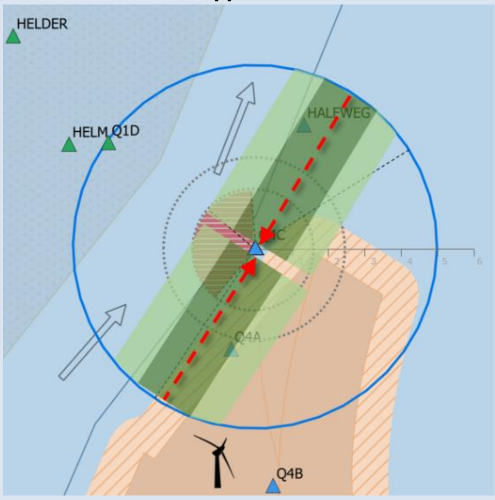
Accessibility Q4-C under IMC by PinS

A PinS procedure could be implemented to permit accessibility in low visibility conditions. Below a suggestion how such procedure could be located for platform Q4-C. A so-called stop procedure for certain wind turbines might be necessary to eliminate wind turbine generated turbulence.

Departure



Approach

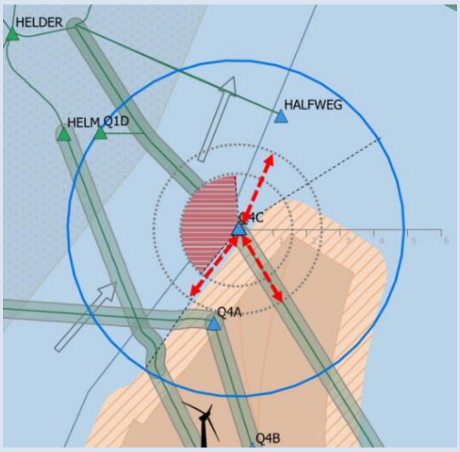


VMC accessibility Q4-C, Q4-A, Q4-B (HKN)

Corridors should be established within the wind park to reach accessibility in normal visibility conditions. Below suggestions how such corridors could be located for platforms Q4-C, Q4-A and Q4-B, using the cable/pipeline maintenance zones as much as possible. Although specific design and safety studies (for example a FOSA – Flight Operational Safety Assessment) should determine the minimum width of the corridors and the conditions under which safe helicopter operations can take place through these corridors, the current width of 1000 meter (2x 500 meter on each site of the cable/pipeline) of the maintenance zones is likely to be sufficient for VMC-day flight operations (i.e. approach, departure and missed approach with both engines operating and one-engine-inoperative conditions).

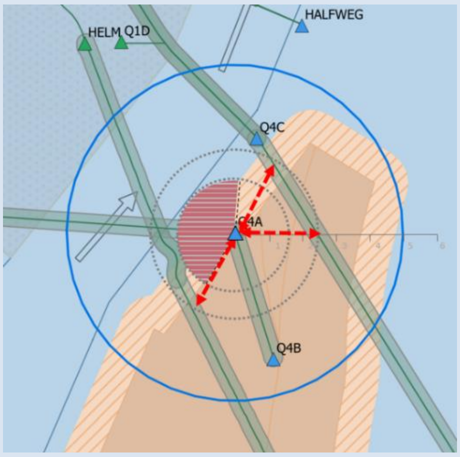
Normal visibility conditions (VMC-day) prevail for approximately 75% of the time, but the exact accessibility of the platform highly depends on the orientation, availability of the corridors, and the conditions under which safe helicopter operations can take place. Also, a stop procedure for wind turbines within 1 NM from these corridors is required to eliminate wind turbine generated turbulence.

Q4-C Departure & approach



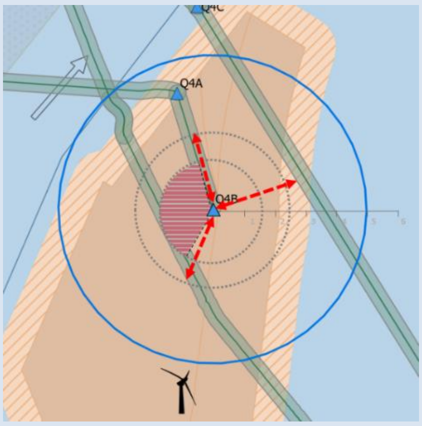
A stop procedure for wind turbines located within 1 NM from the corridor should be applied.

Q4-A Departure & approach



A stop procedure for wind turbines located within 1 NM from the corridor should be applied.

Q4-B Departure & approach



A stop procedure for wind turbines located within 1 NM from the corridor should be applied.

6 Implementation considerations

The increased complexity of the situation in the North Sea (i.e. the construction of the wind farms) has a potentially negative effect on the level of safety of flight operations to and from the oil and gas platforms & rigs by helicopters. In short, the presence of an increasing number of potential obstacles mean that navigational errors or loss of performance in-flight have a greater potential consequence.
A greater level of data integrity in the aeronautical information made available to operators is a positive safety mitigation. The accuracy and clarity of timely information relating to obstacles adjacent to the helidecks and wind farms or other oil and facilities is essential. This data is safety critical to the usefulness of the rig plates required by EASA AIR OPS. As far as these comments are concerned, the operating minima are out of scope; it is the infrastructure and its exact location that is of concern. Whilst the production of rig charts is, by EASA AIR OPS, the responsibility of the operator, there is a case to be made for a harmonized approach to the data that is published for offshore helidecks in the Amsterdam FIR (i.e. Dutch airspace). This could be achieved by an operator representative group, an oil and gas representative group or the government.

The above is applicable for the data required to plan and execute ARA approaches. In principle, charts for visual approaches only are not required. There is an exception to this position, in case corridors through the wind farms are established to allow access of platforms Q4-A, Q4-B and Q4-C in normal visual conditions. The visual approaches to these helidecks are so complex that a visual approach path should be defined and promulgated.

There are arguments for and against this work being performed by any of the parties mentioned above. A document produced by an industry organization will have a very high level of subject matter knowledge. However, there is no guarantee that any industry organization will continue to function in the future, limiting the long term viability of this approach. A governmental body, LVNL for example, would ensure continuity as an Air Navigation Service Provider (ANSP) will always exist.

Prior to the use of an ARA approach, the collation of the data and the preparation of the diagrams discussed in this paragraph will require a number of steps to be undertaken. These include:

- Rig chart design, and
- Adherence to the LVNL data integrity standards.

Nothing in this report provides alleviation from the need to submit, for the approval of ILT, a Flight Operational Safety Assessment (FOSA

7 Conclusions

The location and boundary of the offshore windfarms farm zones Hollandse Kust (zuid and noord) will have impact on the accessibility of a number of North Sea oil & gas platforms by helicopter. Eight helicopter landing sites were evaluated. This evaluation included weather conditions (wind and visibility), other platforms in the helicopter 5 NM area of the platform, the layout of the platform, and windfarm generated turbulence. Shipping (both in transit as moored) was excluded (see also chapter 8).

The impact was assessed as:

- Platforms P15-C, P18-A and HALFWEG → Impact insignificant
- Platform Q13, P15-E → Impact minor
- Platforms Q4-C, Q4-A and Q4-B → Impact major

The three terms used here are defined as:

- Insignificant: the accessibly drops with 1% points maximum;
- Minor: the accessibility drops with 5-8% points;
- Major: no longer accessible under low visibility conditions. To permit accessibility in good visibility conditions, corridors within the wind farm should be established and a procedure to enable stopping the wind turbines is necessary.

8 Considering shipping

The previous conclusions on accessibility are made without regard to the potential impact that ships near the platforms will have on the accessibility. As ships can be considered as (moving) obstacles, a ship near a platform will influence the ability of a helicopter crew to conduct an ARA approach in low visibility. The intensity and locations of shipping near the platform is therefore an important consideration for the accessibility. Appropriate data on shipping was not available for this study. If for specific platforms the additional impact of shipping on the platform accessibility should be included, further study with appropriate data is required to determine the impact on accessibility that shipping might have. Potential impact by shipping on offshore helicopter operations under low visibility has not been taken into account in these notes.

Whilst further study is required, the notes below are offered as a first indication on the way accessibility will be impacted under VMC when considering the 2,5 NM-maneuvering area as a reference:

- Ships inside the 2,5 NM-maneuvering area may impact the accessibility of the platform by helicopter. Their impact is dependent on the intensity of the shipping present inside this area.
- Under normal visibility conditions, ships present outside the 2,5 NM-maneuvering area are unlikely to impact the accessibility of the platform by helicopter, as these ships or objects can be easily avoided by 'see and avoid' navigation. It is noted that during the time that helicopter operations take place, normal visibility conditions prevail for approx. 75% of the time.

Using the above notes on shipping, the following assumption can be made regarding the additional impact of shipping on the platform accessibility. Under normal visibility conditions (which prevail for approx. 75% of the time):

  - For those platforms with insignificant or minor impact (P15-C, P15-E, P18-A, HALFWEG and Q13), the additional impact of shipping is similar for the baseline situation (no wind farm) as for the situation with wind farm.

9 Considering PinS

The PinS approach offers a number of advantages over the current airborne radar approach (ARA) that is primarily used. Whereas a ARA does not provide vertical separation, a PinS procedure does. A PinS procedure therefore allows obstacles within its dimensions (even overfly these), although these obstacles will influence the visibility conditions in which the designed PinS procedure can be used, depending on their height.

It is therefore recommended to explore if a PinS procedure could be a solution to regain accessibility under low visibility conditions for those platforms where significant impact on accessibility is expected due to the wind farms and/ or shipping.

10 Reference material

Regulation, standards & Guidelines

National

- Dutch AIP (Aeronautical Information Publication)
- Werkproces gezamenlijk luchtruim- en procedureontwerp (Wet luchtvaart artikel 5.11)
- Luchtruim Catalogus

International

- ICAO annexes and docs
- EASA OPS regulations
- UK CAA's CAP 764 'Impact of wind turbines on aviation'

Policy guidelines

- Criteria Catalogus Luchtruim

Consulted papers / studies

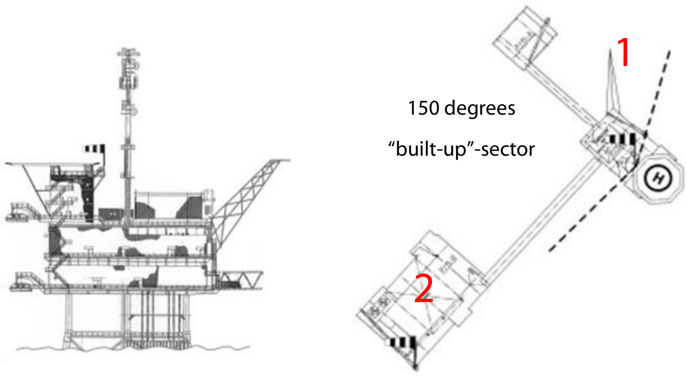
- NLR-CR-2016-266 Offshore windturbine zog en veilige helikopteroperaties
- FOSA voor ARA en departure Q01-HELM-A na realisatie Helmveld windmolenpark
- De invloed van offshore windturbinepark 'Helmveld FOSA' op veilige helikopterbereikbaarheid van platforms Helm, Helder en Hoorn

Other

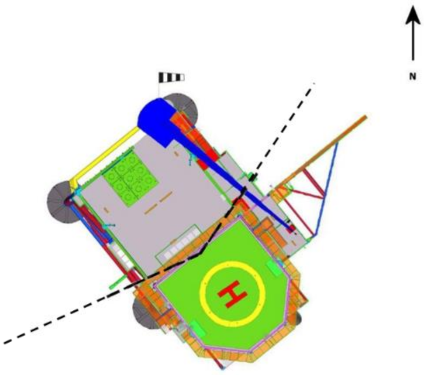
- Notitie vliegveiligheid 2008

Appendix A Platform descriptions

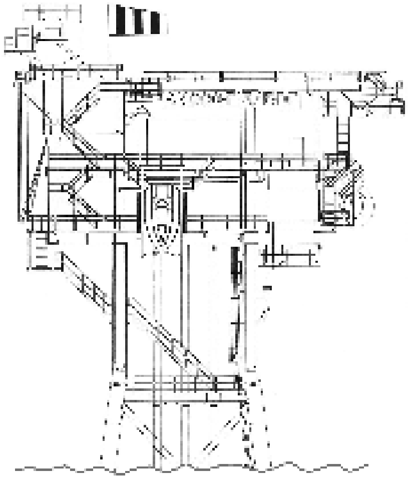
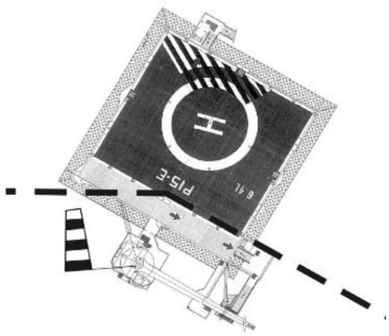
P15-C

Photo	
Layout	
Critical objects in the limited obstacle sector preventing an enhanced class 2 departure / drop-down procedure)	• Flare stack (1) • Super structure (2)
Info 2016	• Company: TAQA • Manned • Heli operator: CHC • Frequency of flights: ~250 / year

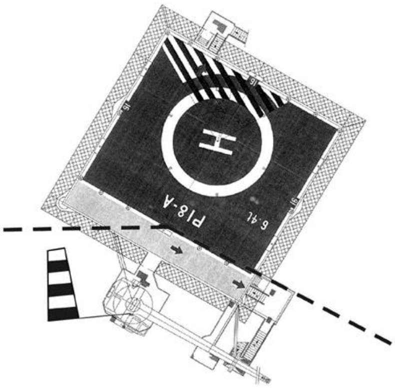
Q-13

Photo	
Layout	
Critical objects in the limited obstacle sector preventing an enhanced class 2 departure / drop-down procedure)	• none
Info 2016	• Company: ENGIE • Unmanned • Heli operator: CHC • Frequency of flights: ~100 / year

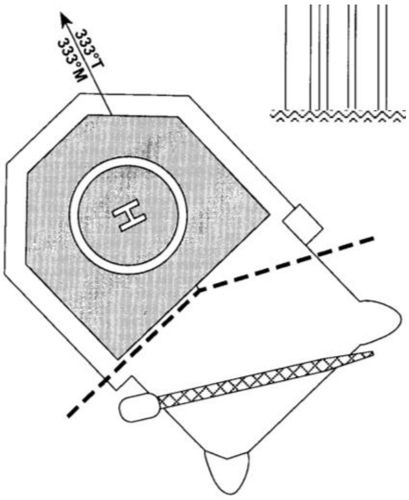
P15-E

Photo	
Layout	
Critical objects in the limited obstacle sector preventing an enhanced class 2 departure / drop-down procedure)	• none
Info 2016	• Company: TAQA • Unmanned • Heli operator: CHC • Frequency of flights: ~30 / year

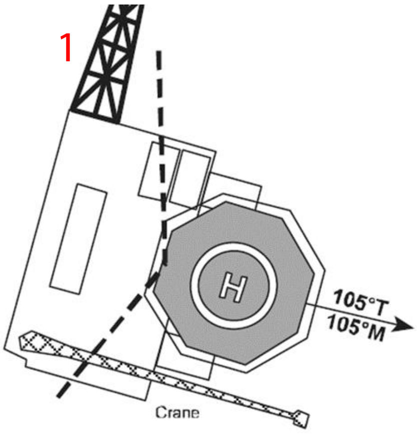
P18-A

Photo	
Layout	
Critical objects in the limited obstacle sector preventing an enhanced class 2 departure / drop-down procedure)	• none
Info 2016	• Company: TAQA • Unmanned • Heli operator: CHC • Frequency of flights: ~50 / year

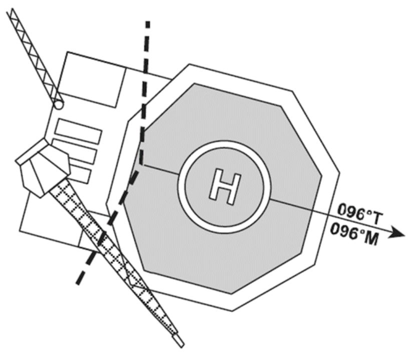
HALFWEG

Photo	
Layout	
Critical objects in the limited obstacle sector preventing an enhanced class 2 departure / drop-down procedure)	• none
Info 2016	• Company: PETROGAS • Unmanned • Heli operator: Heli Holland • Frequency of flights: <10 / year

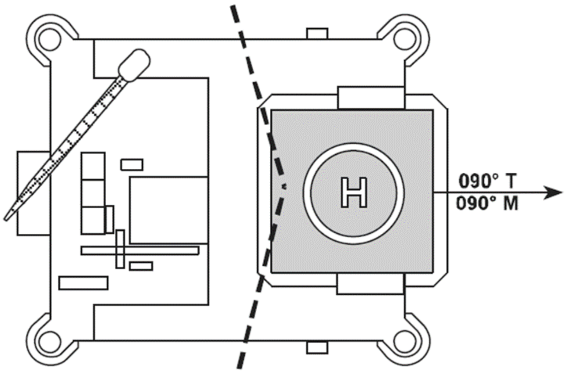
Q4-C

Photo	
Layout	
Critical objects in the limited obstacle sector preventing an enhanced class 2 departure / drop-down procedure)	• Flare stack (1)
Info 2016	• Company: WINTERSHALL • Unmanned • Heli operator: NHV • Frequency of flights: ~100 / year

Q4-A

Photo	
Layout	
Critical objects in the limited obstacle sector preventing an enhanced class 2 departure / drop-down procedure)	• none
Info 2016	• Company: WINTERSHALL • Unmanned • Heli operator: NV • Frequency of flights: ~100 / year

Q4-B

Photo	
Layout	
Critical objects in the limited obstacle sector preventing an enhanced class 2 departure / drop-down procedure)	none
Info 2016	• Company: WINTERSHALL • Unmanned • Heli operator: NHV • Frequency of flights: ~50 / year

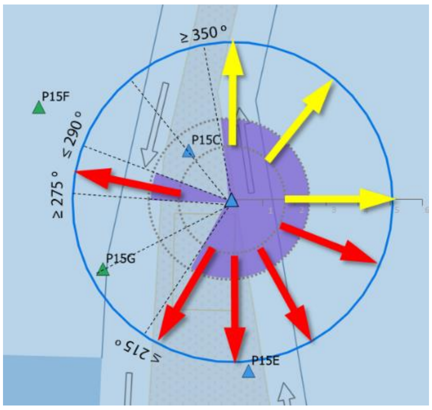
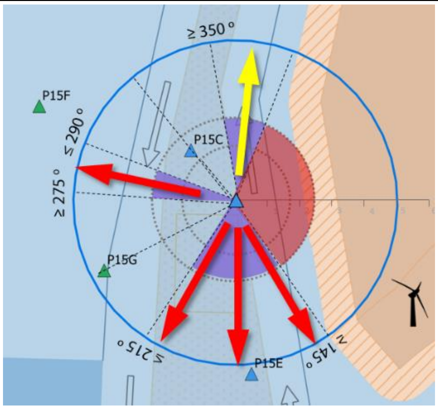
Appendix B P15-C subsea completion platforms

Subsea completion P15-10S option 1, 2 and 3[12]

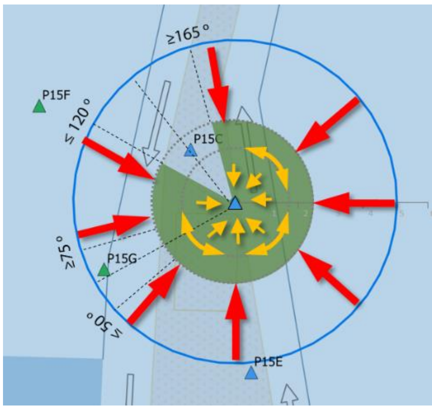
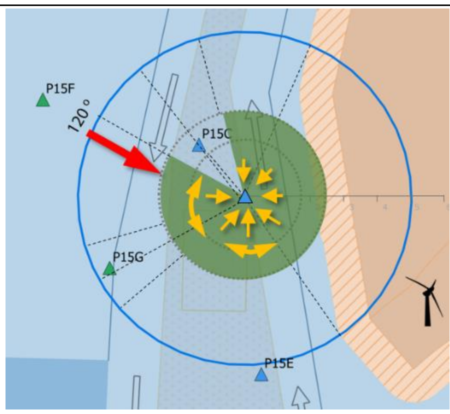
Critical objects in the limited obstacle sector preventing enhanced class 2 procedure in this direction: Assumed NO.

Other rigs within the 5 NM circle: P15-C and P15-G.

Departures

<table>
<tr><td>Baseline</td><td>With wind farm (HKZ)</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Possible departure directions:
• between 350° – 215° (225 ° sector)
• between 275° – 290° (15 ° sector)</td><td>Possible departure directions:
• between 145 ° – 215° (70 ° sector)
• 350 ° and between 275 ° – 290° (15 ° sector)</td></tr>
</table>

Approaches

<table>
<tr><td>Baseline</td><td>With wind farm (HKZ)</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Possible approach directions:
• between 75 ° – 120° (45° sector)
• between 165 ° – 50° (245° sector)</td><td>Possible aproach directions:
• 120°</td></tr>
</table>

Calculated accessibility

Baseline	With wind farm (HKZ)
Average: 95%	Average: 87%

[12] The three options for the subsea completion of P15-C differ only in the orientation of this rig, and therefore the orientation of the limited obstacle sector. No information was available on the criticality of obstacles in this sector. Assumed is there are no critical objects. This makes the 3 options identical to each other for the accessibility assessment.