Morecambe Offshore Windfarm: Generation Assets

Examination Documents

Volume 9

The Applicant’s Response to Spirit Energy’s Deadline 4 Submission Appendix B: Effect of Proposed Morecambe Offshore Windfarm on Offshore Oil and Gas Operations

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MORECAMBE OFFSHORE WINDFARM

Effect of Proposed Morecambe Offshore Windfarm on Offshore Oil and Gas Operations

Morecambe Offshore Windfarm Limited

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Customer:	Morecambe Offshore Windfarm Limited, Hobart House, 80 Hanover Street, Edinburgh EH2 1EL	Building 3 Level 2 AIBP Dyce Drive Aberdeen AB21 0BR
Customer contact:	Oliver Gardner	Tel: +44 1224 335000
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Objective:

Assessment of safety impact of the proposed Morecambe Offshore Windfarm on existing oil and gas operations.

Prepared by:	Verified by:	Approved by:
Alex Guild Senior Principal	John Morgan Senior Principal	John Morgan Senior Principal

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0	17.01.2025	First issue	A. Guild	J. Morgan	J. Morgan
1	22.01.2025	Minor changes throughout and updated risk calculations	A. Guild	J. Morgan	J. Morgan
2	11.03.2025	Updates following client meetings and most recent representations. Improved discussion of maintenance impact, emergency response (including examples) and other aspects. Includes offshore working time analysis. Inclusion of executive summary.	A. Guild	J. Morgan	J. Morgan

Executive Summary

Background

Spirit's Morecambe Field comprises a central processing complex of three platforms (CPC-1) and four normally unmanned installations (NUIs); Calder DP6, DP8 and DPPA. Calder has a separate gas export route whereas the other NUIs flow gas to CPC-1 for ongoing export to Barrow. CPC-1 is manned with a maximum of 177 people onboard allowing all non-specialist tasks on the installation to be carried out by persons whom are there for their whole 2 or 3 week shift. The NUIs are serviced by crews that day-trip by helicopter from CPC-1, though flights also occur directly from the onshore heliport at Blackpool to the NUIs.

Helicopters are the normal means of transportation of people and some goods to offshore installations and the above arrangements are a normal means of operation of such a collection of assets especially with CPC-1 being located so close (15 minutes) to Blackpool. Travel time to a NUI from CPC-1 is only a few minutes.

Plans for the Morecambe Offshore Wind Farm place turbines at locations that have the potential to reduce the range of weather conditions in which flights to CPC-1 (and so the NUIs) are possible. This is because helicopters need to avoid the ~300m wind turbines and this cannot be achieved if the wind is in a direction aligned with the closer wind turbines. The Anatec report /1/ states that Visual Meteorological Condition (VMC) flying is not affected by the MOWF, but that Instrumented Meteorological Condition (IMC) flying (or conservatively VMC at night) is not possible, unless a turbine free corridor is introduced allowing helicopter use in specific wind sectors in IMC flying conditions. The AviateQ report /2/ also states that IMC is not possible, but also claims restrictions on VMC. Assuming full day VMC access, this report is not dependent on either analysis and does not use data derived in them.

This report analyses the safety impact of the reduced flying capability for the different reasons that a helicopter needs to fly, which are commensurate with different timescales. It utilises analysis on the working time available on the NUIs. Comment is also made on risk and safety case impact for the Morecambe field.

Offshore Working Time

One of the key aspects of the safe operation of a NUI (and CPC-1) is maintenance of safety and environmentally critical elements (SECEs). To avoid inefficiencies, a minimum number of hours in a day on a platform are required and Spirit has used a minimum of 7 hours in an analysis of how offshore working time on the NUIs is affected by the MOWT. The affected hours may be sensitive to this parameter (e.g. 6½ hours is hardly any change, but reduces the number of days affected), but the same value is used here in a DNV repeat analysis.

Using weather data to determine if helicopter flights can go ahead and Vantage data of flights over 2018-2022, it is possible to determine how the actual maintenance programme in this period would have been affected by the MOWF had it been there. If a flight that was taken would now be delayed, the reduction in time at a NUI is calculated accounting for the fact that a late flight might have knock-on effects and make others later. Additionally, recoverable time that can be made up by a longer stay when this is possible due to good flying conditions with no more than 10 hours being spent on the NUI is calculated.

The results show that without the corridor, the hours lost, without considering any that may be recoverable by longer stays, represents 1.5 – 3% of the total working hours (different values for different NUIs due to different working requirements on them). With the corridor, this figure drops to 1-2%. Both figures are low and are an order of magnitude less than the recoverable hours of ~10% that are available from longer stays on the NUI when this is possible.

Emergency Response – Timescale – up to an hour

Offshore Installation Managers will follow an emergency response protocol when determining the best course of action to preserve life and prevent injury to all personnel onboard. While helicopters including commercial air transport (CAT) are the preferred means of evacuation from an installation because they are the normal means of access, if there is an immediate emergency requiring evacuation of personnel, it will need to be carried out quickly to remove personnel from danger to a place of safety. For this reason, it is most likely that lifeboats are used to evacuate, which are then assisted by the standby vessel that is always in the field.

Even if there is a commercial helicopter in the field and the helideck was not directly affected, it would be unlikely to be able to approach a small NUI as there would be minimal separation between the hazards and the helideck and the pilot would have no training or procedures for such an approach. A Search and Rescue (SAR) helicopter does have such capability but is not guaranteed to be available in the required timescale and may or may not be able to offer assistance depending on the emergency. A SAR helicopter is able to fly to the platforms regardless of wind turbine location as it operates under CAP 999. It also has facilities to deal with injured personnel, which a commercial helicopter does not.

An hour is considered as the initial emergency time, being the survivability time of many temporary refuges (TRs) offshore. However, for CPC-1, which is bridge-linked, the distance between the TR platform and the process means that the survivability may be longer. On CPC-1, the helideck may be separated from the hazardous event allowing helicopters to use it, but evacuation by commercial helicopter would take many hours due to there being up to 177 personnel to evacuate. SAR helicopters located at Caernarfon, Prestwick and Humberside once arrived at site could take more personnel on each trip, but this process would still take well over an hour. For an event on CPC-1, it should be possible to muster to the temporary refuge on the accommodation platform and shelter until the event is over, at which point SAR helicopters could evacuate non-essential personnel.

Overall, there is no realistic potential for a commercial helicopter to provide emergency evacuation and so any greater restriction to the weather conditions it can operate in is not relevant in this regard. The second helideck on the CPC-1 complex is for day use only and has restrictions related to wind direction. Thus, it cannot be relied on for emergency response.

Medical Emergency – Timescale – An Hour to Hours

CPC-1 will be equipped with a sick-bay manned by a medic, with first aid facilities and an advanced first aider provided at the NUIs. For a medical emergency, the first port of call is the medic, or first aider. If they cannot provide treatment, then the patient needs to be taken ashore.

If the emergency is acute, a SAR helicopter would be called and such a helicopter is set-up to allow medics to accompany a patient. If there is a commercial helicopter in the field, it could be on the helideck sooner, but it is not equipped to allow any treatment for the patient on the journey, nor accept a stretcher. Furthermore, it is required to carry out a risk assessment regarding how casualties would be evacuated in the event of a ditching. This is a time-consuming process which renders CAT helicopters unsuitable for evacuation.

If the emergency is not acute and there is time for a commercial helicopter to be kitted out to accept a patient, or the patient does not need such care, it is essentially not an emergency situation.

Overall, there is no realistic potential for a commercial helicopter to need to provide medical evacuation quickly and so any greater restriction the weather conditions it can operate in is not relevant in this regard.

Precautionary Evacuation - Timescale – Up to a Day

For a developing adverse situation, there is the possibility that an installation needs to be downmanned. This may occur for a process related reason e.g. a well work operation where the control of the well is difficult, or non-process related such a problem with potable water provision.

As the NUIs are only manned by a small number of personnel and they are only manned when flying is possible, downmanning can be achieved by commercial helicopter. Use of a SAR helicopter is possible, but as the evacuation is precautionary, there is no immediate need to require emergency services.

Downmanning CPC-1 would take longer (up to 18 hours for a single helicopter taking personnel to Blackpool; less is additional helicopters from Blackpool or elsewhere are used, though the latter is unlikely as these helicopters would have their normal operations to execute). As is currently the case, if commercial flying was not possible, SAR helicopters would have to assist. As the accommodation platform does not have any hydrocarbon process on it, it is unlikely that a process issue would require CPC-1 to be downmanned. This is the only type of event that potentially needs to happen in a restricted timescale: lack of potable water is clearly serious, but not an issue that triggers downmanning immediately.

Overall, downmanning of a NUI is not affected by the windfarm as NUIs are only accessed in suitable flying conditions. Downmanning of CPC-1 may require SAR services instead of commercial helicopters, but this only needs to be achieved in hours and so any timing change has no impact.

Maintenance – Timescale - One day

If preventative maintenance of safety and environmental critical equipment (SECE) is planned for a particular day on a NUI and this cannot occur, there is no immediate risk as the maintenance can simply be done on another day. Assuming the maintenance is not already in critical backlog, there is no maintenance that is critical to the day, week, or even month. Postponement of a flight on a particular day has no significant risk impact from postponed preventative maintenance of SECEs.

Maintenance on CPC-1 can continue as planned unless specialist vendors are required to be flown from Blackpool, but the same conclusion applies in this case.

If the visit is for corrective maintenance of a SECE, it is already implied that the risk is manageable otherwise the risk would have been removed by, for example, shutdown or restriction of production. On this basis, a short delay to the corrective is not significant and, if the delay is longer, risk removal needs to be considered.

Overall, postponement of a maintenance visit does not create a significant safety risk.

Maintenance - Timescale - Months

If a maintenance visit is curtailed because of weather conditions (which may happen now, but has a marginally higher likelihood with the windfarm in place), this time needs to be made up otherwise, the maintenance backlog on the platform would gradually increase and eventually become unacceptable unless the NUI was shut-in. In regard to this:

- Analysis of the lost "offshore NUI time" due to the windfarm (for no restrictions in VMC and flying in IMC in only wind directions 220-300 and 010-090i.e. the corridor)) shows that 1-2% of time is lost, but 10% can be made up by longer days (while staying within a 10 hour limit). Further time is also available by flying to the NUIs on days where either no flying was undertaken or only crew change flight to Blackpool).
- In 2018 Spirit operated 6 NUIs (current 4 plus DP3 and DP4) with a single helicopter (Vantage shows a small number of days where crew change to Blackpool may have used 2 helicopters, but this could also be a data error). Spirit now operates 4 NUIs, so the flight programme compared to 2018 has 50% additional capacity, which is more than enough to cover any loss of flights caused by the windfarm.
- In addition to this, if Spirit were to assign an additional maintenance crew to "catch-up" NUI work, then, if a visit to a NUI was not possible on a particular day, it could be carried out by the "catch-up team" on another day in tandem with maintenance on a different NUI. While the number of additional days when flying can occur may be limited, there is an abundance of days that an additional NUI could be visited. This would have the effect of allowing maintenance to occur almost unchanged from now and reducing individual risk to the NUI crews as the transportation risk would be spread out amongst more people.
- There is very significant normal variation in visits to a NUI from no visits in a given month to almost every day. The change in helicopter access adds to this variation but does not materially change it.
- Spirit has stated (13th Febraruary meeting) that there will be some tapering of maintenance in the run in to CoP to reducing the overall the maintenance load.
- Other strategies are also possible such as use of:
    - A larger helicopter as is used in the Central and Northern North Sea.
    - Two helicopters in the summer when there are always fewer flight restrictions.
    - Campaign maintenance potentially using a flotel, or walk to work (W2W) vessel (which may require a material change to the safety case if W2W is not already included in it – such a change is a relatively common occurrence).

The above shows that any longer-term impacts on reduced helicopter availability are manageable.

Safety Case and Risk

The safety case covers operation of the Morecambe Field. There is a memorandum of understanding between the CAA and HSE for the regulation of helicopter operations. Within this, all operations when a helicopter is flying (which has to include everything outside the 500m zone, which is the scope of the safety case) are under CAA jurisdiction and so there is no direct impact on the safety case from the windfarm.

If additional flights to the NUIs are required because of the windfarm and no other changes are made as suggested above, this creates additional risk to the NUI teams. However, the number and percentage of such flights would be small and the impact on the overall risk even smaller (as other risks do not change). There is no possibility of the risk becoming intolerable as this would require an individual to take an additional 700+ flights between CPC-1 and a NUI per year. None of the helicopter related safeguards change and none of the other potential impacts outlined here are material as they do not affect the basis on which the safety case was accepted.

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Acronyms

Acronym	Meaning
ACOP	Approved Code of Practice (to a regulation)
ALARP	As Low as is Reasonably Practicable
CA	Competent Authority
CAT	Commercial Air Transport
EBS	Emergency Breathing Systems
ERRV	Emergency Response and Rescue Vessel
HSE	Health and Safety Executive
HTAWS	Helicopter Terrain Awareness and Warning System
ICP	Independent Competent Person
IMC	Instrument Meteorological Conditions
IRPA	Individual Risk per Annum
MAFD	Maximum Allowable Finish Date
MOWL	Morecambe Offshore Windfarm Limited
MOWF	Morecambe Offshore Wind Farm
NUI	Normally Unattended Installation
ORA	Operational Risk Assessment
POB	Persons on Board
RTB	Return to Base
SAR	Search and Rescue
SECE	Safety and Environmental Critical Element
TR	Temporary Refuge (on an installation)
UKCS	UK Continental Shelf
VMC	Visual Meteorological Conditions
W2W	Walk to work

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The Authors

John Morgan is a Senior Principal with DNV in Aberdeen with 30 years' extensive technical experience. He is an expert in ALARP, safety cases and safety regulation, has visited many platforms in the UK, chaired the OEUK Major Hazards Technical group for 5 years and led the generation of industry guidance on Management of Fire in Accommodation, Workforce Involvement in Safety Cases, Cumulative Risk and Risk-based Decision Making and been a key member of the workgroup that updated the Operational Risk Assessment (ORA) guidance. He is DNV's representative on the International Association of Oil and Gas Producer's (IOGP) safety committee and process safety sub-committee. John's technical specialisms include safety regulation, quantified risk assessment and consequence modelling. He has led many projects that have resulted in new assessment methodologies and have improved operational, or safety performance for an operator. John has led, or worked on, many safety case thorough reviews for a range of operators.

Alex Guild is a Senior Principal with DNV in Aberdeen with 30 years of varied technical experience gained in the energy sector and the chemical industry. A chartered electrical engineer, he spent nine years in ICI, then three years in the Health and Safety Executive before joining Chevron in a variety of technical safety roles based in both the UK and the USA. Alex's expertise includes legal compliance, management systems and technical integrity. Alex is also a qualified commercial pilot and runs a flying school in his spare time.

1 INTRODUCTION

This report evaluates the potential effect to the helicopter operations associated with a number of offshore oil and gas installations situated in close proximity to the Morecambe Offshore Windfarm Project. Helicopter access reports produced by Anatec /1/ and AviateQ /2/ identify that the range of environmental conditions in which helicopter flight operations to nearby oil and gas facilities can be carried out would be reduced due to the wind turbines.

The facilities are operated by Spirit Energy with the permanently manned platform complex CP-1 being the hub of the operation (CPC-1 comprises CPP-1, AP-1 and DP-1). Work parties fly from CPC-1 to the Normally Unoccupied Installations (NUIs) for up to 12 hours before returning to CPC-1. Flights at CPC-1 and the NUIs Calder and DP-6 are potentially affected by the Project. Flights to DP-8 and DPPA are potentially affected as personnel travel there via CPC-1. These facilities are collectively termed the 'affected assets' for this purpose of this report, following the terminology used by Spirit Energy in their representations.

Specifically, the effect of the wind turbines is that the availability of Commercial Air Transport (CAT) helicopters to access these installations could be restricted to daytime Visual Meteorological Conditions (VMC) due to the obstacle clearance needed at night or in bad weather being impinged on by the windfarm and specifically, the high turbine blades (~300m above sea level).

This report evaluates the effect of the project on helicopter operations associated with the offshore installations with respect to:

- Increased risks associated with the possibility of additional helicopter flights to the NUIs if a greater number of shorter visits (restricted to VMC conditions) to the NUIs are needed.
- Evacuation in the event of an emergency.
- Maintenance of safety critical equipment.
- Overall impact on the safety case.

This report is written for an audience that is technically literate, but which is not experienced in oil and gas operations. Therefore, some of the key concepts are explained before addressing the situation at Morecambe.

Apart from Vantage[1] data (helicopter flight recording system used across the oil and gas industry – see below), DNV has not been provided any information from Spirit (via Morecambe Offshore Windfarm Limited - MOWL) beyond that in written submissions to the DCO Examination process. Therefore, this report is based on this information provided by Spirit in the DCO Examination process together with experienced oil and gas knowledge of offshore operations and especially NUIs combined with publicly available knowledge of the South Morecambe operations.

The impact of the MOWF had it been there in 2018-2022 on actual offshore maintenance visits to the NUIs in this period has been used as a basis for considering the overall impact. The conclusions are not dependent on the details of this analysis and so not on the details of the Spirit operation. Non-standard operations such as overnight stays on the NUIs have not been considered and there is no suggestion, or indication that they are occurring.

[1] Vantage is a Persons on Board (POB) tracking system that is widely used by oil and gas companies to track personnel movements to and from offshore installations. It is accessed by helicopter operators as part of their system for managing passengers. As such, it contains flight data that can be used to track the dates, times and destinations of flights. Vantage also contains an up-to-date list of those on board an offshore installation and therefore has a role to play in emergency response. Only the flight timings and routings from vantage were provided to MOWL. No data on POB on the helicopters was provided.

2 BACKGROUND

2.1 OFFSHORE OIL AND GAS OPERATIONS IN MORECAMBE BAY

2.1.1 Permanently Staffed Platforms

Spirit's oil and gas operations in Morecambe Bay are based around the permanently staffed CPC-1 installation. This installation processes oil and gas and condensate from wells on the CPC-1 complex and from the DP (drilling platform) NUIs, the latter being conveyed to CPC-1 by subsea pipelines. With CPC-1 being manned 24/7, any issue on it can be dealt with almost immediately by the skilled persons aboard, though specialist tasks will often be carried out by vendors who typically visit for shorter periods than the main workforce. The main workforce will work a 2 or 3 week rota of 12 hour days. They then have leave ashore of 2 or 3 weeks. If the rota is 2 weeks offshore, 3 weeks onshore, the pattern is more complex, but its detail does not affect this analysis.

Maintenance is planned well in advance, but there is always flexibility as to when it is carried out as there is no effort required to get to the worksite (because it is permanently staffed) and plans can be easily changed other than for maintenance that requires major outages of equipment. This is typically planed for the summer, when gas demand is lower and the weather is better (e.g. crane operations are more likely to be curtailed in winter due to high winds).

CPC-1 acts as a hub for the maintenance of the Calder, DP6, DP8 and DPPA normally unattended (NUI) installations in the Morecambe Bay area.

2.1.2 Normally Unattended Installations

Normally unattended installations are designed to be operated remotely, either from another offshore installation or from an onshore facility. The Calder, DP6, DP8 and DPPA installations are operated from the CPC-1 platform. CPC-1 also collects fluids from the DP6, DP8 and DPPA installations where they are processed before being piped onshore. The Calder platform has a dedicated pipeline to the Barrow terminal where its well fluids are processed. These fluids do not pass through the CPC-1 complex.

Normally unattended installations (NUIs) have minimal processing facilities to minimise the need for personnel to visit the installation. Typically, they have a small number of wells, each with a flowline to a common manifold to collect the fluids from each well, valving and an export riser which is connected to a subsea pipeline. Some NUIs have accommodation facilities to allow maintenance crews to stay overnight. Others have basic accommodation for use in emergencies only, which is understood to be the case for Calder. With the development of subsea technology, the function of many NUIs is now carried out by subsea wells that are tied back to a central production installation. It would not be economic to make this magnitude of change at Morecambe Bay.

Maintenance is planned in advance and is normally carried out on a campaign basis to make best use of the different trades required. This means that work is batched and carried out over a period of days or weeks. Maintenance is typically weighted towards the summer months to take advantage of longer days and better weather. Additional short duration visits may be required for minor repairs, to top up chemicals or bleed down well annuli[2] that have become pressurised. Finally, short duration visits may be required to reset equipment that has tripped and which – for safety or asset protection reasons – cannot be reset remotely. This would most commonly happen if a shutdown has been caused by the:

- Platform Emergency Shutdown System operating, which shuts down the process if the process conditions (pressure, temperature, or level in vessels) near their safe limits for whatever reason. In such an instance, an offshore visit would be required to check that restarting the platform would not result in an unsafe condition.
- Fire and Gas system, when the system determines correctly or otherwise that there is a fire, or gas release.

[2] A well anulus is the annular space between the production tubing, which carries the well fluids, and the casing that provides structural integrity to the well. If an annulus is pressurised it is because there is a problem with the well integrity – often leaking production tubing or failed packers, which themselves seal the bottom of the annular space in this case.

- Systems that ventilate an equipment volume to preventative flammable atmosphere from building up from small, operational releases through, for example, seals. Such systems are less likely to be on a NUI, but may exist for compressor turbines, which may be on CPP-1.

Further, it may be the case that safety systems such as the fans that provide the positive pressurisation of the temporary refuge (TR) to prevent gas, or smoke ingress in an emergency, or equivalent area on a NUI (which may not have a TR), cause a platform shutdown should they fail. The TR being a safe refuge to allow personnel to muster and make a decision on further action is a key safety measure and its impairment (e.g. through failed fans) is safety critical.

2.1.3 Helicopter Operations

Helicopter operations in Morecambe Bay are operated by an 8-seater AW169 helicopter based at Blackpool Airport. It is understood that the operator of the CAT helicopters has only three AW169 helicopters based at Blackpool Airport – of which Spirit has access to two. The helicopters are also understood to be shared with other oil and gas Operators in the area and only one helicopter is used for access to CPC-1 and the NUIs at any one time. The closest other CAT helicopters routinely used in servicing oil and gas operations are based on the east coast (Great Yarmouth, Humberside and Aberdeen).

A proportion of the flights are simply return flights to CPC-1 to take personnel there from Blackpool for their 2 or 3 week shift and these people may never visit the NUI. One some days no other platforms are visited.

For taking persons to the NUIs, the vast majority of the flights are from Blackpool to CPC-1 to pick up an intervention crew who board the helicopter and are flown to Calder, DPPA, DP6 and DP8 as required. The helicopter then returns to Blackpool mostly via CPC1 potentially also taking other work parties to other NUIs. In some cases, more than one work party may go to the same NUI. This pattern is flown again at the end of the day to pick up personnel from the NUIs.

The number of return flights each year on average over the period 2018-2024 visits to each NUI currently in operation is given below:

NUI	CAL	DP6	DPPA	DP8	All NUIs	Average NUI
Average Number of Days Visits Occur on per year	95	74	161	124	454	114
Average Number of Flights per year	112	100	254	174	640	160

Table 1: Average number of days per year NUI is visited

In an average year, the number of currently operating NUIs visited each day is given below.

Number of NUIs Visited	Average number of days in the year
0	64 (18%)
1	160 (44%)
2	130 (36%)
3	11 (3%)
4	0

Table 2: Average number (and percentage) of days per year currently operating NUIs are visited

This shows that if flying to a NUI is affected, it is almost equally likely to be one or two NUIs. Visiting more NUIs in the same day is less frequent, though this does change as decommissioning occurs with the NUI that is being decommissioned being frequently visited while others are visited as normal.

The time spent on the NUI can be estimated from the Vantage data and this varies over the year as shown in Figure 1.

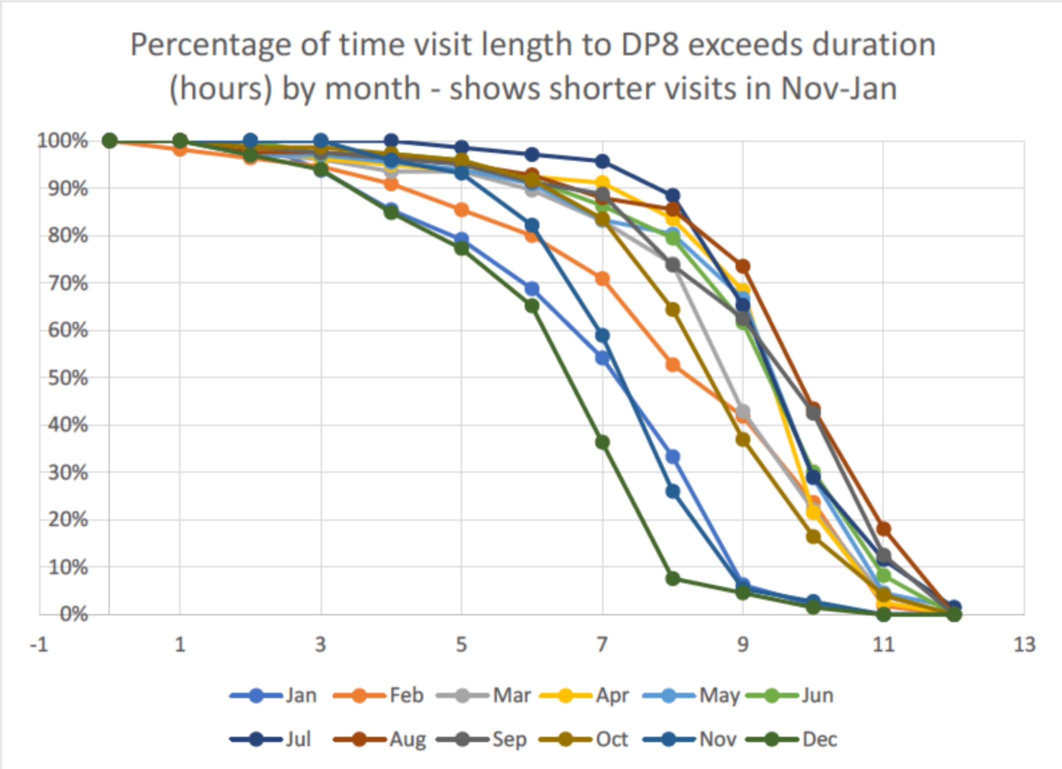

Figure 1: Percentage of visits above specified number of hours (DP8)

This data assumes that:

- Personnel leave or arrive at the NUI at the midpoint of the overall flight (from Blackpool to Blackpool); and
- Personal are at the installation the whole time between the first and last visits to the platform in a particular day (there being no overnight stays).

The data shows that visits are already dependent on hours of light available. This is further shown in Figure 2 by comparing the average visit time with available light (sunrise at sunset) at Blackpool.

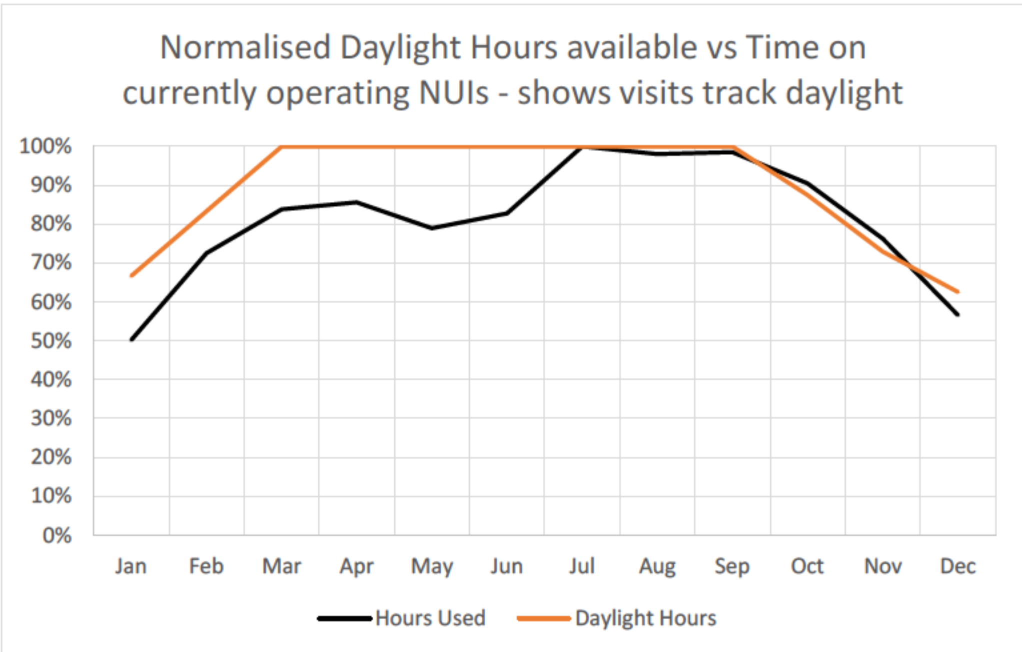

Figure 2: Average NUI visit time compared to daylight available (subject to 12 hour maximum)

There are some flights flown directly from Blackpool to DP6 and DP8 with the helicopter then returning to Blackpool. There are also instances of flights between NUIs. which may indicate a work party working on the two NUIs, each for part of the day.

There is a high degree of variability in the monthly number of visits to each NUI as shown in Appendix A.1 (noting the dip in flying during COVID) and also Appendix A.2, which shows the total risk from all flying activities in terms of the potential number of fatalities. DNV have no direct knowledge of why this is the case, it could be postulated that periods of higher manning are to do with either campaign maintenance, or small projects. It is notable that all NUIs have months in which there are a minimal number, or zero visits.

2.2 Overview of Offshore Safety Legislation

2.2.1 Regulations

Offshore safety is governed by the Health and Safety at Work etc Act 1974. The premise of the 1974 Act is that those creating the risk are responsible for managing it. Employers have a duty to ensure, so far as is reasonably practicable:

- *the health, safety and welfare at work of all his employees*
- *that persons not in his employment who may be affected thereby are not thereby exposed to risks to their health or safety*

"So far as is reasonably practicable" requires the employer to balance the benefit in risk reduction against the cost in terms of money, time and trouble.

By virtue of The Health and Safety at Work etc. Act 1974 (Application outside Great Britain) Order 2013 there are two key sets of regulations that are relevant to this report.

- The Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 (SCR 2015) /3/
- Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) Regulations 1995 (PFEER 1995) /4/

Regulations are law and compliance is mandatory. PFEER 1995 has an approved code of practice and meeting it ensures compliance with the regulations (see Section 2.2.2).

There is guidance to the safety case regulations that provides advice on legal compliance.

Safety cases must be accepted by the Competent Authority (CA) – in this case the Health and Safety Executive – prior to the introduction of hydrocarbons to an offshore installation. The case is accepted as opposed to approved by the CA. This means that the onus is on the installation dutyholder to ensure that the appropriate risk assessments have been carried out and that the case for safety is robust. The CA will assess the case but is not required to address each aspect of it in depth. SCR 2015 details:

- What is deemed to constitute a major accident.
- What must be included in a safety case.
- The process for submitting a safety case for acceptance.
- The process of revising a safety case.

PFEER 1995 addresses specific measures that must be taken to prevent fires and explosions and to ensure effective emergency response should a major accident occur. Some regulations are absolute meaning that they must be complied with to the letter. An example is Regulation 11(2) which sets out requirements for visible and audible alarms. Other regulations are subject to the concept of "as low as is reasonably practicable" where the benefit in terms of risk reduction can be weighed against the cost in terms of money, time and effort. Examples include Regulations 12 and 13 which address the survivability of equipment should a major accident occur.

The terms "so far as is reasonably practicable" and "as low as is reasonably practicable" are equivalent.

2.2.2 Approved Code of Practice

Approved Codes of Practice are approved by the Health and Safety Executive (HSE) Board with the consent of the Secretary of State. They provide practical advice on how to comply with regulations and legal compliance can be achieved by following it. However, an ACOP has a special legal status. If a dutyholder is prosecuted for an alleged breach of health and safety law and it was proven that the ACOP was not complied with, then the onus is on the defendant to prove that he has complied with the law in some other way. The burden of proof is the balance of probabilities.

2.2.3 Guidance

Guidance is issued by the Competent Authority and also by various industry bodies. Compliance with guidance – whether provided by the regulator or the industry – is not mandatory. However, meeting guidance is generally Good Practice and this is the first test of whether a risk is ALARP.

2.2.4 Enforcement Notices

Under the HSW Act 1974, breaches of law may be remedied through the issue of enforcement notices of which there are two types:

- Improvement notices may be served under s21 of the act if an HSE inspector is of the opinion that the dutyholder is contravening one or more of the relevant statutory provisions. Such a notice will require the dutyholder to remedy the deficiency within a timescale set by the inspector.
- Prohibition notices may be served under s22 of the act if an HSE inspector is of the opinion that the dutyholder is carrying out, or may out activities that could result in serious personal injury. Such a notice requires that the activity in question be stopped immediately and that the deficiencies be remedied within a timescale set by the inspector. The activity may not be restarted until the deficiencies have been remedied.

In the last 5 years in the offshore oil and gas industry:

- There have been 20 improvement notices issued on failings related to maintenance. Of these:
  - 6 have been served on ineffective management of a maintenance backlog
  - 13 have been served on specific maintenance issues as opposed to failing with the overall maintenance management system.
- There has been one prohibition notice served for a specific issue related to blocked deluge heads on a firewater system. For the avoidance of all doubt, it was not served on an issue related to maintenance backlog, but inadequate maintenance of the firewater system.

Improvement notices may be issued to require that dutyholders remedy systems that are not working effectively. Thus, they may be issued to address systemic issues within a dutyholder's management systems.

Prohibition notices can only be served where, in the opinion of the HSE inspector concerned, there is a risk of serious personal injury. That is a test that would be difficult to achieve if the issue was the failure of a management system – for instance a failing maintenance system evidenced by a rising backlog in safety critical maintenance. Such an issue would be remedied with an improvement notice. The use of prohibition notices is generally reserved for equipment specific issues such as failings on a firewater system or a lifeboat that is in a state of disrepair.

3 POTENTIAL EFFECT ON INSTALLATION RISK LEVELS DUE TO INCREASED HELICOPTER FLIGHTS

3.1 Individual Risk per Annum

History has shown that offshore oil and gas operations can be dangerous and the volumes of flammable material on any offshore installation mean that the offshore oil and gas industry is a “high hazard industry”. Like any worksite, there is the possibility of occupational accidents e.g. slips and trips, but there is also the possibility of a gas release that if ignited could have very serious consequences. For this reason, it is required to determine the risk to person working on the installation and compare the risk tolerance criteria described in Section 3.3.

This is done through calculation of the individual risk per annum (IRPA), which is the statistical probability of a person being killed as a result of work activities in any given year. Different group of workers e.g. production operators, technicians, domestic staff are subject to different risk levels due to the nature of their work activities. It is therefore standard practice to calculate the IRPA for each group of workers on an offshore installation. Worker groups are generally split into production operators, maintenance technicians, catering/office staff, deck crew and construction staff.

3.2 Contributions to IRPA

IRPA is typically assessed by the different hazards that people are exposed to. The risk associated with these categories is calculated separately and then summed up to give the total IRPA. This is done separately for each worker group.

The different hazards at, which are relatively common across the industry, are:

- Fire and explosion
- Helicopter transport – typically calculated for take-off/landing and cruise flight then added together
- Ship collision
- Structural failure
- Occupational – every day risks slips trips and falls type risks to which workers could be exposed.

3.3 Risk Tolerance Criteria

Once risk has been calculated, it must be compared to risk tolerability criteria to determine if the risk is tolerable or not. In the UK, the HSE document Reducing Risks, Protecting People /5/ sets out the accepted risk tolerance criteria. For IRPA, the upper bound of tolerability is a risk of fatality to an individual of 10^{-3} or one in one thousand per year. Any risks above this level would need to be mitigated irrespective of the cost.

If a risk is considered to be tolerable then, it needs to be as low as is reasonably practicable (ALARP). This means implementing all risk reduction measures that are reasonably practicable. A risk reduction measure is reasonably practicable if it is required to meet Good Practice, or the benefit it provides in terms of risk reduction is not grossly disproportionate to its cost in terms of time, money and effort /5/.

In determining tolerability, risk is considered in its entirety and not by the individual risk categories detailed in section 5.2 of this report.

3.4 Representative Installation Risk Levels

Table 3 provides representative examples of IRPA for production technicians on a range of UKCS oil and gas installations. The data has been taken from the relevant safety cases and the installations have been anonymised. There is significant variation in risks, many of which are due to the assessment technique used, but it generally shows the overall proportion of risk from helicopter transportation. This data has been used because Spirit have not provided the risk figures that will be stated in their safety case. The NUIS are manned some of the time, which is different situation to Morecambe and the flight risk at Morecambe may be slightly higher due to the increased number of flights, but conversely lower due to its proximity to the heliport. However, overall the figures are representative.

Installation	A	B	C	D	E	F	G	H	Average Across All Installations
Installation Type	Manned	Manned	Manned	Manned	Manned	Partially manned	NUI	NUI	
Well fluid type	Gas	Heavy oil	Oil/Gas	Oil/Gas	Gas condensate	Gas condensate	Gas condensate	Oil/Gas	
Fire/Explosion	4.99E-05	9.95E-05	1.62E-04	3.19E-05	1.72E-05	6.62E-05	1.70E-05	6.23E-05	6.33E-05
Helicopter Transport	3.40E-05	1.77E-05	2.90E-05	2.51E-05	4.07E-05	5.70E-05	6.41E-05	4.30E-05	3.88E-05
Ship Collision	1.00E-05	1.44E-05	1.00E-05	2.92E-06	1.10E-06	1.14E-04	8.80E-06	1.10E-05	2.15E-05
Structural Failure	4.50E-07	0.00E+00	1.60E-05	4.33E-05	1.28E-05	1.80E-05	1.51E-05	1.70E-06	1.34E-05
Occupational	1.20E-05	9.01E-05	1.30E-05	1.30E-05	8.11E-05	2.05E-05	5.10E-05	1.20E-05	3.66E-05
Total	**1.06E-04**	**2.22E-04**	**2.30E-04**	**1.16E-04**	**1.53E-04**	**2.76E-04**	**1.56E-04**	**1.30E-04**	1.74E-04
% Risk from helicopter transport	**32.0%**	**8.0%**	**12.6%**	**21.6%**	**26.6%**	**20.7%**	**41.1%**	**33.1%**	**24.5%**

Table 3: IRPA Levels for a Series of Representative Offshore Installations

The risk of helicopter transportation is proportional to the time flying plus the number of take-off and landings and for a short flight the take-off and landing element dominates the risk. For the short flight between Blackpool and CPC-1 and even more so between CPC-1 and the NUIs, the risk is dominated by the take-off and landings as the flight time is very short.

For someone working on CPC-1 on a standard offshore rota, the helicopter transportation risk would be less than an average North Sea worker due to the short flight time. For someone regularly going to the NUIs, the risk would be higher due to the number of take-offs and landings.

For the affected assets, the risk on the NUIs is unlikely to be reported separately in the safety case. It is normal that the safety case covers the whole operation over multiple platforms.

3.5 Effect of Morecambe Offshore Wind Farm

3.5.1 Current Risk of Helicopter Operations

The current helicopter transportation risk to people who visit the NUIs can be estimated from the flight data, though the number of up to 8-man helicopter passenger groups (termed NUI work parties here for convenience) that this is spread over is not known to DNV and is estimated.

The number of NUI work parties is at least 3 as there are times when there are this many helicopter trips to a NUI in a morning and later in the day to pick-up. There are also back-to-backs who are on the leave part of their rota ashore. Different workscopes will also need different skill sets and so taking these factors together, 10 NUI work parties is estimated. This means that each person takes a tenth of the total yearly number of flights between CPC-1 and the NUIs.

Those people will also take ~10 return trips between Blackpool and CPC-1 each year for the normal crew change, though this is a smaller contributor to helicopter risk due to the short flight time.

From historical data (see section 3.5.2), each short flight to a NUI is calculated to give a risk of 9.2×10^{-7} per flight. There have been no fatal helicopter crashes in UK offshore operations for over 10 years and crashes most recently outside this window occurred in poor weather, in which it is less likely that the Morecambe Bay helicopters would be flying. Furthermore, monitoring of mechanical issues in helicopters in operation has improved since then. Therefore, this is a conservative figure.

With 640 flights per year (see Table 1), each person who visits a NUI takes 64 flights per year, a risk of 5.9×10^{-5} per year. The Blackpool element adds 1.4×10^{-6} and so the total transportation risk is 7.3×10^{-5} per year. This is slightly above any of the numbers in Table 3 because of the large number of take-off and landings from visiting the NUIs. This difference may also be affected by using the most recent helicopter transportation data in this report, which has no recent events and so just improves (lower number).

For the crew of CPC-1 who work only on CPC-1 and do not visit the NUIs, there will be no change in their transportation risk as their flights will only be delayed and rearranged - they will not be subject to additional flights.

3.5.2 How Helicopter Risk was Calculated

DNV used a data set containing flight hours and number of flights for UK offshore helicopter operations. The number of fatal accidents is known and therefore the risk per flight hour (for cruise flight) and per take-off and landing is known. Hence the additional individual risk per flight was calculated.

It is important to use the most representative dataset for any risk assessment. For the assessment of helicopter risk, DNV has used a dataset of UK offshore helicopter flights over the last 22 years. This is the most representative dataset available as it is based on UK operations only and hence takes into account the nature of said operations and the types of helicopter used in the UK. DNV notes that there have not been any fatal helicopter incidents in the last 10 years. This is simply a statement of fact and does not imply that such incidents might not occur in the future.

A number of previous incidents in the UK had root causes related to human factors and also to the aircraft type used: AS332L Mark 2 and EC225. These helicopter types are no longer used and aircraft condition monitoring – most notably in the area of vibration analysis – has improved significantly in the last 10 years. The human factors issues have been addressed by stabilised approaches, use of autopilots, improved training and the CAA mandate that Helicopter Terrain Awareness and Warning Systems (HTAWS) be used. HTAWS identifies low energy situations which are often a marker for an unstable approach. It is therefore reasonable to conclude that helicopter transportation risks have reduced.

3.5.3 Additional Flights

If a flight is delayed because of weather, there is no change in risk as there is no change to the number of flights. This is irrespective of whether the flight was cancelled because of weather in which flying was not possible either before or after the MOWF is installed. It is normal to plan for weather many days in advance so that if it is likely that a flight cannot occur, appropriate plans are made.

If work is urgent for whatever reason, there is a possibility that with reduced flying hours, two visits to a NUI are required for a workscope rather than one, though the working time analysis shows that this is not the case for maintenance. This in itself would create issues as the workscope would have to be left overnight in a safe condition. In this case and also now, it is preferable for the Operator to arrange for the work to be done in as a few a number of shifts as possible.

Analysis of Vantage data (see Figure 1) shows that the time spent on each NUI is highly variable day-to-day and over longer timescales (an exact analysis cannot be carried out as the purpose of each flight is unknown). This shows that Spirit's normal business is to be flexible. Within this, there is a clear pattern that summer visits are longer whereas winter visits are shorter (see Figure 1 and Figure 2). Shorter visits would have to occur in the winter due to the VMC requirement, but this is already largely the case as demonstrated by the Vantage data.

Analysis of the Vantage data shows that the vast majority of visits to a NUI are executed through single return flight from CPC-1 to a NUI. Less than 10% of helicopter flights take a route between two NUIs (for example taking a maintenance crew from a workscope on one NUI to another workscope on another NUI immediately after). A very small number of flights have a more complex routing. This means that the conservative approach to considering an extra flight is appropriate i.e. rather than an additional flight amongst a complex and higher risk routing with a large number of flights between NUIs, what was going to be a single return flight to a NUI becomes two return flights to the same NUI over 2 days i.e. the flight risk to do that workscope is doubled. An extra flight just due to reduced daylight is less likely: reduced hours on the NUIs is already in the Spirit planning and there is significant variation in the time spent on them across the year. If this time is further reduced due to weather, there is the possibility of an extra visit (and hence flight) being required.

As above, using historical UK data on fatal helicopter crashes, the additional individual risk from a short return flight is ~ $9.2x10^{-7}$.

3.5.4 Risk Impact

3.5.4.1 Tolerability

Assuming conservatively from Table 3 that the risk from all hazards to a worker who visits the NUIs is $3x10^{-4}$ per year, a figure just above all the risk values quoted, the additional flight risk for the overall risk to be intolerable is $7x10^{-4}$ per year.

Thus, the tolerability limit would only be threatened if an individual took an extra $7x10^{-4}$ / $9.2x10^{-7}$ = 764 return flights in a year. This is not possible and so the tolerability limits cannot be threatened by any additional restrictions caused by the MOWF.

3.5.4.2 Materiality

For the increase in the number of flights to have a material impact on the risk, an average individual would have to take maybe the same number of flights again that they already take i.e. 64. The word "maybe" is used as there is no quantitative test of materiality of a risk change. Neither aviation analysis suggests this level of impact to all workers and flights.

Further to this, as given in Table 1, on average over the last seven years for the currently operating NUIs, 454 visits are made i.e. a little over one per day (this varies between zero and four and may include more than one visit to the same NUI i.e. a work party larger than 8 people). Considering this variable flight pattern and the ability of the Operator to successfully plan for such variability, it is not considered credible that any change could be considered material.

Further to the above, the overall month-to-month pattern of flying is highly variable, with some NUIs not visited in a particular month whereas in other months, they may be visited for 20 or more days (see Appendices A.1 and A.2). Thus, the variability in helicopter usage (and hence risk) is far greater than the occasional additional flight.

Therefore, it is considered that even using conservative, industry helicopter failure data, the additional risk presented by the occasional additional flight is not material and falls far short of any potential impact on risk tolerability.

Further discussion of materiality is given in Sections 3.6 and 6.

3.6 Conclusion

It is concluded that due to the proximity of the proposed windfarm, an increase in the number of helicopter flights will not result in a material increase in transportation risk to the personnel on board the affected assets. Furthermore, the overall risk levels are dependent on a number of factors, of which helicopter transport is only one, which further minimises the overall magnitude of the change.

Furthermore, the dutyholder of the affected assets is already taking all reasonable steps to reduce risks to ALARP – including transportation risk. This is evidenced by the fact that they have accepted safety cases. There are no further steps that the dutyholder will need to take as a result of the proposed windfarm. There is a change to environmental conditions in which a flight can occur, but this is a not a material change as the basis on which the safety case has been acceptance does not change and the risks on the affected assets will remain ALARP.

4 EFFECT ON SAFETY CRITICAL MAINTENANCE

4.1 Definition of Safety Critical Maintenance

Regulation 2 of The Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 /3/ defines a Safety and Environmental Critical Element (SECE) as follows:

“safety and environmental-critical elements” means such parts of an installation and such of its plant (including computer programmes), or any part of those –

(a) the failure of which could cause or contribute substantially to a major accident; or

(b) a purpose of which is to prevent, or limit the effect of, a major accident.

Safety critical maintenance is defined as any form of maintenance carried out on a SECE.

4.2 Examples of Safety and Environmental Critical Elements (SECEs)

The objective of some SECEs is to prevent a major accident occurring. Examples include:

- Hydrocarbon containment – pipework and vessels
- Primary structure – the jacket or hull of the installation
- Lifting equipment
- Electrical equipment that is designed to be used in a potentially flammable atmosphere – known as Ex equipment.

Other SECEs are designed to detect or mitigate an accident once it has occurred. Examples include:

- The firewater system (only CPC-1 has a fire water system, the NUIs do not)
- Emergency shutdown systems
- Fire and gas detection systems
- Lifeboats.

Some SECEs have in-built redundancy to ensure that they are sufficiently reliable – see Section 4.4.2 for examples.

4.3 Offshore Working Time

In terms of working at the NUIs, the number of offshore hours that can be executed there is key to ensuring continued production and appropriate maintenance and key to this is being able to get there. Any effect of helicopter transportation restrictions can be judged using past, historical data to compare the actual number of offshore working hours to any changes.

This section describes the actual hours, plus the methodology to determine whether this is impacted by transportation restrictions. The base case is for no IMC (with day VMC allowed), thus covering the IMC conclusions of both Anatec /1/and AviateQ /2/ and so being independent on these analyses. A case is also run for the access corridor. Data used is the Vantage data plus the Anatec analysis of the flying conditions (VMC day, VMC night, IMC, or no flying) every 10 minutes over the period 2018-2022. There is no VMC Night and IMC access in the base case.

4.3.1 Actual Hours

Actual hours have been calculated based on the difference between the first and last flights landing at a NUI in any particular day. For each flight, its midpoint time-wise is taken as the time personnel arrived or left the NUI. This will not exactly be the case, but as the flight times are relatively short it will be reasonably accurate and an underestimate of time spent at the platform, say, at the start of the day, is likely to be countered by an overestimate at the end.

There are some single flights to NUIs (no return leg) – these have been ignored as persons never stay overnight and are more likely to be data errors.

The working time has been split into two categories:

- Maintenance – if the visit if >4 hours
- Production – if the visit is <4 hours

Maintenance visits are planned in advance and will generally be a whole day's work whereas production visits may be simple troubleshooting, or other matters that take less time. This distinction is made as it is easier to move a 4 hour shift during a day with non-flyable weather than a longer shift. This analysis is concerned with maintenance visits.

4.3.2 Predicted Hours with Helicopter Restrictions

4.3.2.1 Methodology

The methodology to predict any change in working hours caused by helicopter restrictions is straightforward and consists of two parts.

Flying – Determine using the weather data and availability of Blackpool airport whether flying is possible in VMC or IMC conditions in 10 minute time steps over the period 2018-2022.

Visit – If there was a flight to the NUI in question, it is determined whether that flight would have been affected by a change in flying restrictions.

Delay – If the flight would have been affected, the delay until the flight can go ahead under the applied restrictions is calculated; if the delay is so large that it would be impossible to spend a minimum acceptable amount of time on the platform, or if restrictions make no flight window possible whilst Blackpool is open, the day is considered lost.

Available – The analysis finally considers the possibility of gaining additional time by leaving the NUI during the latest available flyable window. For example, a flight that returned at 16:00 but that could have returned at 18:00 would contribute 2 hours to the total recoverable time.

All of the above is subject to:

Working Type: Of the two visit types (production < 4 hrs, maintenance > 4hrs), just the maintenance type is analysed.

Minimum Maintenance Visit: A minimum visit period of 7 hours is used as this has been used as Spirit. Some shorter visits may be productive, but this has not been considered.

Maximum Visit: To calculate the total recoverable time, a maximum visit time of 10 hours is assumed so that people can carry out their whole work schedule within a 12 hour shift. Where an offshore visit has been calculated as having been longer than ten hours, its original length has been taken as the maximum acceptable visit time for the analysis, but no shift is extended beyond 12 hours when it was previously shorter than this.

For the key aspect of whether it is possible to fly, two different types of flight are considered:

- VMC in the day: Where the following needs to be true for a flight to occur:
  - VMC flying conditions
  - Sea conditions to allow rescue of personnel in an emergency
  - Blackpool airport open (between 07:00 and 20:45)
- IMC and flying at night: Where the following needs to be true for a flight to occur:
  - IMC flying conditions
  - Sea conditions to allow rescue of personnel in an emergency
  - Blackpool airport open (between 07:00 and 20:45)
  - Wind direction between (and including) 220 and 300, or 010 and 090, which models the corridor being in place. The analysis is also run for no night or IMC flying.

The analysis of the weather to determine if the two flying modes are possible has been carried out by Anatec.

No consideration is made of days in which it is possible to fly, but no NUIs have been visited. Additional flights to the NUIs on these days would provide more offshore hours.

Blackpool airport is not subject to IMC restrictions, but in the analysis the same restrictions as per offshore are applied for conservatism and ease of analysis. Thus, there may be a flight that could not operate because the weather when it landed at Blackpool did not allow IMC whereas it could have landed. This approach is conservative, but expected to have a minimal impact on the results.

The provided weather data required a small amount of cleaning and processing: some 10-minute time steps weren't represented in the data set, and others were missing key data (e.g. visibility Generally, the time periods with missing / incomplete data were short and the adjacent weather could be considered representative.

4.3.2.2 Results

The results of the analysis are given below for maintenance, then production. The values for days lost are conservative: it has been assumed that a visit to a platform is untenable if the time spent offshore is less than seven hours, and this minimum-time restriction constitutes the predominant contribution to days lost in each instance in Table 4.

Maintenance Analysis (> 4hrs) for period 2018-2022					
Parameter / NUI		DP6	DP8	Calder	DPPA
Actual (no VMC, or IMC restrictions)	Working Hours	2766	3924	4065	7055
	Days Visited	324	450	457	780
VMC Day and some IMC / Night VMC (corridor)	Working Hours Lost	36	69	80	79
	Days Lost	3	7	6	10
	Working Hours recoverable	426	501	427	614
VMC Day only (no corridor)	Working Hours Lost	55	100	120	111
	Days Lost	5	7	9	12
	Working Hours recoverable	419	500	415	616

Table 4: Results of the working time offshore analysis for maintenance work

The results show that without the corridor, the hours lost, without considering any that may be recoverable by longer stays represent 1.5 – 3% of the total working hours. With the corridor, this figure drops to 1-2%. Both figures are low are dwarfed by the recoverable hours of ~10% that are available from longer stays on the NUI when this is possible.

The fact that the impact is so small and that the Operator used to operate an additional 2 NUIs means that no maintenance impact is likely over the long term. Individual visit may be impacted and these scenarios are considered in Section 4.4. The Operator needs to be aware of the weather, but this is already the case.

If any days were lost they could also be made up by assigning an addition NUI team and flying to an additional NUI in better weather.

4.4 Possible Maintenance Impact

4.4.1 Planned Safety Critical Maintenance

Preventative maintenance of SECEs to test their operation and prevent future failure is typically scheduled to occur every 6, 12 months, or on a longer frequency. Thus, for any item of equipment, it is known years in advance what maintenance will be carried out on it. Specific planning when layout and materials to carry out the work are considered is generally planned at least a number of months in advance (maybe a 90 day plan) and longer than this for more critical items. The purpose of the maintenance is to ensure that equipment remains fit for purpose and will operate properly when it is required to do so.

Maintenance intervals are set conservatively. This, together with equipment redundancy, ensures that delays to safety critical maintenance will minimally increase on risk. Furthermore, much preventative maintenance consists of inspection and testing – it does not necessarily involve changing components.

Typical maintenance intervals are:

- Inspection of lifeboats: 6 or 12 monthly with some parts 24 months.
- Fire pump maintenance: 6 monthly.
- Testing of fire and gas systems and emergency shutdown systems: 12 monthly.
- Testing of emergency shutdown valves: 12 monthly.
- Inspection of electrical equipment for use in potentially flammable atmospheres: 24 or 36 monthly.
- Inspection of vessels and pipework: 5 yearly.

Planned maintenance is carried out by the installation core crew with support from specialist vendors. Specialist vendors are typically used tasks such as crane maintenance, lifeboat maintenance and temporary refuge pressure testing i.e. tasks where specialist skills and equipment are required. These are carried out on longer frequencies typically annually or longer.

For a permanently staffed installation such as the CPC-1 complex, delays in helicopter flights will not have a material impact on maintenance tasks as the crew will already be on the installation. For NUIs there may be delays to maintenance if a planned flight now cannot go-ahead, or a visit is reduced in length because of the windfarm.

4.4.2 Safety Critical Breakdown Maintenance

Breakdown maintenance is carried out on demand. Equipment is designed to be fail-safe such that its failure does not lead to a dangerous situation and its resolution is not necessarily a safety issue, though this may require some degree of shutdown. There are few safety system failures that would directly give a shutdown. Possible causes are real demands on or failures in the fire and gas system; the ability of deluge system to maintain pressure; process parameters nearing unacceptable limits or the failure of instrument air.

In some cases, and more so on larger manned platforms such as CPC-1, equipment redundancy ensures that a failure does not result in a platform shutdown and by implication, not a significant change in risk. For example:

- For all assets (NUIs and CPP-1):
    - Fire and gas systems have sufficient detectors such that several detectors will cover one area. Hence the failure of one detector does not affect the system's ability to detect a gas release or fire.
- For the CPC manned installation (which has more safety systems than a NUI, which may not have, for example, deluge):
    - There is generally more than one fire pump, and each fire pump is normally capable of meeting the entire firewater system demand.
    - PFEER 1995 Regulation 15 requires that there is sufficient lifeboat capacity for 150% of the maximum complement of the installation. The intent of the law is that there is a lifeboat seat for each person on board with the largest lifeboat out of service.

Where there is no redundancy and a safety critical system fails, the Operational Risk Assessment (ORA) that is carried out typically by experienced persons offshore and onshore, may conclude that the resultant risk needs to be removed and the only way to do this may be to shutdown. So, if there is a single firepump on a NUI and it fails, the NUI would likely to be shutdown before any person visits it, thus the risk is mitigated albeit at the cost of lost production. Shutting down the NUI before any visits is an asset protection measure as no persons would be at risk before the visit. A failed firewater pump on CPC-1 is more likely to just represent a loss of redundancy and slightly altered operations until it is repaired e.g. starting a firepump when flying is occurring to ensure that a pump works during the higher risk activity of landing, or take-off.

4.4.3 Impact of Specific Postponed Maintenance

If specific preventative maintenance of safety and environmental critical equipment (SECE) is planned for a particular day on a NUI and this cannot occur, there is no immediate risk as the maintenance can simply be done on another day. There is no maintenance that is critical to the day, week, or even month or more. Postponement of a flight on a particular day has no significant risk impact with regard to preventative maintenance of SECEs.

Maintenance on CPC-1 can continue as planned unless specialist vendors are required to be flown from Blackpool, but the same conclusion applies in this case.

If the visit is for corrective maintenance of a SECE, it is already implied that the risk is manageable otherwise the risk would have been removed by, for example, shutdown or restriction of production. On this basis, a short delay to the corrective is not significant and, if the delay is longer, risk removal needs to be considered.

Overall, postponement of a maintenance visit does not create a significant safety risk and whether this is the case over many maintenance visits is examined below.

4.4.4 Impact Analysis

While there is minimal impact of the postponement of a single visit, this would not be the case if this time could not be recovered as the maintenance backlog would carry on growing until significant failures started to occur offshore.

However, while DNV does not have access to maintenance information from Spirit, it is considered that any lost time could be recovered as:

- Analysis of the lost "offshore NUI time" from the windfarm (for no restrictions in VMC and flying in IMC in only wind directions 220-300 and 010-090) shows that 1-2% of time is lost, but ~10% can be made up either by longer days. Additional time is available from flying to the NUIs on days where either no flying was undertaken or only crew change flight to Blackpool.
- In 2018 Spirit operated 6 NUIs (current 4 plus DP3 and DP4) with a single helicopter, though Vantage shows a small number of days where crew change to Blackpool may have used 2 helicopters. Spirit now operates 4 NUIs, so the flight programme compared to 2018 has 50% additional capacity, which is more than enough to cover any loss of flights caused by the MOWF. Two helicopters are mentioned below as a further mitigation measure.
- There is very significant normal variation in visits to a NUI from no visits in a given month to almost every day. The change in helicopter access adds to this variation but does not materially change it.

Further to this, a slight change to the way in which Spirit operates would eliminate any impact of postponed flights.

- If Spirit were to assign an additional maintenance crew to "catch-up" NUI work, if a visit to a NUI was not possible on a particular day, it could be carried out by the "catch-up team" on another day in tandem with maintenance on a different NUI. While the number of additional days when flying can occur may be limited (though probably not critically), there are an abundance of days that an additional NUI could be visited. This would have the effect of allowing maintenance to occur almost unchanged from now and reducing individual risk to the NUI crews as the transportation risk would be spread out amongst more people.

Additionally, Spirit has stated (meeting of 13th February), that there would be some tapering of maintenance towards CoP (which is by 2029 for all assets), which would reduce the maintenance load.

Other more significant changes are possible to remove the impact of cancelled flights such as use of:

  - A larger helicopter.
  - Two helicopters in the summer.
  - Campaign maintenance potentially using a flotel, or W2W vessel (which may require a material change to the safety case if not already in it – such a change is a relatively common occurrence).

4.5 Verification Activities

Regulation 9 of the 2015 Safety Case Regulations requires that a verification scheme is established to ensure that the Safety and Environmental Critical Elements (SECEs) are suitable for purpose by design and that they remain suitable for purpose through maintenance. Verification is a formal process that is governed by a written scheme of verification. Verification activities are carried out by an Independent Competent Person (ICP) and involves reviewing maintenance records, witnessing maintenance activities and carrying out functional testing of SECEs.

Maintenance is carried out by the installation dutyholder who will also carry out assurance activities – in the form of inspection, testing and audit – to ensure that the maintenance activities are effective in controlling risk. Verification is an independent check that maintenance and assurance is being carried out effectively by the installation dutyholder. It is effectively a third line of defence. Any delays caused to verification activities will not result in additional risk because verification activities are an additional check and do not themselves involve any form of preventative or corrective maintenance. Verification activities are important, but not urgent, as they are an independent check on a (Spirit) system to ensure that SECEs are operated that should be fully functional and operational. They can be rescheduled – to an earlier or later date – without creating any safety risk.

4.6 Conclusion

From the analysis of offshore working time, the impact of additional flight restrictions is minimal over the course of a year.

Changes to a single, or small number of maintenance visits does not create a safety issue. A safety issue only arises when maintenance backlog continues to rise without any means of reducing it. However, this is not considered to be the case for Spirit as, from the offshore working time analysis, additional time is available to “catch-up”. Furthermore, a simple change to provide an additional crew who could visit NUIs, who would normally work on CPC-1 would eliminate any impact.

5 EVACUATION OF INSTALLATIONS IN AN EMERGENCY

5.1 Legal Definitions

Regulation 2 of The Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) Regulations 1995 (PFEER 1995) /4/ defines two means of abandoning an offshore installation in an emergency.

- Evacuation is defined as a planned and controlled means of leaving the installation that does not involve directly entering the sea. This would normally be done by helicopter or lifeboat.
- Escape is defined as the process of leaving the installation in an emergency when the evacuation system has failed. This may involve directly entering the sea.

Although PFEER 1995 requires a means of evacuation to be provided, it does not specify the means of evacuation.

5.2 Preferred Means of Evacuation

The preferred means of evacuation from an offshore installation is by helicopter. This is in accordance with the ACOP to Regulation 15 of PFEER 1995 (paragraph 204).

If helicopter evacuation is possible when this will most likely be by SAR helicopter for the following reasons:

- The CAT helicopters available have very limited capacity (max 8 passengers). Evacuating the entire crew complement would therefore take more than 18 hours. Therefore, CAT helicopters would only be useful in a very slowly developing emergency.
- The Operations Manual of a commercial air transport (CAT) helicopters operator will forbid an approach to a platform which has an ongoing event e.g. unignited gas release or fire.

Therefore, any helicopter evacuation will be by SAR helicopter. These are based at Prestwick, and Caernarfon. The current S92 in Carnarvon will be able to carry about 30 and the AW189 from Prestwick >15. SAR support from Dublin is also possible, with passengers sitting on the floor during transit. Passengers will be taken to a place of safety. This is defined in the guidance to Regulation 15 of PFEER as a location with facilities for medical treatment and the care of survivors. This would most likely be an onshore location, a vessel or a manned offshore installation. Non attended installations are not places of safety, thus evacuees could not legally be taken to such a location.

In the event of the main CPC-1 helideck being impaired, there is a second helideck on the furthest bridge linked platform. However, this is limited to day VFR only and is closed when the wind is from 270-340º and the windspeed is >=20kt. Thus, it cannot be relied upon in an emergency.

The CPC-1 installation consists of three platform linked together by bridges. The accommodation platform is separate to the wellhead and hydrocarbon processing areas. It is therefore possible that the crew may be able to sit out the event then evacuate once it is over. In this instance, evacuation by CAT helicopter might be possible, although this would take over 18 hours. If the weather was unsuitable for CAT helicopters then SAR helicopters would be used as described above. The NUIs have no such facilities and it is likely that evacuation would use SAR helicopters.

If helicopter evacuation is not practical, then lifeboats will be used. Although helicopter evacuation is the preferred means, it is likely to be slow – helicopters have a limited capacity and there is only one shared helicopter (with 8 seats) available at Blackpool. Furthermore, the nature of the emergency may make the use of helicopters impractical. In the case of a fire, helicopter evacuation may be impractical because:

- Smoke or flame may obscure the helideck making an approach impossible.
- The heat of a fire will reduce air density and reduce the helicopter's performance, most likely below a safe level.
- Smoke ingestion may result in engine failure.

In the event of an errant vessel – defined as a passing vessel as opposed to an attendant one – colliding with the installation it is unlikely that there will be sufficient helicopter capacity available to evacuate the entire crew of the installation in a timely manner.

Thus, lifeboats are likely to be used as they can evacuate the entire crew within an hour from initial identification of the emergency and far less than this on a NUI. The operation of a lifeboat is not affected by the MOWF Project.

5.2.1 Previous Offshore Emergencies

Table 1, below, lists a number of offshore emergencies and the means of evacuation used. This illustrates the point that evacuation by helicopter cannot be relied on, though it is acknowledged that it is more likely to be possible for CPC-1 where the temporary refuge is on a separate bridge-linked platform. Of the installations below, Bombay High, Rough and Elgin Franklin are bridge linked.

Year	Installation	Nature of Emergency	Means of Evacuation Used	Additional Information
1988	Piper A /6/	Hydrocarbon release, fire and explosion	Uncontrolled	Impairment of helideck by fire and smoke
1988	Ocean Odyssey /7/	Blowout	Controlled - lifeboats	Impairment of helideck by fire and smoke
2005	Bombay High /8/	Attendant vessel collided with riser causing fire	Uncontrolled - two of eight lifeboats launched	Impairment of helideck by fire and smoke
2006	Rough 47/3B	Catastrophic failure of gas cooler followed by gas release and fire	Combined lifeboat and helicopter	Helicopters not deployed until fire was out. Bridge linked platforms with accommodation and processing facilities on separate platforms.
2010	Deepwater Horizon /9/	Blowout	Controlled - lifeboats	Impairment of helideck by fire and smoke
2012	Elgin Frankin	Unignited release from well on bridge linked platform	Combination of SAR and CAT helicopters	During the evacuation of non-essential personnel from Elgin-Franklin, the full extent of the gas release was not known and the helicopter operator was probably not given the full facts. Had the facts been known then a helicopter evacuation would not have been practical. A 2nm/2000ft no-fly zone put was in place around the platform for weeks until the leak was plugged.

5.3 Role of Emergency Response and Rescue Vessel (ERRV)

Each installation has a ERRV attending it. The ERRV provides a number of safety related functions, namely:

- Recovery of personnel in the event of evacuation, escape or persons falling overboard.
- The recue of personnel from a helicopter ditching in the vicinity of the installation.
- Acting as a place of safety for the above, including the provision of medical facilities and for the care of survivors.
- Mitigating the threat from passing vessels that present a collision risk to the installation.

The function of the ERRV is not affected by the MOWF Project.

5.4 Evacuation in the Event of Injury or Illness

The evacuation of personnel in the event of injury or illness will normally be by SAR helicopter for the following reasons:

- SAR helicopters are permanently equipped with stretcher access. A CAT helicopter would have to have its seats removed to allow a stretcher to be secured aboard– something that is time-consuming to achieve.
- SAR helicopters are staffed with paramedics. CAT helicopters are not.
- SAR helicopters may fly in weather that CAT helicopters will not fly in.
- Specific risk assessments are required for a “medically incapacitated passenger” defined as a person who is unable to wear the required survival equipment, including life jackets, survival suits and emergency breathing systems (EBSs), as determined by a medical professional /10/. This is not a quick process and an SAR helicopter will be required for any such person.

CPC-1 will have a trained medic aboard able to deal with more minor ailments and illness reducing the demand on any emergency SAR requirement.

5.5 Precautionary Downmanning

Precautionary downmanning is common practice when a non-emergency situation makes it desirable to reduce the platform crew to the minimum required for safety operations. An example may be an issue with the potable water system, or galley. Non-essential personnel will be transported onshore at the first convenient opportunity. However, as this is not an immediate emergency, the normal helicopter operator is used and so for CPC-1, this process would take days and thus only slightly affected by any flying restrictions. Downmanning of a NUI is not relevant as they are only ever manned with one or two crews.

It must be emphasised that precautionary evacuation takes place in non-emergency situations. Thus, in such an instance, the presence of a windfarm and any slight delays will not create a problem for emergency response as no emergency exists.

5.6 Conclusion

Previous incidents have shown that evacuation by helicopter from an offshore platform is unlikely and evacuation by lifeboat is a far more likely scenario. Furthermore, in the Morecambe Bay fields, evacuation by CAT helicopter is unlikely due to the limited capacity of the helicopter (the AW169 has only 8 seats). Even if helicopters are used, it is more likely that it will be an SAR helicopter which is not subject to the same weather restrictions as a CAT helicopter /11/ and has greater capacity. The windfarm will comply with MGN654 /12/ therefore SAR operations will be possible. Finally, if the weather is below VFR minima it is unlikely that helicopters will be a viable means of evacuation anyway – even if there is no windfarm in the vicinity. Consequently, it is concluded that the proposed windfarm will not have any impact on emergency response from offshore installations.

The CPC-1 installation has three bridge linked platforms, making it likely that the crew will shelter in the temporary refuge on the accommodation platform and may well remain there until any event is over, or at least under control. This issue is not discussed here because the focus is on how an evacuation would be carried out and not on whether one would actually be required.

It is therefore concluded that:

- The proposed windfarm does not impede emergency response on any of the nearby oil and gas installations.
- There will be no need to revise the emergency response sections of the safety case as a result of the proposed windfarm.
- The proximity of the windfarm will not result in the dutyholder of the affected assets breaching any health and safety legislation.

6 POTENTIAL SAFETY CASE IMPACT

6.1 Safety Case Material Change

The relevant legislation governing material change to an offshore installation, or its operation is addressed in Regulation 24(2) of The Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015. A material change is likely to be one that changes the basis on which the original safety case was accepted. Before such a change is made the safety case must be resubmitted to the competent authority for assessment and acceptance prior to the changes taking effect. The onus is on the installation dutyholder (the operator in the case of a production installation) to identify any such changes.

Whether a change to operations is material is generally a qualitative decision, although it may make use of quantitative data. If a change is considered by the dutyholder to be material, then the revision of the safety case will detail the nature of the change and what control measures have been taken to ensure that the risks remain ALARP. As a prudent Operator, Spirit would only submit a material change if they considered the change to be material. Material changes are not submitted just because a change "might be material", though there may be discussion with the HSE on materiality.

6.2 Examples of Material Change

The following are examples of material changes:

- Introduction of a new hazard e.g. hydrogen sulphide caused by the souring of wells.
- An increase in the hydrocarbon inventory e.g. a new subsea tie-back.
- Introduction of a new activity e.g. the use of walk to work to transfer additional personnel to the installation.
- A permanent increase in the number of persons on board.
- A change in owner or operator.
- The extension of use of an installation beyond its original design life.
- The decommissioning of a production installation.

Further examples are given in the paragraph 293 of the guidance to Regulation 24 of the 2015 Safety Case Regulations.

6.3 Likely Impact on the Safety Case

The basis of safety of the installation is not changed by the potential for a slight change in helicopter operations that is considerably less than the natural variation in the activity of the course of a year. This is because:

- From any additional flights required, the change in transportation risk is small (though there are no accepted quantitative criteria to determine materiality – see Section 3).
- No new risk reduction measures can be put in place, and no changes to the way in which operations are carried out other than a change to the definition of safe flying conditions.
- As described in section 4 of this report, short delays to maintenance give a minimal increase in risks and longer term, delays, which are shown to be small by the Working time analysis can be managed in numerous ways.
- Section 5 of this report demonstrates that the presence of the windfarm will not have any material impact on emergency response or to the evacuation of any installation in an emergency.

By comparison, Operators may change the maintenance interval on a SECE by even a factor of two without it being material. DNV is also aware of an operator that changed the way that they flew to their asset from being fixed wing to Shetland and then helicopter, to helicopter from Aberdeen (without the fixed wing segment). This increased the transportation risk, far more than may possibly be the case for Spirit, but no material change was required.

Therefore, it is concluded that the presence of the windfarm will not represent a material change to the Morecambe Bay offshore installation safety cases and thus they will not need to be submitted to the Competent Authority. The safety case will need to be updated to reflect the slight change in operations, but this is a very minor task.

7 FINANCIAL COSTS RELATED TO PROXIMITY OF THE WINDFARM

Outside of the safety questions, there is the potential for increased costs due to delayed helicopters. This may be an additional flight, extra time for persons needing to work around an affected flight and in some circumstances lost production.

7.1 Cost of Lost Production

The following assumptions are made in the calculations contained in this analysis.

- The installations are near the end of their life therefore production is lost rather than deferred.
- Economics of lost production are based on Wood Mackenzie asset reports /13, /14. Wood Mackenzie is a global provider of data and analytics across the renewables, energy and natural resources sectors. This data is consistent with public data available on gas flows into the gas National Transmission System (at Barrow in this case - https://data.nationalgas.com/gas-system-status) and the gas price.
- Calder is assumed to cease production in 2028 and the South Morecambe complex in 2029 (stated by Spirit as 2027 ± 2 years).
- Costs have been calculated for Calder, and South Morecambe. Lost production from DP-6, or DP-8 is likely an order of magnitude less than that from South Morecambe. North Morecambe is unaffected by the proposed windfarm and is therefore not included in these calculations.
- Cost of lost production is based on gross revenues as it is assumed operating costs are incurred even if the installations are not producing.
- It is assumed that there is one day of lost production per year when the inability to get to a NUI means that an outage cannot be resolved. Given the simplicity of the NUIs, the number of possible, direct process related trips causing a shutdown is likely to be minimal and it is more likely that a utility, or safety system trips. However, in these circumstances, there may be no risk in continuing to produce until an intervention (with people) is planned. In this case there is no lost production from a delayed flight. Overall, it is unlikely that a trip or equipment failure requiring a rapid intervention will coincide with bad weather. If this occurs at night, with Blackpool airport not open, it would already not be possible to respond. Further detail would need to be provided on the operation of the NUIs and the equipment on them to test the validity of the one day of additional lost production.
- For CPC-1, it is highly unlikely that a delayed helicopter flight results in lost production. The platform is manned and so most shutdowns can be responded to by the on-board crew. If a specialist item of equipment fails, then a vendor may be required, but they would not be available on stand-by and so the helicopter delay is likely to be irrelevant (and may be more critical the day after, or whenever the vendor is available). Critical spares should be on CPC-1, but in some cases equipment may need to be brought from shore to allow production to recommence, but this can be done by boat almost as easily.

From data the Wood Mackenzie asset reports, Table 5 below gives an estimate of the annual gross revenue (in $) and the lost revenue from a day's lost production.

Year	Gross revenue (£M)		Lost revenue for a day (£M)	
	South Morecambe	Calder	South Morecambe	Calder
2026	[redacted]			
2027				
2028				
2029				
2030	Decommissioned (2027 ± 2 years)			

Table 5: Estimated Cost of Lost Production per Year

The above figures are consistent with those calculated from the cost of gas and the publicly available gas National Transmission System (NTS) entry figures (at Barrow for Morecambe).

7.2 Cost of Additional Helicopter Flights

Regarding helicopter operations, at night or if the weather is IMC at the offshore installation, the flight will not depart from Blackpool and no costs will be incurred. Thus, planning with respect to an accurate weather forecast will minimise the number of helicopters having to return to Blackpool without landing offshore known as return to base - RTB.

Due to the position of CPC-1, RTBs are unlikely. CPC-1 is only 15 minutes flying time from Blackpool and has a weather station with a trained weather observer. There are weather stations to the west and southwest (Ronaldsway Airport, RAF Valley on Anglesey, Dublin, Belfast, Waterford) and so they have excellent forecasts and METARS (a METAR is a now-cast of the weather at a given airport).

No examples of a RTB could be found from the existing Vantage data. Thus, it is concluded that RTBs are a very rare event and thus compensation is very unlikely to become due.

7.3 Cost of Deferred Mobilisation of Vendor Personnel

If vendor personnel experience delays in mobilising or demobilising, then the installation operator will be liable for that vendor's day rate. Using the data from the AviateQ report, 16% of flights may experience a delay or cancellation. Assuming that ten vendors a week visit an offshore installation in Morecambe Bay and assuming they experience a delay that is related to the windfarm 16% of the time, then:

Additional cost = [redacted]

7.4 Cost of Deferred Safety Critical Maintenance

Most safety critical maintenance is carried out by the installation's regular (core) crew. With careful planning, delays to safety critical maintenance can be avoided. However, delays merely mean that the regular crew will carry out the maintenance at a later date, thus no compensation is due to the installation operator.

8 CONCLUSION

The analysis contained in this report reaches the following conclusions, with respect to the effect of the proposed Morecambe Offshore Wind Farm on the current oil and gas operations:

- There is no material increase in risk to personnel from additional helicopter flights.
- Offshore working time at the NUIs is little affected by the MOWF. CPC-1 will be minimally affected as most of the people who carry out SECE maintenance stay there.
- There is no safety impact due to a delay in maintenance of days, or weeks. There would be an impact if any backlog was not mitigated, but Spirit likely have many ways to do this.
- There will be no impact on emergency evacuation and escape from either CPC-1 or any of the NUIs.
- There will be no significant increase in risk to personnel on either CPC-1 or any of the NUIs nor any significant change in the way that the helicopter operations are managed. There will be no new risk reduction measures introduced and no change to the demonstration that the risk is ALARP other than the additional helicopter weather restrictions. Thus, there will be no need to submit a material change to the installation safety case(s). Minor revisions will suffice.
- The highest financial cost to existing offshore installations is the cost of lost production. Assuming one days' lost production in a year, this is estimated to be a maximum of [redacted]. There is also the potential for extra vendor costs if flights are delayed and this may be [redacted] Both figures require additional data from Spirit to be validated.

9 REFERENCES

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/3/ HSE Books, *The Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015*, Guidance on Regulations, L154, first edition

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/11/ Civil Aviation Authority, CAP 999, Helicopter Search and Rescue (SAR) in the UK National Approval Guidance, March 2023

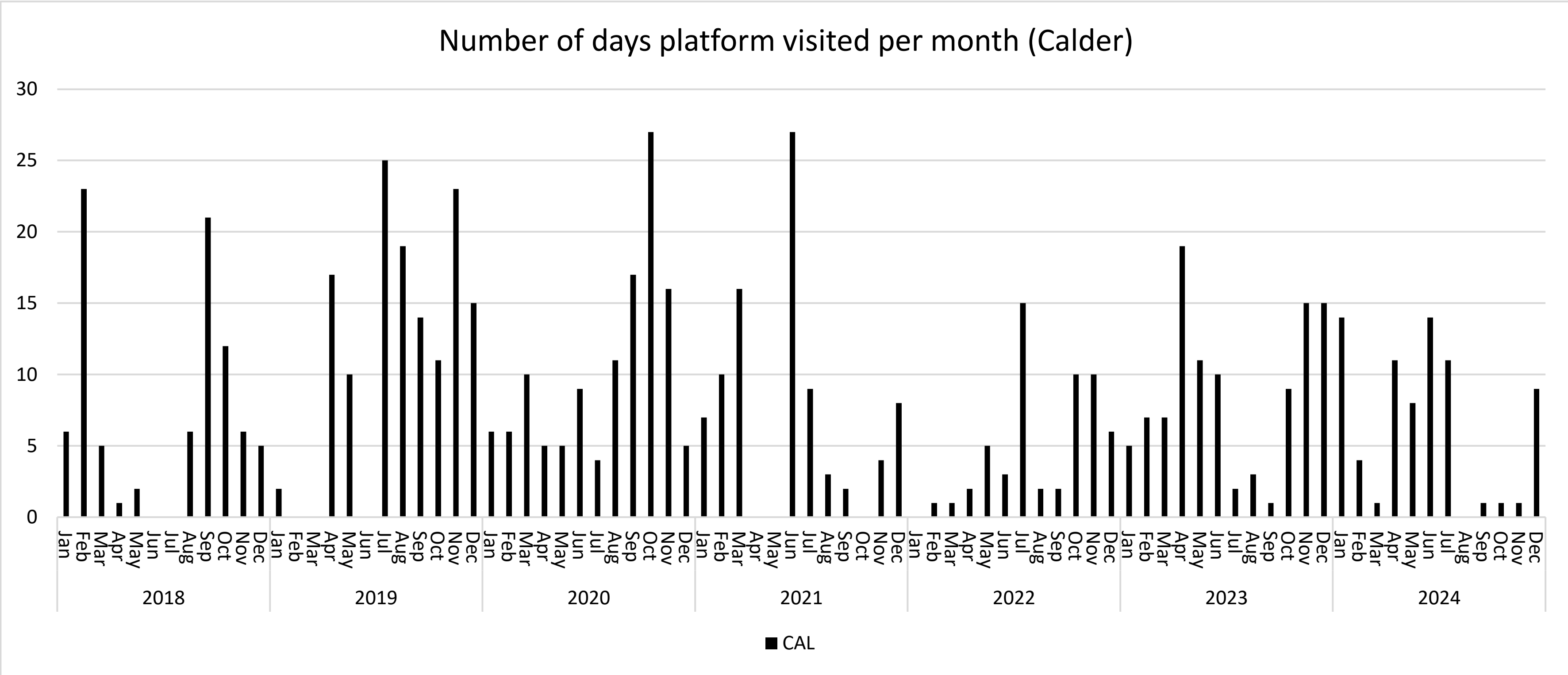
/12/ Maritime and Coastguard Agency, Marine Guidance Note 654 Safety of Navigation: Offshore Renewable Energy Installations – Guidance on UK navigational practice, safety and emergency response, April 2021

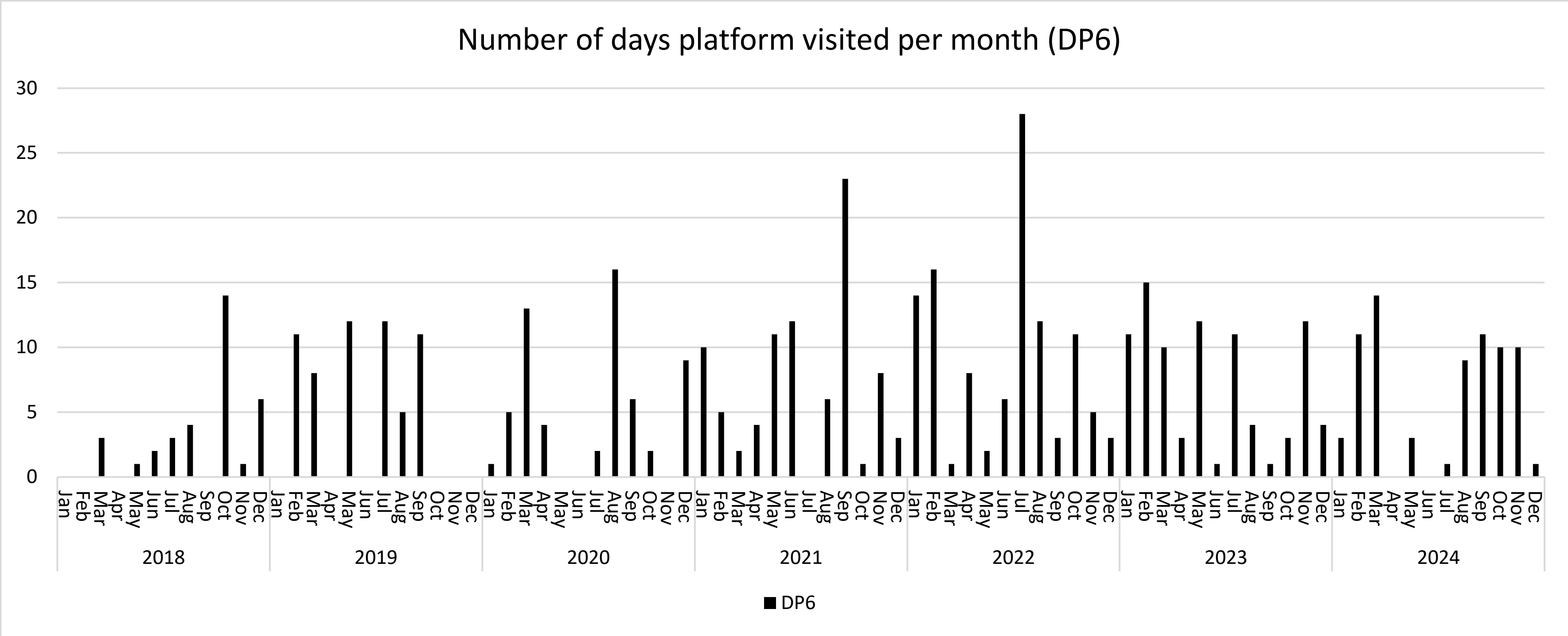
/13/ Wood Mackenzie, Asset Report – Calder, May 2024

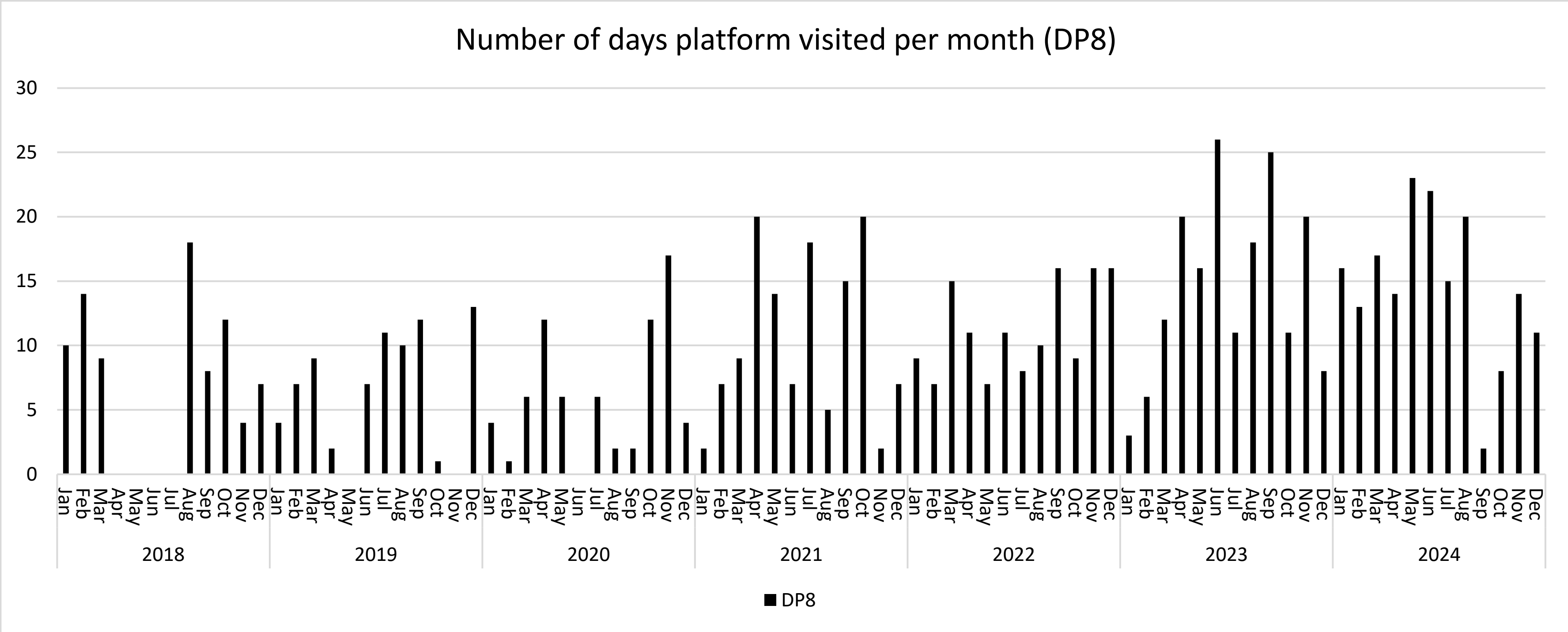
/14/ Wood Mackenzie, Asset Report – South Morecambe, June 2024

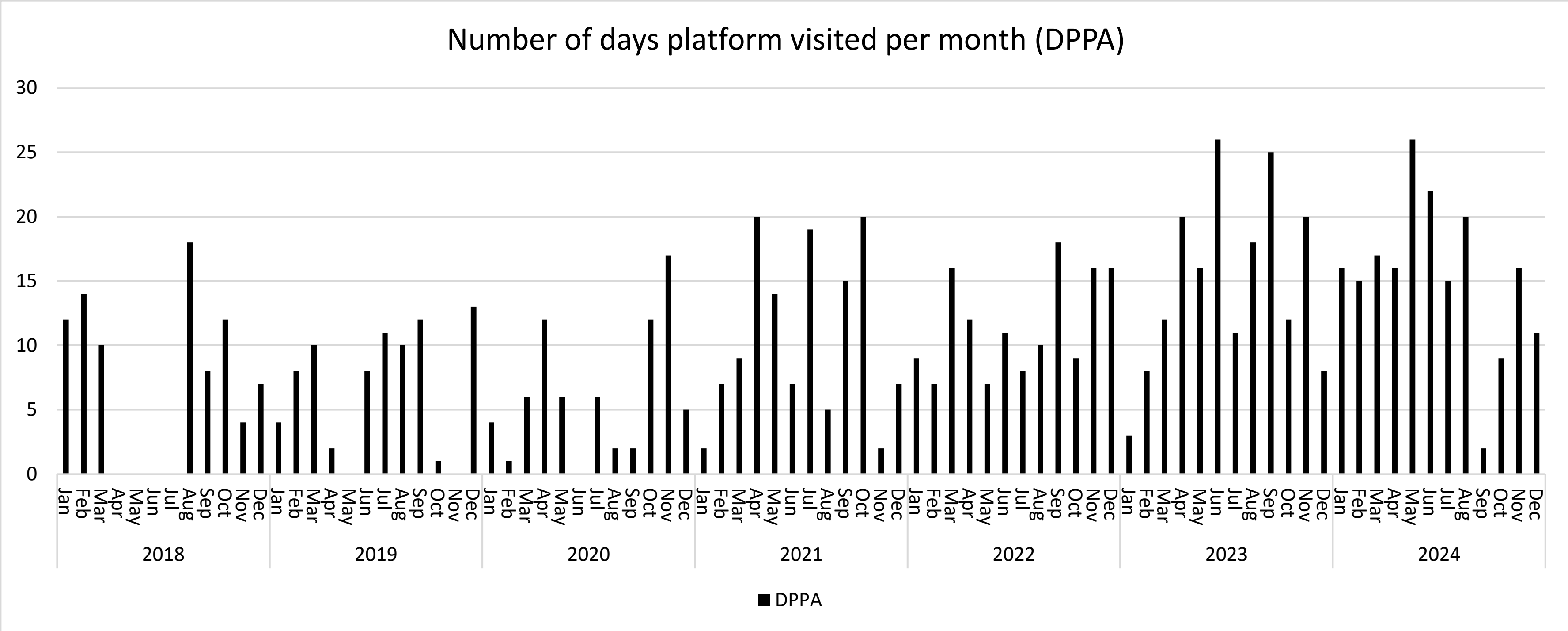
APPENDIX A DIAGRAMS

A.1 VARIABILITY IN FLYING



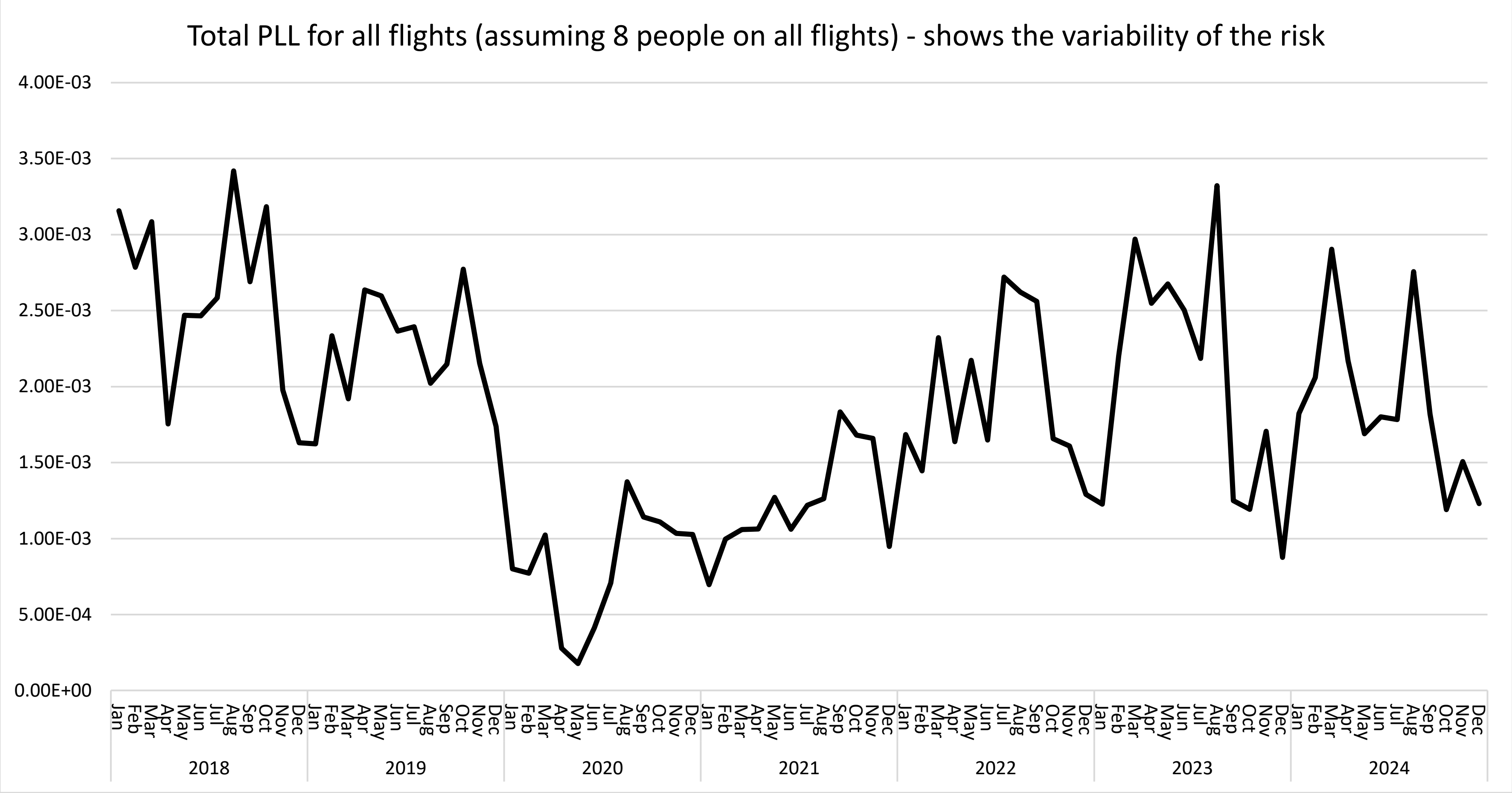

Number of days platform visited per month (DP6)
0
5
10
15
20
25
30
2018
2019
2020
2021
2022
2023
2024
DP6


Number of days platform visited per month (DP8)
30
25
20
15
10
5
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
2018
2019
2020
2021
2022
2023
2024
DP8



Number of days platform visited per month (DPPA)
30
25
20
15
10
5
0
2018
2019
2020
2021
2022
2023
2024
DPPA

A.2 TOTAL PLL FOR ALL HELICOPTER ACTIVITIES



The PLL data excludes sectors from Blackpool to CPC-1 and vica versa.

About DNV

DNV is the independent expert in risk management and assurance, operating in more than 100 countries. Through its broad experience and deep expertise DNV advances safety and sustainable performance, sets industry benchmarks, and inspires and invents solutions.

Whether assessing a new ship design, optimizing the performance of a wind farm, analyzing sensor data from a gas pipeline or certifying a food company's supply chain, DNV enables its customers and their stakeholders to make critical decisions with confidence.

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