Current practice offshore helicopter operations

Helios JIP – WP 1

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1 Background

The maritime industry involves many 24/7 type of operations that often take place in remote areas and require tendering for crew changes and supply. Helicopter operations have become crucial in the operation of these industries because of the increasingly remote areas and the time and hazards involved in ship to ship transfers. The operation of helicopters involves substantial risks of its own which unfortunately sometimes is underlined by, even fatal, incidents.

Specific safety procedures were adopted following dramatic incidents in the early two thousands. The safety procedures have been in place ever since and are being adopted from time to time as insights improve.

The backgrounds of the present situation are not based on scientific facts related to the marine environment. Requirements are limiting helicopter operation availability. Yet safety may still be jeopardized by factors not included in the rules.

The Helios project was started in order to clarify helicopter – ship operation safety, and allow maximizing operability by optimized designs, training and systems. This is to be achieved by better understanding of the procedures and physics involved. The starting point of that work is the state of the art in ongoing helicopter operations.

This report covers a review of the current practice in offshore operations. It provides an overview of stakeholders, responsibilities, regulatory framework and the technologies in use.

2 MARINE HELICOPTER OPERATIONS

2.1 Type of operations

Helicopters have been, and are becoming even more important for marine operations. Typical applications are:

- Offshore installation crew changes and supply
- Emergency assistance and evacuation
- Search and Rescue
- Pilot operations
- Navy missions

2.1.1 Offshore installation crew changes and supply

Offshore facilities are often heavily manned but are at the same time not easy to access by sea. Helicopters are used for decades to avoid hazardous ship-ship or ship-platform transfers.

Figure 1 Offshore installation crew change (photo Bond aviation group)

2.1.2 Emergency evacuation, assistance, search and rescue

On the bigger platforms, helicopters are the primary means of escape in case of emergency. Emergency assistance to ships and structures also is typically done using helicopters. Large helo operation downtime due to ship motions means that escape route in case of evacuation could lead into the sea by freefall life boat, drop chutes, wire lines and life rafts. The cold environment in the North Sea area might then be lethal by exposure if crew is not rescued by standby vessels rapidly.

2.1.3 Pilot assistance

In the shipping world pilots are being brought to ships to enable safe entry into ports. Helicopters are used if pilots are needed on ships far outside the regular pilot station or if weather is too bad for safe ship-ship transfer. If vessels have a helideck than the helicopter can land. If not than the pilot is lowered down by personnel winch.

2.1.4 Navy operations

Navy operations are different from shipping and offshore operations since the helicopter base is in fact the ship. Helicopters in typical offshore operations return to shore in case of conditions being too severe to land on a ship. Navy helicopters return to a ship and will have to set down on the heli deck in any case. Higher motion extremes are accepted in the military. Few passengers are carried. Specific equipment is used to secure the helicopter after touchdown and prevent tipping and sliding incidents.

2.2 Stakeholders / responsibilities

Above paragraph listed the marine areas where helicopters provide essential services. Many parties are involved to provide the service of air transport, a framework of rules and requirements, and the enforcement of these rules. The parties involved have responsibilities for safety on one side and commercial interests for cost efficiency on the other.
Commercial stakeholders providing services to each other are obvious.

- Offshore operators
- Helicopter operators
- Helicopter manufacturers
- Navy's,
- Pilot services

More personally involved stakeholders are the flight crews and transported passengers. Their safety is regulated by a framework of rules laid out by

- HSE,
- CAA and
- HCA.

2.2.1 Responsibilities / Safety

There are in fact no specific mandatory regulations for offshore helicopter operations. In terms of rules they are treated similar as regular land based operations with the exception that the (offshore) landing platform is "recommended" to satisfy a specified set of requirements.

HSE and CAA define the framework of rules for generic helo operation and have a memorandum of understanding in place to deal with offshore operations in particular. A recommended practice document "CAP 437" on heli deck requirements, flight operation, and limitations, is updated regularly. The evaluation of the recommended practice is delegated to the HCA that supervises heli deck conditions on behalf of the helicopter operators. The helicopter operators in the North Sea area only perform flights to platforms with a valid HCA certificate which makes the HCA recommendations the de facto standard rule set in the North Sea.

CAA and HSE have meetings typically twice yearly to discuss and update CAP437 with the objective of increased safety. Industry representatives are invited to attend the meeting.

The HSE leaflet "Appendix 1 - How Offshore helicopter travel is regulated", reviews the responsibilities for safety in further detail. A summary is included here:

"While the Health and Safety Executive (HSE) and the Civil Aviation Authority (CAA) are responsible for regulating safety, the actual ***achievement*** *of safety is the responsibility of all of those on whom the law places a duty, including:*

- *helicopter operators;*
- *flight crews;*
- *installation operators;*
- *offshore workforce.*

Helicopter operators *must satisfy CAA that they continue to meet the requirements for safe public transport passenger operations. They demonstrate this by holding an Air Operator's Certificate (AOC), which requires operators to publish detailed operational procedures in the company's Operations Manual. They are also responsible for the safety briefing of passengers and, in conjunction with offshore duty holders, for providing certain personal safety equipment aboard the aircraft. Helicopter operators have a duty under the Air Navigation Order (ANO) to only permit flights to suitable landing areas. The Helideck Certification Agency (HCA) acts on behalf of the helicopter operators for inspection of all helidecks operating in the UKCS and, together with them, ensures the application of operational limitations and/or restrictions where appropriate.*

Flight crews *are regulated by CAA in various aspects including licensing, training and testing requirements, and flight and dutytime limitations.*

Installation operators *are responsible for the safety of the entire installation, including the helideck and helideck operations. They are required to ensure that the helideck operating environment is such that helicopter operators can discharge their duties.*
Installation operators have control over the physical characteristics of the helideck, the levels and manning of the rescue and firefighting facilities and communications. They are required to ensure that competent personnel are assigned to all activities on the helideck during helicopter operations. They must also have a weather policy in place for passenger safety on the helideck and for passenger survival and rescue in the event of an incident occurring. It is very important that individuals act in a responsible way and comply with requirements specified by helicopter operators and installation operators.

Who regulates the system?

CAA regulates aviation legislation. HSE regulates health and safety law. They work together, with industry and others, to make sure that provisions for safety are as compatible and complete as possible. A Memorandum of Understanding (MOU) exists between HSE and CAA to ensure they work together effectively.

CAA

CAA is a statutory corporation and consists of several groups. The Safety Regulation Group is responsible for regulating the airworthiness and operational safety of an aircraft, including its passengers. Under the Civil Aviation Act 1982, CAA is responsible for the operation of the ANO. This governs the airworthiness of helicopters and the technical and operational requirements that must be met. It also lays down the requirements for the issue of an AOC that helicopter operators must hold if they are to transport members of the public. CAA has no duty under the Air Navigation order to license offshore helidecks. However, to assist helicopter operators and the HCA to discharge their duty under the ANO, CAA provides 'good practice' guidance (known as CAP 437). This includes criteria helidecks should meet and other information enabling operators to comply with their legal obligations. HSE accepts that conformance with CAP 437 demonstrates compliance with their applicable offshore regulations.

HSE

The Health and Safety at Work etc Act 1974 is the main legislation providing for the health and safety of workers offshore. It also brings into its scope earlier legislation developed by the Department of Energy with specific requirements relating to helidecks on offshore installations and helicopter operations. The Offshore Installations (Safety Case) Regulations 1992, among other things, require installation operators to identify all hazards which could cause a major accident, including helicopter accidents, and to take measures to reduce the risks to as low as is reasonably practicable.

2.2.2 Commercial interests

2.2.2.1 Oil companies

Delayed helo operations on existing offshore production facilities will lead to:

1) direct cost for crews staying longer on board (overtime) and replacement crews staying in hotels on standby waiting for flyable conditions.
2) Production delays if wells or riser systems are worked over by smaller support vessels. Delays of the workflow of the support vessel (e.g. diving support and well intervention vessels) will delay re-establishment of production while day rates of the production facility itself but also the support vessel continue.

Feasibility of helicopter operations is becoming of increasing interest for oil companies now that exploration is shifting further into harsh and remote environments. Due to the environmental conditions helicopter workability becomes even less than it is now, threatening overall operational feasibility.

2.2.2.2 Offshore operators.

The interest of offshore operators in helo operations depends on impact of downtime on their contract.
Downtime has a direct impact on the operator costs in case of lump sum contracts. But many vessels are on time charter so fixed day rates are paid even if time is spent to go in for crew change due to weather conditions. In particular specialized vessels typically operate on time charter. The relevance of downtime due to suspended helo operations is therefore not high in these case.

When a vessel has to be chartered for a new contract then higher availability will be beneficial. Vessels with reduced downtime compared to competitors will have a commercial edge since tasks can be completed with less interruptions thus faster. It provides better contract negotiation position and thus better time charter lease contracts.

2.2.2.3 Helicopter operators

Helicopter operators have an interest in increased flight operability as long as it does not increases risk. Increased workability envelope would mean more flights thus more business.

2.3 Offshore helicopter types

Helicopter services have been used by the offshore for many years. In the coming decades offshore energy production will become more and more dependent on helicopter operations leading to an ever growing market of offshore helicopters.
Most of the offshore helicopter types in service today in Europe are manufactured by AgustaWestland, Eurocopter and Sikorsky. Each company offers a range of various helicopters for offshore missions. The helicopter can be equipped with necessary equipment to safely perform offshore missions, for instance Traffic alert and Collision Avoidance System (TCAS), Automatic Voice Alarm Device (AVAD), external life rafts, flotation gear, Automatic Deployable Emergency Locator Transmitter (ADELT), Quick Access Recorder for Helicopter Flight Data Management - and so on.

2.3.1 AgustaWestland

AgustaWestland offers a range of helicopters that can be used for offshore applications which include the AW101 (marketed as EH101), AW139 (marketed as Agusta-Bell AB139), AW169, GrandNew, AW109Power and AW119 Ke. The latest helicopter under development is the AW189. The helicopters are depicted below along with the total amount of passengers that can be carried (pilots not included) and helicopter maximum take-off weight (MTOW).

Figure 2 AW 101
30 passengers, MTOW 15600kg

Figure 3 AW109Power
7 passengers, MTOW 2850kg

Figure 4 GrandNew
7 passengers, MTOW 3175kg

Figure 5 AW119 Ke
7 passengers, MTOW 2850kg

Figure 6 AW 139
15 passengers, MTOW 6400kg

Figure 7 AW169
10 passengers, MTOW 4500kg

Figure 8 AW189 mock-up
16-18 passengers

2.3.2 Eurocopter

Eurocopter offers a range of helicopters that can be used for offshore applications which include the EC135, EC145, EC145 T2, AS365 N3+, EC155 B1, EC225, AS332 L1 and EC175. The helicopters are depicted below along with the total amount of passengers that can be carried (pilots not included) and helicopter maximum take-off weight (MTOW).

Figure 9 EC135
7 passengers, MTOW 2950kg

Figure 10 EC145
11 passengers, MTOW 3585kg

Figure 11 EC145T2
10 seated h/c, MTOW 3650kg

Figure 12 EC155 B1 Dauphin
12 passengers, MTOW 4920kg

Figure 13 EC175
16 seated h/c, MTOW 6700kg

Figure 14 EC225 Super Puma
24 passengers MTOW 11000kg

Figure 15 AS332 L1 Super Puma
19 passengers, MTOW 8600 kg

Figure 16 AS365 N3+ Dauphin
12 passengers, MTOW 4300kg

2.3.3 Sikorsky

Sikorsky Aircraft Corporation offers a range of helicopters that can be used for offshore applications which include the Sikorsky S-61N, the S-76 and the S-92. The helicopters are depicted below along with the total amount of passengers that can be carried (pilots not included) and helicopter maximum take-off weight (MTOW).

Figure 17 Sikorsky S-61 Sea King
19 passengers, MTOW 9298kg

Figure 18 Sikorsky S-76
13 passengers, MTOW 5307kg

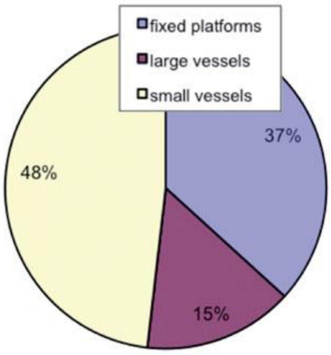
Figure 19 Sikorsky S-92
19 passengers, MTOW 12020kg

2.4 North Sea helicopter operated installations

Approximately 540 helidecks were registered in the Northsea in 2010. Marine structures serviced by helicopter include:

- Fixed platforms
- Large floating structures and vessels (semis, fpso's)
- Smaller support vessels.

The overall number of helidecks is subdivided as listed in



Note that the majority of heli decks (63%) is on moving vessels. Many are smaller vessels which have lesser crew so may not require as many flight operations as the larger vessels and fixed platforms. Still it is clear that many flights will be onto moving platforms indicating the relevance of proper understanding and regulatory framework for these conditions.

2.4.1 Fixed offshore platforms

Figure 20 Fixed platforms

Fixed platforms typically are elevated very high above the waterline. They are not moving so provide a steady landing platform. Wind conditions in combination with the platform design and orientation however may result in turbulence around the heli deck, and exhaust heat plumes that could threaten helicopter engine power.

2.4.2 Large semi submersible installations

Figure 21 Large floating structures

In addition to the parameters listed for fixed platform, the larger floating structures as FPSOs, semi subs, drill ships and pipe laying vessels exhibit wave induced motions. The vessel motions pose a problem for the pilot during the touch down stage since the deck moves but also after that as the helicopter has to follow the ship motions.
Some of the larger structures have weather vaning or DP capabilities enabling optimised choice of heading for helo ops. Effects of wind turbulence and hot gase plumes can thus be minimized. Due to the larger vessel dimensions the induced motions are typically small and have longer periods compared to smaller vessels. The longer periods result in lower accelerations and velocities which is favourable for helicopter operations in comparison to smaller vessels.

2.4.3 Small vessels

Figure 22 Offshore support vessels

Offshore support vessels as anchor handling vessels, well intervention vessels and diving support ships provide services to the bigger structures. Crews can add up to 100 which calls for weekly crew changes. Due to their smaller size they exhibit larger wave induced motions. Prolonged downtime requires the vessel to leave station and call into port. Each port call imposes a one to two day delay on the ships schedule.
Typical vessel dimensions are around 100 meter length. Most common location for the helideck is high up to forward, in order to maximize working deck, and minimize effect of turbulence at the helideck. The vessel are operated under own propulsion or DP and can typically choose optimal heading (into the wind) for helicopter landing.
Heli deck motions are typically dominated by roll, pitch and heave motions. Specifically the roll motions induce transverse displacements where pitch and heave induce large vertical displacements and velocities.
Import difference for smaller vessels compared to larger ones is the lack of visual feedback to the pilot if the helicopter is aligned with the ship into the wind during landing.

2.4.4 classification

Other than with fixed platforms, the landing limits for floating structures are evaluated for motions. The difference in motion characteristics and complicating factors of heli decks of various ship types is given by a classification system. Three categories are recognized:

I Big ships with small and long motions,
II Smaller ships with optimized heli deck configuration
III Smaller ships with poor visual cues

The HCA decides the appropriate category for a ship when a helicopter landing certification is requested. The acceptable motions levels for helicopter landing are defined depending on the classification of the vessels. In this way the classification of the vessels implicitly takes into account factors as:

- the type of the vessel and its typical motion characteristics and periods.
- Location of the heli deck on the offshore structure
- Visual cues during landing

3 OPERATIONAL LIMITS – CRITERIA

Helicopters are often used for sea-based missions, operated for example from ships and oil rigs. Both the maritime conditions and the relatively small landing platforms result in different, often more stringent, demands and requirements. The helicopter operational limitations are defined by

- Helicopter limitations: performance and handling characteristics
- The environment of the platform: obstructions, the turbulent airflow and hot gas flows. In case of floating installations also by its motions and possible spray

3.1 Helicopter operational limitations

Helicopter performance and handling characteristics are dependant on all-up mass, outside air temperature and pressure and relative wind direction and speed. As a result of the latter, the different types of general helicopter limitations can be visualized in a wind rose for landing (1&2) and on deck (3) as shown in Figure 23 (wind speed is shown radially in kts).

1. The first limitation shown is the helicopter power performance at low wind speeds. As the helicopter approaches the helideck it translates from a forward flight into a hover. Due to the helicopter aerodynamic characteristics at low speeds, the power requested from the engines increases as the relative airspeed of the helicopter decreases. In the case of low wind speed conditions the relative airspeed of the helicopter becomes critical.

   In the turbulent ship borne environments, a helicopter requires more power to operate than in land based environments. The combination of a low speed, turbulent airflow above the deck in combination with a heavy helicopter could lead to a situation in which the helicopter becomes underpowered and unable to hover above the helideck (especially in older type helicopters equipped with less powerful engines). In this situation the pilot needs to land the helicopter in one smooth motion. In the case of a moving vessel the pilot needs to be able to follow the heave rate of the helideck and therefore the requested power increases even more typically up to 15% more power could be needed in ship borne operations w.r.t. land based operations.

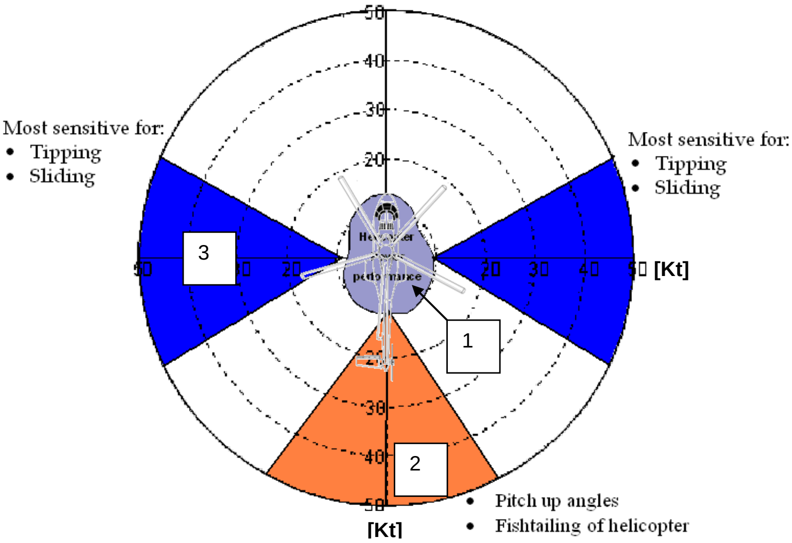


Figure 23 Helicopter limitations as function of relative wind direction and speed

2. The second limitation occurs if the pilot tries to land the helicopter in a tailwind condition. This will normally only occur in the navy and will be avoided in the civil world. Due to the tailwind higher pitch up angles will be needed to hover above the helideck. This will limit the pilot's view and will bring the tail (rotor) closer to the ground which should be avoided to minimise the risk of an inadvertent tail strike (especially in combination with vessel motions). Furthermore, it becomes more difficult for the pilot to decelerate during the approach and to control the heading direction because the helicopter starts to fishtail. Due to these reasons a pilot always tries to land the helicopter with the nose into the wind.

3. Finally, if the pilot lands the helicopter in a crosswind condition the helicopter becomes most sensitive to tipping and sliding once landed. Because of the crosswind condition the rotor lift for minimum pitch on ground (MPOG) increases making the helicopter lighter on the wheels (the increase or decrease in helicopter rotor lift is a function of wind direction and speed). Furthermore, the fuselage drag will be near its maximum. This, in combination with the vessel motions and accelerations, results in a high risk situation for tipping and sliding. For some older helicopter types also tail rotor control problems can be an issue in cross wind conditions.

3.1.1 Fixed installations

Helidecks normally create little turbulence when placed in a wind flow due to the relative streamlined shape. However due to the structures placed around the helideck flow distortion and turbulent wakes occur. Also any hot or cold gas emissions could endanger the helicopter operations (see Figure 24).

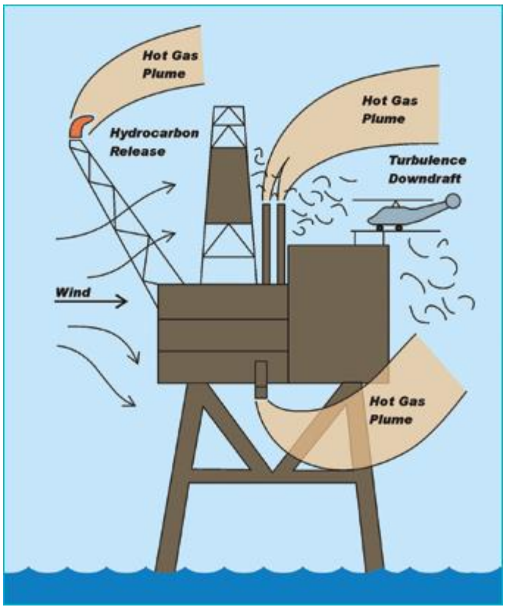


Figure 24 The main elements of aerodynamic flow interaction (Ref. 5)

• The flow around the bulk of the offshore installation itself. Platforms are slab-sided, non-streamlined assemblies ('bluff bodies') which create regions of highly distorted and disturbed airflow in their vicinity
• The flow around large items of superstructure, notably cranes, drilling derricks and exhaust stacks. Like the platform itself, these are bluff bodies, and it is the turbulent wake flows behind these bodies that are important
• Hot gas flows emanating from exhaust outlets and flare systems. This not only causes turbulence but can seriously affect the helicopter performance with loss of engine power at its worst (Source ref. 5).

These phenomena are defined in CAP 437 and are taken to be the limiting conditions for safe helicopter operation.

3.1.2 Floating installations

Besides the aerodynamic effects floating installations and vessels experience dynamic motions due to the ocean waves. These motions (see Figure 25) are a potential hazard to the helicopter, and operational motion limits are set in order to avoid unsafe conditions.

Figure 25 Vessel wave motions definition

The setting of these operating limits should involve consideration of two aspects:
• motion limits for executing a safe landing, and
• limits for safely remaining on the deck for the period necessary to effect passenger and cargo transfer.

The heave motions of the helideck depend on its horizontal location, and on how the vessel's heave, roll and pitch motions combine at that location. The operability of the helideck therefore depends on its location on the vessel or floating installation, both longitudinally and transversely.

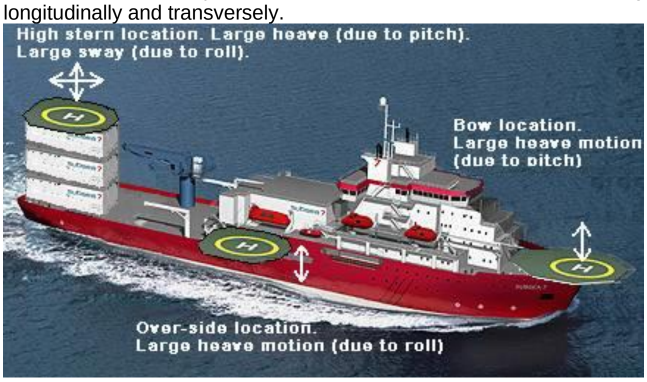


Figure 26 Areas of larger wave motions on a ship-shaped vessel

This location dependence is particularly marked for ships and ship-shaped installations such as FPSOs. The pitching motion of a ship is such that the vertical heave motion experienced by the helideck will generally be much greater if it is located at the bow or stern, and will be least if it can be located amidships.

Helidecks are also often located off the vessel's centreline. In some cases they are cantilevered over the side (which provides the benefit of an unobstructed falling gradient). In this case, helicopter downtime due to wave motions will generally tend to increase because of greater helideck heave motions caused by roll.

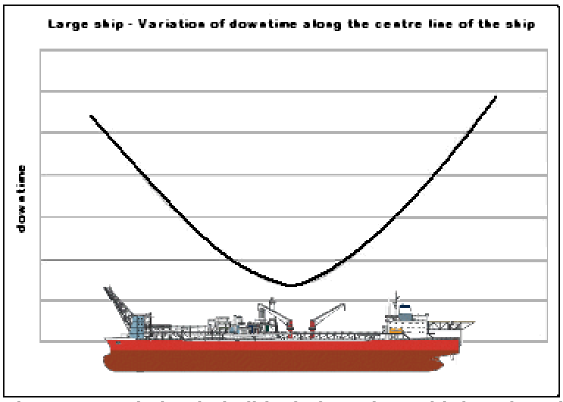


Figure 27 Variation in helideck downtime with location along the length of a large ship (ref.5).

Figure 27 illustrates how wave motion downtime for a helideck typically varies with its location along the length of a large ship (in this case: an FPSO) when operating in a reasonably harsh environment. Maximum downtime occurs when the helideck is located at the bow or stern, and minimum downtime when the helideck is amidships. Variations in downtime in this case are a direct consequence of variations in predicted heave motions (Source ref. 5).

A workability analysis of a bow mounted helideck of an 80m light well intervention vessel in the Northern North Sea has been performed by Marin and is illustrated in Figure 28 (vessel speed 0kts). The downtime analysis is represented by a graph of the workability against the wave direction during the months December till February. The graph shows that the downtime for helicopter operations in winter time, assuming good visibility, varied between 70 and 90% depending on the relative wave direction. This demonstrates the great concern for new technology to improve workability.

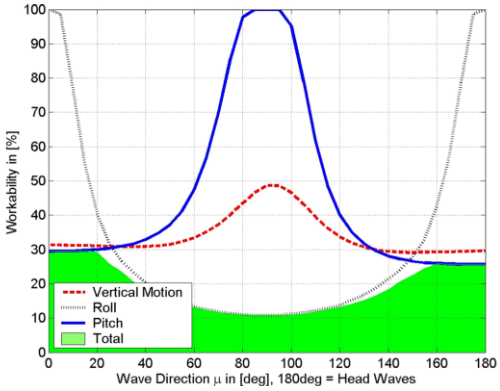


Figure 28 Light well intervention vessel workability from December to February

3.2 Failure modes / incident types

To improve the flight safety the English Civil Aviation Authority (CAA) reports, collects and stores incidents and accidents in the Mandatory Occurrence Reporting Scheme (MORS) since 1976. The objective of the MORS is the prevention of accidents and incidents.

From this MORS database 27 cases that are related to offshore incident and accidents have been extracted by the English CAA. These have been categorized into 6 different subjects as represented in Figure 29.

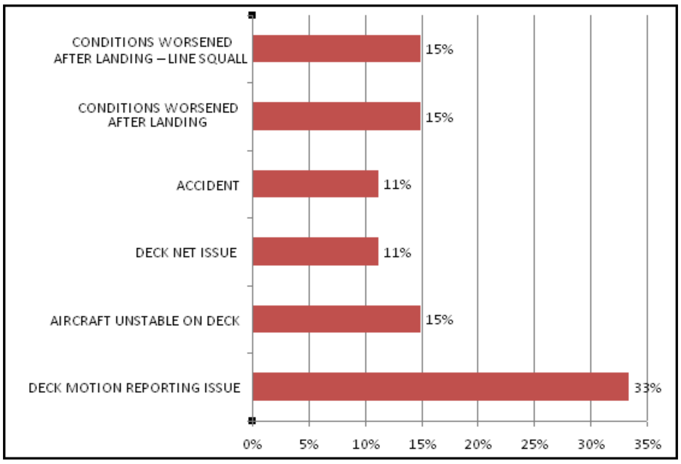


Figure 29 Accidents and incidents from MORS database

This overview reveals that the “deck motion reporting issue” field is by far the most reported incident. The reason for a deck motion reporting issue to occur can be explained due to the different priorities between a vessel operator and a helicopter pilot. The priority of the vessel operator is to remain in operation which can only be achieved through a regular crew change (and supplies). This crew change depends on the helicopter services which are only being deployed if the reported vessel motions are within certain limits. If the vessel operator judges the motions slightly overoptimistic (to ensure the helicopter will be deployed), the helicopter pilot might disagree with the reported vessel motions at arrival. To resolve these reported incidents the helicopter operators requested to install deck motion repeater lights which clearly indicate the landing limits to prevent any misinterpreting. This system is currently being developed and will be validated in the near future through full scale trials; this will not be part of the Helios project.

Another incident that is often reported in the MORS database is the “aircraft unstable on deck” incident. For this on deck stability problem a programme of research is carried out by the CAA which is supported by the HELIOS project and will be further highlighted in paragraph 3.4.

To also obtain an insight in the Dutch situation, a list of incidents has been requested and provided to NLR by the Dutch CAA “Inspectie Leefomgeving en Transport” (ILT, formerly known as IVW) containing 9 incidents that have been reported since 2007.

These incidents have been divided into 6 different categories; an overview is given in Figure 30. Unfortunately it is hard to draw any conclusions due to the limited amount of incidents reported.

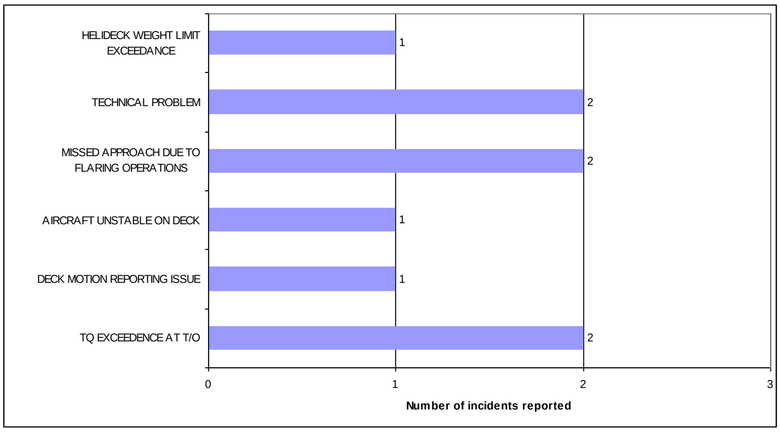


Figure 30 Incidents reports from the Dutch CAA

3.3 Existing landing criteria

In countries around the North Sea, civil aviation authorities and helicopter operators have agreed on limits for safe operation of helicopters to floating offshore vessels. Since the introduction of this regime, no major helicopter deck accidents have occurred in the Norway region. At the same time it is noted that this restriction is limiting several offshore operations in terms of logistics and planning. In the UK the landing limits in the past were based on a maximum heave value of 5m double amplitude but the UK and Norwegian Offshore Helicopter Operators have agreed, through The Helideck Certification Agency (HCA) Technical Committee, to adopt a common helideck classification and a common set of pitch, roll and heave rate limitations. This common standard is effective for all installations in UK and Norwegian waters. This classification is defined in the following table.

Table 1 Operational limitations (ref. 6)

		HELIDECK CATEGORY								
AIRCRAFT CATEGORY		1			2			3		
		P/R	INC	H/R	P/R	INC	H/R	P/R	INC	H/R
HEAVY	DAY	±3	3.5	1.3	±2	2.5	1.0	±2	2.5	1.0
	NT	±3	3.5	1.0	±2	2.5	0.5	±1	1.5	0.5
MEDIUM	DAY	±4	4.5	1.3	±3	3.5	1.0	±3	3.5	1.0
	NT	±4	4.5	1.0	±2	2.5	0.5	±1.5	2.0	0.5

Key:
P/R = Pitch and Roll (deg);
INC = Helideck inclination (deg);
HR = Heave Rate (m/s);

Helideck Category 1 = Compromises semi-submersibles;

Helideck Category 2 = Compromises small vessels;
Helideck Category 3 = Compromises small vessels with poor visual cues;

Aircraft Category Heavy = Compromises h/c in the AS332 series, EC225, SK61 and SK92;
Aircraft Category Medium = Compromises h/c in the AS365 series, EC135, EC155, EC175, S76 series and AW139.

The helideck classification contains three categories based on the actual floating unit's size, configuration and motion characteristics. It simplifies the current HCA classification and is based on the current Norwegian classification.

3.4 On-deck stability

3.4.1 CAA On-deck stability chart

The operational limitations, Table 1, are very useful for the approach and landing phase but are a poor predictor of whether the helicopter will tip or slide once landed on the helideck because this also depends on the environment and deck accelerations. Furthermore, the present limits take no account of wind which can significantly affect on-deck stability.

For this reason a programme of research has been carried out by the CAA to devise and validate a new Motion Severity Index (MSI), based on helideck accelerations, and an associated Wind Severity Index (WSI), (ref. 4). Helicopter operating limits in terms of the MSI and WSI are being established in the form of a chart, representing a safe- and an unsafe zone, see Figure 31.

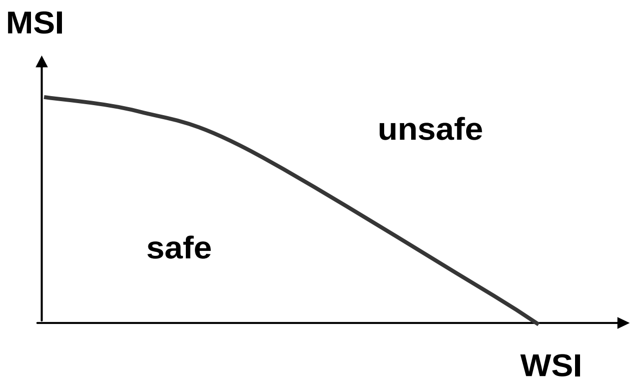


Figure 31 The CAA on-deck stability chart

By limiting the high wind speeds conditions you will lose operation as illustrated in Figure 32. On the other hand, if the on deck stability, at low wind speed conditions, results in higher limits than the current operational limitations you could gain operation. However, high motion limits for the on deck stability phase do not necessarily result into higher operational landing limits. This requires extensive research and acceptance of helicopter operators before implementation occurs. If the area "operations gained" is smaller than the area "operations lost", the overall workability decreases compared to the past situation.

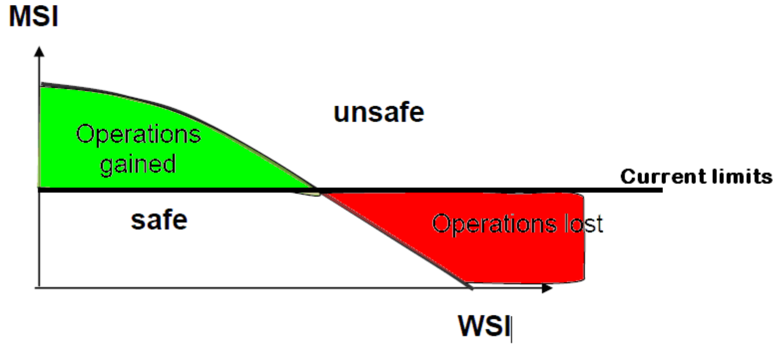


Figure 32 Operations gained and lost

Although the MSI/WSI implementation is improves the on-deck safety it does not necessarily improves the workability. For this reason the HELIOS project will also focus on other potential solutions, like the use of a deck lock system. The deck lock system is successfully used by the RNLN and other navies for many years and could be an alternative for the on-deck stability chart.

3.4.2 Deck lock system

One of the latest RNLN helicopters used for maritime operations is the NHIndustries NH90 NATO Frigate Helicopter (NFH). The NH90 NFH has been equipped with a harpoon which enables it to secure the helicopter to the deck of a vessel. During landing the helicopter connects a harpoon into the grid and pulls the helicopter towards the deck. In rough seas the helicopter remains stable and fixed to the deck due to this deck lock system. The harpoon or deck lock system has a max pull of 80 kN which remains operational within 30 degrees of static roll (ref. 7). The deck lock system has been extensively used by the RNLN with the Westland Lynx helicopter since the seventies.

Figure 33 NH90 NATO Frigate Helicopter
20 passengers, MTOW 11000kg

If this deck lock system could be used for offshore applications it should lead to a higher workability. The disadvantage however is that this would require a one-time extra investment for the installation of the helideck grid system on the vessel and the installation of a deck lock system on the helicopter which also adds extra weight. For many civil helicopters this is possible: EC120, EC135, AW109, AW119, AS365, SuperPuma, Sea King and more (ref. 7). Furthermore, the pilot needs to be familiar with the deck lock system and has to land the helicopter exactly above the helideck grid. If successfully implemented, the potential increase in workability could justify the required investments for the system.

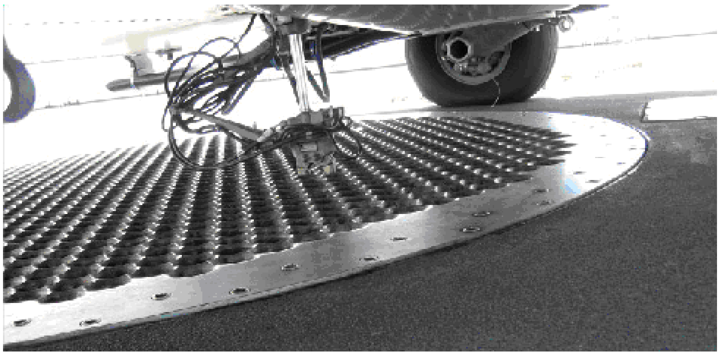


Figure 34 Harpoon locked to deck grid

3.5 Landing phase

The most challenging phase of the flight for a pilot is the landing phase. During the approach the pilot has to have the right altitude, the right airspeed, judge the vessel's motion and be alert for an unexpected engine failure. As normal civil airplanes can rely on an ILS system that will guide them during the landing such an instrumented approach does not exists in the offshore world. Furthermore, if a helideck is mounted on the bow of a vessel the pilot could, depending on the direction of approach, suffer from a lack of view on the vessel motions because the vessel structure is partly/completely outside the pilot's field of view. During poor weather conditions (or at night) judging these motions becomes even more challenging once the horizon is not visible anymore.

Although a (high) bow mounted helideck has a number of disadvantages (but usually also the advantage of a clean aerodynamic environment) many offshore vessels have it installed since it is most often the only available location. One of the activities in the HELIOS project will therefore focus on improving the pilot's view on the vessel motions. Potential solutions that might be investigated are the use of a cockpit display to present the vessel motions, the use of a Helmet Mounted Display (HMD) to visualize the helideck motions and to guide the pilot. This will be evaluated with experienced offshore pilots and further development and testing in the simulator will take place. Figure 31 shows the HMD on the left side and a possible display representing the helideck motions combined with wind conditions on the right side.

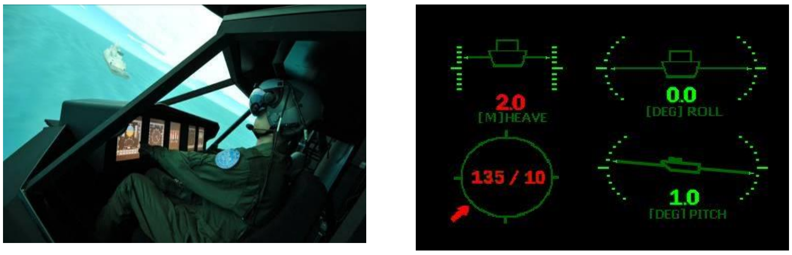


Figure 31 HMD (left) and prototype cockpit display showing vessel motions and wind conditions

Trials in the simulator will take place on a representative small offshore vessel, the Island Frontier, with a bow mounted helideck to simulate this difficult situation. A first impression of the vessel used for simulation can be seen in Figure 36.

Figure 36 Island Frontier vessel (left) and first impression of the simulated vessel

4 OPERATIONAL PROCEDURE

4.1 Approach & Landing

The final landing approach should give an unobstructed go-around path, as far as possible approximately into wind. In strong wind conditions consideration should also be given to adjusting the approach direction to minimize the effect of likely turbulence. Beyond the committal point the pilots' safest option is to continue the landing in the event of a single engine failure, see Figure 37.

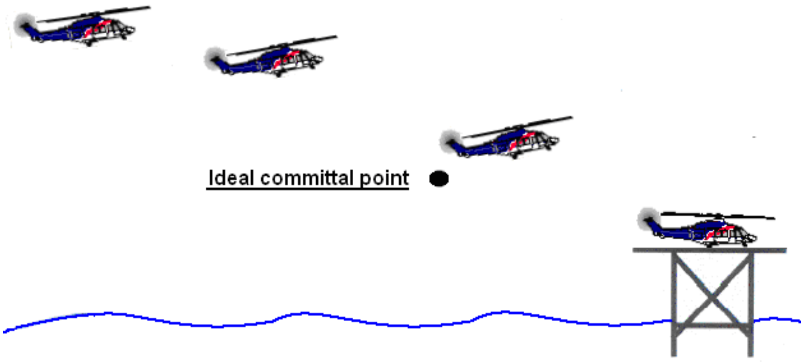


Figure 37 Normal landing procedure offshore

For moving helidecks the optimum landing condition will be with the helideck level and at the top of the heave cycle. Landing with the helideck pitched nose down (dependent on approach direction) should be avoided to minimise the risk of an inadvertent tail strike.

4.2 On-deck

Once the helicopter is safely down on the helideck, the Pilot Flying (PF) will physically monitor the controls at all times and maintain the cyclic and yaw pedals in a central position and collective full down (rotors are running). On moving decks the helicopter should be chocked fore and aft of both main wheels and parking brake should be set.

4.3 Take off

The normal offshore take off profile will be the vertical procedure with a certain Take off Decision Point (TDP) height. The pilot with the best visual reference to the helideck and obstructions should perform the take-off. The Pilot Not Flying (PNF) will monitor the flight instruments to guard against over-rotation or inadvertent descent. He advises whether the aircraft is climbing or descending and monitors the power.

If the helideck is moving, the aim is to make the take-off as the deck comes level at the top of the swell. Taking off with the helideck pitched nose down should be avoided to minimise the risk of an inadvertent tail strike. Sufficient pitch should be applied to get the aircraft light on the wheels and then the power should be positively increased to lift the aircraft directly into climbing forward flight, without pausing in the hover.

5 INCIDENTS

The international association of oil and gas producers publish annual statistics on incidents. The fatalities are reported and broken down per categorie and type of actions performed during the incident. Figure 38 shows the percentage of fatal incidents of transport related events compared to the overall number.

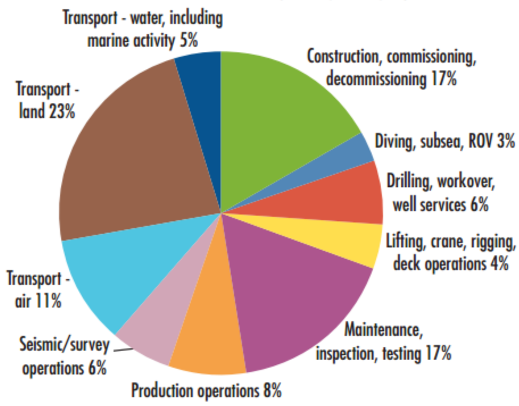


Figure 38 Incident breakdown 2011

The majority of fatal incidents (39%) occurs in transport related events. 11% of the total comes from air transport.

More specifically for helicopter operations following overview is obtained from “OGP - Aviation transport statistics 2010” which is using incident statistics from 1998 thru 2006.

North Sea	Flight Hours				Take-Offs and Landings					Accidents by heli type					Fatals by heli type				
Flight Phase	SE	LT	MT	HT	SE	LT	MT	HT	Accidents	SE	LT	MT	HT	Fatals	SE	LT	MT	HT	Fatalities
In-flight	0	414	341,470	971,320	-	-	-	-	10	0	0	3	7	2	0	0	2	0	18
Take-off	-	-	-	-	-	-	-	-	1	0	0	0	1	0					0
Landing	-	-	-	-	-	-	-	-	0	0	0	0	0	0					0
TO/L	-	-	-	-	0	456	1,284,244	1,066,270	1	0	0	0	1	0	0	0	0	0	0

GoM	Flight Hours				Take-Offs and Landings					Accidents by heli type					Fatals by heli type				
Flight Phase	SE	LT	MT	HT	SE	LT	MT	HT	Accidents	SE	LT	MT	HT	Fatals	SE	LT	MT	HT	Fatalities
In-flight	2,598,714	285,614	719,222	95,609	-	-	-	-	36	30	2	4	0	12	10	1	1	0	27
Take-off	-	-	-	-	-	-	-	-	14	13	1	0	0	3	3	0	0	0	6
Landing	-	-	-	-	-	-	-	-	21	18	1	2	0	4	4	0	0	0	7
TO/L	-	-	-	-	9,812,645	942,850	1,542,599	159,899	35	31	2	2	0	7	7	0	0	0	13

Other	Flight Hours				Take-Offs and Landings					Accidents by heli type					Fatals by heli type				
Flight Phase	SE	LT	MT	HT	SE	LT	MT	HT	Accidents	SE	LT	MT	HT	Fatals	SE	LT	MT	HT	Fatalities
In-flight	401,561	117,569	2,127,399	464,692	-	-	-	-	23	3	1	16	3	17	3	1	11	2	99
Take-off	-	-	-	-	-	-	-	-	8	2	2	2	2	2	1	0	1	0	13
Landing	-	-	-	-	-	-	-	-	15	1	0	11	3	5	0	0	3	2	12
TO/L	-	-	-	-	2,482,319	240,428	5,334,178	832,160	23	3	2	13	5	7	1	0	4	2	25

SE = Single Engine; LT = Light Twin; MT = Medium Twin; HT = Heavy Twin

Figure 39 OGP tabularized incident statistics (2010)

Notably more single engine and smaller helicopters are operated in the Gulf of Mexico and rest of the world compared to the North Sea area. The single engine type operations have higher number of incidents. In terms of incident probability the safety in flight is similar but the hazard during landing comes out close to a factor 6 higher. (Figure 40)

Region	Flight Phase	Frequency	Unit	Prob of fatal incident		Probability of death in incident
North Sea	In Flight	8.5 e-6	per fly hr	0.2		0.85
	Take off / Landing	4.3 e-7	per flight stage	0.17		0.48
Gulf of Mexico	In Flight	8.5 e-6	per fly hr	0.33		0.59
	Take off / Landing	2.7 e-6	per flight stage	0.24		0.49
Rest of World	In Flight	8.5 e-6	per fly hr	0.074		0.87
	Take off / Landing	2.7 e-6	per flight stage	0.24		0.49

Figure 40 OGP Incident probability (2010)

5.1 Review of some historical accidents

Incidents can be rated from smaller to larger ones. Incident could turn into accidents potentially leading to fatalities. Chapter 3.2 mentioned the MOR data bases by CAA's . These are the Mandatory Occurrence Reports that need to be filled out by the crew when situation exceeds prescribed limitations. These can include actual incidents, and obvious near misses but typically also low fuel levels, aborted landings and deviations due to visibility.
A (not complete) review of recent helicopter incidents in the Northsea lists

Figure 41 Westland Navion incident

2001, November 1	Westland Navion incident. Occurred on deck. 1 crewmember injured (broken leg). Caused by DP system heading control failure.
2009, February 18	In flight ditched EC225. All 18 passengers rescued. Pilot error
2009, April 1	In flight crash Super Puma during return flight BP Miller platform. 16 fatalities. Gear box failure detaching main rotor.
2012, May 10	In flight ditched Super Puma EC225. All 14 on board rescued.
2012, October 22	In flight ditched Super Puma EC225. All 19 on board rescued

6 CONCLUSIONS

- Helicopter operations are becoming increasingly important for operations in the maritime and offshore environment.
- Operated ship types vary from very big and mild moving to smaller vessels with severe motion responses.
- Helicopter – ship operations are by nature hazardous
- Transport related incidents pose one of the larger risks to offshore workers.
- Incidents occur both in flight and during take off, landing and on deck
- There is no mandatory regulatory framework for operation of helicopters. Helicopter operation itself is fundamentally treated similar to shore based operation.
- The difference of offshore helicopter operations is thus in the types of helicopters in use (marinized) and the take off, landing and on deck stay offshore.
- Operators are only allowed to fly towards safe landing areas.
- The HCA represents the operators and sets and enforces minimum standards and operational limits. These are historically based on pilot hands on experience.
- In absence of mandatory rules, CAA/HSE formulated good practice guidelines for helideck standards. These are laid out in the CAP437 code.
- Specific hazards threatening helicopter – ship operations are
  - excessive ship motions and inertia loads
  - limited visible information in the landing stage
  - hot exhaust gas induced power loss during landing and take off
  - variability of wind speed and direction due to ship geometry and meteorological effects (shifts, squalls)
- Incidents in the past suggest that the on-deck phase is the most hazardous in terms of number of events in the vicinity of the landing platform.
- The main focus is on safe landing conditions. whose focus?
- The on-deck phase is specifically hazardous as the pilots have a reduced sense of changing conditions and limited options to control the craft without directly endangering personnel on flight deck.
- Acceptable safety levels during the deck phase are assumed when conditions are inside landing limits.
- There is limited scientific background to the limits that are currently in use
- This limits the options that are open to ships, offshore and helicopter designers to optimise their designs for sake of operability.
- Effects that are not covered by existing landing limits remain threatening for safety of helicopter operations since they are not included in decision parameters.
- Since all kinds of possible effects during stay on-deck are implied in the landing criteria, it may be that they are too strict in conditions where these effects are known not to take place.
- Technology available in the military is available to increase safety during the on deck period. It is not applied in civil aviation due to certification.

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8 APPENDIX 1 - HOW OFFSHORE HELICOPTER TRAVEL IS REGULATED